A VALIDATED TOOL FOR ASSESSING TASK-ORIENTED PHYSICAL PREPAREDNESS OF SOUTH AFRICAN EMERGENCY MEDICAL CARE STUDENTS

A thesis submitted in fulfilment of the requirements for the Degree of Doctor of Philosophy: Emergency Medical Care, in the Faculty of Health Sciences at the Durban University of Technology

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2023

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DECLARATION OF ORIGINALITY

This is to certify that the work is entirely my own and not of any other person, unless explicitly acknowledged (including citation of published and unpublished sources). The work has not previously been submitted in any form to the Durban University of Technology or to any other institution for assessment or for any other purpose.

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Date: 30th June 2023

ETHICAL CLEARANCE

This is to certify that this study received ethical approval from the Institutional Research Ethics Committee (IREC) of the Durban University of Technology (DUT) in KwaZulu-Natal.

The ethics clearance number is: **IREC 058/19**

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ABSTRACT

Introduction

This study focused on the development of new knowledge and the delivery of a scientifically defendable, pragmatic tool for the assessment of the physical preparedness of South African emergency medical care (EMC) students. The study was premised on the understanding that emergency care and rescue environments (both operational and training) can be physically demanding, potentially hazardous and are consequently associated with a risk of work-related injuries and illnesses. During their training, EMC students are exposed to a number of different disciplines and learning environments such as mountain rescue; water rescue; confined space rescue; rope rescue; and fire search and rescue. These diverse exposures in turn mean that EMC students require physical abilities and attributes that would allow them to participate successfully in each of the diverse learning experiences and environments they would encounter during the course of their training. For this reason, universities offering emergency care programmes require a suitable assessment tool that is recognised as both a valid and pragmatic way of assessing the physical preparedness of their students.

Aim of the study

The central aim, and unique contribution, of this doctoral study was the development of a valid tool for the assessment of physical preparedness of South African EMC students enrolled in an undergraduate professional Bachelor of Health Science Degree in Emergency Medical Care (BHSc EMC).

Methodology

The study followed an exploratory, sequential mixed methods design, beginning with a literature review that included a review of existing published literature and documentation to contextualise and frame the research. The findings from the literature review were used to inform the development of a purpose designed survey questionnaire which consisted mainly of closed ended questions generating mostly quantitative data. The survey questionnaire was pre-piloted before being distributed to respondents who were emergency medical care students registered for either their third or fourth year of study in the BHSc EMC programme, as well as academic staff members engaged in the teaching of the Medical Rescue and/or Physical

Preparedness modules at the participating higher education institutions (HEIs). The quantitative data from the survey questionnaire was then analysed and the outcomes were used to develop an agenda for follow-on focus group interviews. These, in turn, produced qualitative data to develop a deeper understanding of the research problem and current context. A critical reflection on the findings constructed from the literature review, the questionnaire, and the focus group discussions allowed the researcher to design a specific battery of tests. These tests focused on comparing existing elements and approaches used by the universities for the assessment of physical preparedness to already accepted and validated tests. The final phase of the study involved a sample of students from the participating universities completing the battery of tests that were specifically selected for the study. Analysis of, and critical reflection on the students' performance in the testing phase of the study as well as pragmatic considerations relating to the setting up and conducting of each test in the EMC student education context were then used to develop, refine and defend the final physical preparedness tool proposed by the researcher.

Results

The research found that there is support from both the academic staff and emergency medical care students for universities offering emergency care programmes to develop, maintain and assess an EMC student's level of task-oriented physical preparedness using a standardised validated tool. Out of the 117 emergency medical care students who completed the survey questionnaire, 73/117 (62.4%) strongly agreed and 40/117 (34.2%) agreed that it is important for a BHSc EMC student to be physically fit. Similarly, 10/12 (83.3%) of the academic staff strongly agreed that the BHSc EMC student must be physically fit, and 2/12 (16.7%) agreed. The focus group interviews allowed the researcher the opportunity to explore three important concepts that had been identified during the survey questionnaires in more detail. It was agreed by both the academic staff and emergency medical care student participants that the physical preparedness assessment should be standardised and that the tool should be "user friendly" and pragmatic considering the EMC education context. The study found that a physical performance test with absolute standards is best suited to assess the level of task-oriented physical preparedness of BHSc EMC students in the context of general physical fitness.

Cardiovascular endurance (aerobic capacity); muscular endurance; muscular strength; flexibility, and swimming aerobic capacity were identified as the components of fitness essential for an EMC student to engage successfully with the physically strenuous content of the BHSc EMC programme. The tool that was developed and validated by the researcher to assess the essential components of fitness for EMC students includes a modified sit-and-reach test; a flexed-arm hang test; the maximum push-up test; the seven-stage abdominal strength test; a grip strength test; a 5km run test and a 200m swim test.

Conclusion

EMC students are exposed to a number of different rescue disciplines and learning environments during the course of their undergraduate education and training. A minimum level of physical preparedness is required to support successful participation in the associated learning activities. Universities offering emergency care programmes are therefore required to formally assessment the level of physical preparedness of their students. The tool used for such an assessment should be shown to be valid and pragmatic. A physical performance test with absolute standards comprising a battery of tests that include a modified sit-and-reach test; a flexed-arm hang test; the maximum push-up test; the seven-stage abdominal strength test; a grip strength test; a 5km run test and a 200m swim test is a pragmatic, scientifically validated tool for the assessment physical preparedness of EMC students.

Further research needs to be conducted to develop norms and standards for each of the tests making up the developed tool, including studies that explore the impact and success of different approaches relating to the use of physical fitness testing as a selection/entry requirement for EMC programmes including the approaches to facilitation of physical fitness education and training within local BHS EMC programmes.

Keywords: physical fitness, physical performance, physical tasks, occupational fitness, fitness for duty, paramedic, emergency medical care; emergency responder

DEDICATION

This thesis is dedicated to:

My husband, Reghard, who has always supported me with my education, profession, and life. Without your support I would not have been able to achieve what I have achieved to date, and I am forever grateful for all your love and support in this journey.

My four-legged companions, Daisy, Holly, Danny, Kittie, and Finn, who loyally sat by my side through all of the long days and nights whilst I worked on this thesis.

ACKNOWLEDGEMENTS

Throughout my doctoral degree journey, several people have provided me with the support and guidance needed to complete this thesis. I am tremendously thankful to each one of you.

To Prof. Craig Vincent Lambert and Prof. Yoga Coopoo, my supervisors. Without your patience and support this research would never have been completed. Thank you so much for your guidance and motivation throughout the process. You were both always just a phone call away, and I could never thank you enough for your input in this process.

To Dr Gill Hendry, my statistician, Ms Ethel Ross, my language editor and Ms Erica Webster, my formatting and layout designer. Thank you for your insights, guidance, and effort throughout this process.

Lastly, to the academic staff and emergency medical care students that volunteered to participate in all the different phases of my data collection process. This research would not have been possible without your valuable participation, and for this I am forever grateful.

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PUBLICATIONS AND/OR PRESENTATIONS RELATED TO THIS STUDY

CONFERENCE PRESENTATIONS

Mühlbauer, D., Vincent-Lambert, C., Coopoo, Y. 2019. Task-oriented physical preparedness and the assessment of South African emergency medical care students. Paper read at the 10th International Conference on Sport and Society held in Toronto, Canada, from 20–21 June 2019.

PUBLICATIONS

Mühlbauer, D., Vincent-Lambert, C., Coopoo, Y. 2021. Emergency Care Education in South Africa and the Unique Requirement of Physical Preparedness: A Scoping Review. Australasian Journal of Paramedicine, 18 (18): 1–6.

PAPERS IN REVIEW AND PREPARED FOR SUBMISSION

Mühlbauer, D., Vincent-Lambert, C., Coopoo, Y. The perceptions and views of academic staff and students regarding the assessment of physical preparedness in emergency medical care students in South Africa. Submitted to Occupational Health Southern Africa for review in June 2023.

Mühlbauer, D., Vincent-Lambert, C., Coopoo, Y. Correlation between validated fitness tests and an existing physical preparedness assessment among undergraduate emergency medical care students in South Africa. Preparing for submission to Paramedicine for review in July 2023.

Mühlbauer, D., Vincent-Lambert, C., Coopoo, Y. The ideal type of physical preparedness assessment to determine the physical preparedness of emergency medical care students in South Africa. Preparing for submission to Strength & Conditioning Journal in July 2023.

LIST OF ACRONYMS

ACSM	American College of Sports Medicine
BEMC	Bachelor's Degree in Emergency Medical Care
BHSc EMC	Bachelor of Health Science Degree in Emergency Medical Care
BMI	Body mass index
CHE	Council on Higher Education
CPR	Cardiopulmonary resuscitation
DUT	Durban University of Technology
ECP	Emergency Care Practitioner
EMC	Emergency medical care
EMS	Emergency medical service
HART	Hazardous Area Response Team
HEI	Higher education institution
HOD	Head of department
HPCSA	Health Professions Council of South Africa
IREC	Institutional Research Ethics Committee
NFPA	National Fire Prevention Association
NQF	National Qualifications Framework
NSRI	National Sea Rescue Institute
PBEC	Professional Board for Emergency Care
PE	Physical Education
PES	Physical Employment Standard
RPE	Rating of perceived exertion
SAQA	South African Qualifications Authority
SORT	Special Operations Response Team
SPSS Statistics	Statistical Package for the Social Sciences
UK	United Kingdom
US	United States
WHO	World Health Organization

GLOSSARY OF TERMS

Absolute standards:

Absolute standards require the same level of physical performance from a participant irrespective of any of the demographic criteria such as age and sex (Cooper 2014).

Advanced life support:

Advanced life support refers to a level of care which may be provided within the Paramedic, Emergency Care Technician (ECT) or Emergency Care Practitioner (ECP) scope of practice as determined by the Health Professions Council of South Africa in terms of the Health Professions Act (South Africa, PBEC 2002).

Age- and gender-based normative standards:

Age- and gender-based normative standards set physical performance standards, dependent on an individual's age and sex: i.e. the fitness standard for a 20–29-year-old male would differ from that for a 20–29-year-old female (Cooper 2014).

American College of Sports Medicine (ACSM):

The American College of Sports Medicine (ACSM) represents 70 sports medicine professions and has more than 50 000 members and certified professionals from 90 countries. The ACSM is responsible for helping people to live longer, healthier lives, worldwide, by advancing and integrating scientific research in order to provide educational and practical applications of exercise and sports medicine (American College of Sports Medicine 2023).

Bachelor of Health Science Degree in Emergency Medical Care (BHSc EMC):

The BHSc EMC is a four-year professional bachelor's degree which is offered at higher education institutions (HEIs) in South Africa. The purpose of this qualification is to develop an Emergency Care Practitioner (ECP) competent in the clinical knowledge and skills required for the emergency medical care and medical rescue profession. A graduate with this qualification will be eligible for registration as an Emergency Care Practitioner with the Health Professions Council of South Africa (HPCSA) (Professional Board for Emergency Care 2019; SAQA 2015).

Council on Higher Education (CHE):

The Council on Higher Education (CHE) is the independent statutory quality council for South African higher education (Council on Higher Education 2023).

Diploma in Emergency Medical Care:

The Diploma in Emergency Medical Care is a three-year diploma which is offered at HEIs in South Africa. The purpose of this qualification is to develop a mid-level worker, leading to registration as a Paramedic with the HPCSA. The diploma produces healthcare professionals with the focused knowledge, skills, applied competence, and professional attributes required for rendering quality emergency medical care and rescue services to diverse communities within a South African context (Council on Higher Education 2022).

Emergency care:

Emergency care is defined as the rescue, evaluation, treatment and care of an ill or injured person in an emergency situation, inclusive of the continuation of treatment and care en route to definitive care (South Africa, PBEC 2002).

Emergency Care Practitioner (ECP):

Graduates of the four-year BHSc EMC programme offered at HEIs register with the HPCSA as Emergency Care Practitioners. The list of capabilities these graduates have includes advanced clinical procedures, such as thrombolysis and rapid sequence induction, as well as competence in the 12 Medical Rescue modules (Professional Board for Emergency Care 2019; South Africa, Department of Health 2017).

Emergency medical services (EMS):

These are organisations, bodies and services which are dedicated, staffed and equipped to operate ambulances, medical rescue vehicles and medical response vehicles to provide out-of-hospital treatment for illnesses and injuries that require an urgent medical response and transport to definitive care (South Africa, Department of Health 2017).

Emergency Responder:

This is a person employed by an organisation as either a police officer, firefighter, emergency care provider or lifeguard (Farlex 2018).

Health Professions Council of South Africa (HPCSA):

The Health Professions Council of South Africa is a statutory regulated body established in terms of the Health Professions Act, 1976 (Act No. 56 of 1974), which is mandated to provide guidance to registered healthcare practitioners on aspects of education, professional conduct, ethical behaviour and registration (Health Professions Council of South Africa 2018).

Higher education institutions (HEIs):

Higher education institutions (HEIs) are accredited providers of postsecondary education, such as universities, universities of technology, colleges and polytechnics (Council on Higher Education 2016).

National Qualifications Framework (NQF):

The NQF consists of three components: basic education, further education and training and higher education. The NQF also assigns level descriptors (one-to-ten) to qualifications to indicate the educational level of achievement necessary to obtain a specific qualification (SAQA 2023a).

Paramedic:

Graduates of the three-year diploma programme offered at higher education institutions register with the HPCSA as Paramedics. In addition, emergency care providers who hold either the Emergency Care Technician or Critical Care Assistant certification are also eligible for registration on the Paramedic register with the HPCSA (South Africa, Department of Health 2017).

Physical activity:

Physical activity can be defined as any bodily movement which is produced by the contraction of skeletal muscles resulting in an increase in energy expenditure above base level (Vuori 1998).

Physical employment standards (PESs):

A physical employment standard (PES) identifies a minimum level of physical fitness which is required in order to perform critical and essential, profession-specific, tasks. A PES must be job-related and it must be scientifically valid; that is, the test must measure what it is intended to measure (Siddall *et al.* 2021).

Physical fitness:

Physical fitness is a state of good health and the ability to perform sports, occupations and daily activities. Physical fitness is broadly divided into two categories: a) general physical fitness for health benefits; and b) task-oriented or sport-oriented fitness, be it for sporting performance or physical preparedness for work-specific tasks. General physical fitness refers to a general state of health and well-being. Specific task-oriented fitness deals with the degree to which an individual is able to cope with the physical demands of their chosen profession without excessive fatigue (Tremblay *et al.* 2010; Vinciguerra *et al.* 2013).

Physical performance tests:

Physical performance tests make use of validated fitness tests to test the components of fitness, such as cardiovascular endurance and muscular strength, which would be required to engage successfully in the required operational tasks by the participants (Nazari *et al.* 2018). Physical performance tests were utilised in the assessment of physical preparedness phase of this study.

Physical preparedness:

In the context of this study, physical preparedness is to be read as an overarching term that includes task-oriented fitness and/or task-oriented physical preparedness.

Professional Board for Emergency Care (PBEC):

The Professional Board for Emergency Care was established in terms of the Health Professions Act, 1974 (Act no. 56 of 1974) and was constituted in terms of the regulations relating to the Constitution of the Professional Board for Emergency Care contained in Regulation No. R 1254 of 28 November 2008. The following professions are regulated by the PBEC: Basic Ambulance Assistant; Ambulance Emergency Assistant; Operational Emergency Care Orderly; Emergency Care Assistant; Emergency Care Technician; Paramedic and Emergency Care Practitioner (Health Professions Council of South Africa 2023).

South African Qualifications Authority (SAQA):

The South African Qualifications Authority (SAQA) is responsible for advancing the objectives of the NQF, developing and implementing the NQF, and co-ordinating the NQF sub-frameworks (SAQA 2023b).

Task-simulated tests:

A task-simulated test is a physical fitness test which consists of a variety of profession-specific simulated tasks, such as a firehose drag and stair climb with a high-rise pack in order to assess operational-specific physical fitness in the context of firefighters, or the performance of chest compressions, the carrying of gear and lifting of a patient in the context of an emergency care provider (Mthombeni, Coopoo and Noorbhai 2021; Nazari *et al.* 2018).

Task-oriented physical preparedness:

Task-oriented physical preparedness deals with the degree to which an individual is able to cope with the physical demands of their chosen profession, i.e. are they physically prepared to engage with the daily tasks associated with their occupation of choice? This is also known as occupational physical preparedness (Siddall *et al.* 2021).

VO_2max:

This is a measurement of an individual's aerobic capacity and it is the maximum volume of oxygen consumed per minute during exercise. It is also referred to as maximal oxygen uptake or maximal oxygen consumption (American College of Sports Medicine 2018).

CHAPTER 1: OVERVIEW OF THE STUDY

1.1 INTRODUCTION

This first chapter of the thesis is intended to provide a background and context to the research problem, aim, objectives and methodological approach. The chapter begins by describing the research problem within the context of emergency care education and task-oriented physical preparedness, internationally and locally. Thereafter, the problem statement, research questions, aim and objectives are discussed. Chapter 1 also deals with the envisaged significance and value of the study, before providing a brief introduction to the selected design and methods utilised, both of which are described and defended in greater detail in Chapter 4. Chapter 1 concludes by providing an overview of the layout and structure of the thesis and the chapters to follow.

1.2 BACKGROUND

This study took place within the broad domain of health professions education in the discipline of emergency medical care (EMC). The study focused on the development of new knowledge and the delivery of a scientifically defendable tool and pragmatic approach to the assessment of physical preparedness of South African EMC students. The study was premised on the understanding that emergency care and rescue environments (both operational and training) can be physically demanding, potentially hazardous and are consequently associated with a high number of work-related injuries and illnesses (Reichard, Marsh and Moore 2011).

1.2.1 Emergency care education

At present two programmes within the South African context include EMC and medical rescue education and training as part of the curriculum. These are the two-year diploma in EMC (NQF 6) and the four-year professional bachelor's degree in emergency medical care (NQF 8) (Vincent-Lambert, Bezuidenhout and Jansen van Vuuren 2014). The focus of this doctoral study was on the development and validation of a tool that can be used by educators to assess task-oriented physical preparedness of South African EMC students enrolled in the undergraduate professional Bachelor of Health Sciences Degree in Emergency Medical Care (BHSc EMC).

The curriculum for the BHSc EMC has been approved by the Council on Higher Education (CHE) and the Professional Board for Emergency Care (PBEC) (Council on Higher Education 2016; Professional Board for Emergency Care 2019). The two core modules for the BHSc EMC are EMC and Medical Rescue, and this is reflected in the qualification document, which is registered with the South African Qualifications Authority (SAQA) (SAQA 2015). At the time of this study, the BHSc EMC programme was presented at four higher education institutions (HEI) within South Africa. As far as the researcher is aware, the South African BHSc EMC programmes are unique, and no international qualifications could be found that produce graduates with both pre-hospital emergency medical care and medical rescue competencies.

Taking the above into account, it is logical that higher education institutions (HEIs) offering EMC programmes are responsible for the development, maintenance and assessment of both their academic staff and their students' levels of task-oriented physical preparedness. Fulfilment of such a responsibility becomes problematic in the absence of a scientifically validated tool to inform and guide such assessments – hence the need for this study, in which the researcher develops and describes a validated tool for assessing task-oriented physical preparedness of South African EMC students.

1.2.2 General physical fitness

Within the context of this study, broadly speaking, physical fitness is seen as a state of good health and the ability to perform sports, occupations and daily activities (Tremblay *et al.* 2010). The purpose and value of being physically fit is multifactorial. Multiple studies confirm that regular physical activity reduces the risk of at least 25 chronic medical conditions, including hypertension, coronary heart disease, stroke, diabetes, various types of cancer, and depression, as well as reducing the risk of premature mortality. It also improves bone and functional health, which may reduce the risk of falls leading to hip or vertebral fractures. Additional benefits of regular physical activity include improved muscular and cardiorespiratory fitness and maintenance of a healthy body weight (Warburton and Bredin 2017; WHO 2024). The World Health Organization (WHO) states that higher levels of physical activity in children, adolescents and adults not only yield physical benefits, but can also improve cognitive outcomes, such as academic performance and executive function. Physical activity also aids in alleviating the symptoms associated with anxiety and depression

(WHO 2024). Being physically fit allows the body to function effectively, efficiently, and healthily, in various activities, avoiding and limiting injury and illness, as well as (in the context of this study) being able to function effectively in emergency situations. A state of physical fitness is usually achieved through proper nutrition, physical exercise and rest (Corbin and Pangrazi 2012).

Physical fitness may be divided into two categories: a) general physical fitness for health benefits and b) task-oriented or sport-oriented fitness, be it for sport performance or physical preparedness for work-specific tasks (Vinciguerra *et al.* 2013). General physical fitness refers to a general state of health and well-being. Specific task-oriented fitness deals with the degree to which individuals are able to cope with the physical demands of their chosen professions without excessive fatigue (Vinciguerra *et al.* 2013). This study focused predominantly on task-oriented fitness. This study uses the term '*physical preparedness*', which is to be read as an overarching term that includes task-oriented fitness.

A substantial body of literature addresses the physical preparedness requirements and related assessments for paramedics, military personnel, police officers and firefighters (Barnekow-Bergkvist *et al.* 2004; Chapman *et al.* 2015; Claessens *et al.* 2003; Davis, Dotson and Santa Maria 1982; Hunter, MacQuarrie and Sheridan 2019; Michaelides *et al.* 2011; Noh *et al.* 2018; Ružbarská and Turek 2010a; Stevenson *et al.* 2017; Thornton and Sayers 2014). However, comparatively less literature focuses on the assessment of physical preparedness for emergency care providers who engage in both EMC and medical rescue as part of their operational duties. This limited information is seen to be problematic, as it is the emergency care provider who is commonly required to deliver EMC and rescue services, both during the time they are students engaging in their academic programmes, and later as graduates fulfilling their operational duties.

The delivery of EMC and rescue services is recognised as a challenging, potentially hazardous, undertaking (Reichard, Marsh and Moore 2011). Thus, emergency service employers are placing an increased emphasis on developing and assessing task-oriented fitness in their operational staff. A study by Mthombeni, Coopoo and Noorbhai (2020) researched the fitness of a group of emergency care providers in the North West Province in South Africa. The results showed poor levels of physical fitness and this was seen to negatively impact the work performance of these workers (Mthombeni, Coopoo and Noorbhai 2020a).

1.2.3 Task-oriented physical preparedness

This study focused predominantly on task-oriented fitness and this study uses the term '*physical preparedness*', which is to be read as an overarching term that includes task-oriented fitness. General physical preparedness refers to an individual's ability to carry out daily tasks with vigour and readiness, and without undue exhaustion (American College of Sports Medicine 2018); whereas task-oriented physical preparedness deals with the degree to which individuals are able to cope with the physical demands of their chosen profession: i.e. are they physically prepared to engage with the daily tasks associated with their occupation of choice? As an example, is a paramedic able to cope with physically demanding tasks such as loading and unloading a patient, pushing and pulling a stretcher, carrying a patient and their medical equipment, as well as performing cardiopulmonary resuscitation? (Aljaloud 2018; Armstrong *et al.* 2019b; Mthombeni, Coopoo and Noorbhai 2021; Waack, Meadley and Gosling 2023). The advantages of employee wellness and occupational fitness programmes are well documented, with the central aims being to reduce the number and severity of injuries, and resultant absenteeism, in the workplace, and to increase work capacity (Reichard, Marsh and Moore 2011). Aside from the personal benefits associated with fitness and exercise, healthy persons who are physically prepared for their work environments are more effective and less likely to become fatigued (Claessens *et al.* 2003).

There are requirements and assessment tools to determine the task-oriented physical preparedness for vocations such as firefighting, policing, security and the military. Such assessments are naturally focused on assessing specific physical abilities and attributes that are seen to be required for the successful performance of the duties related to each particular vocation (Baek *et al.* 2018; Gumieniak, Gledhill and Jamnik 2018; Leyk *et al.* 2017).

A unique challenge is faced when it comes to the assessment of the physical preparedness for EMC students in that, during the course of their training, they are exposed to a number of different disciplines and learning environments, such as mountain rescue; water rescue; confined space rescue; rope rescue, and fire search and rescue. These diverse exposures in turn mean that EMC students require physical abilities and attributes that allow them to participate successfully in each of the diverse physically strenuous learning experiences and environments they could encounter during the course of their training. For this reason, universities offering emergency care programmes require a suitable assessment tool that is recognised as a pragmatic and valid way of assessing the physical preparedness of their students.

1.2.4 Assessment of task-oriented physical preparedness

At the time of the study, the local practice was that all of the HEIs offering the BHSc EMC programme ensure that their EMC students undergo some form of physical preparedness assessment. However, these assessments are not nationally standardised, and most are not geared to address the specific task-oriented physical requirements linked to the unique BHSc EMC programme.

In 2015, in an attempt to design a more scientific and defendable physical preparedness assessment, academic staff from a South African university offering both EMC and Sport and Movement Studies analysed the physical preparedness requirements of the BHSc EMC programme. Through collaboration between the EMC and Sport Sciences departments, a physical preparedness assessment tool was developed for EMC students (Vincent-Lambert, Coopoo and Van Nugteren 2022).

The assessment consists of three components: 1) a timed 200m swim; 2) a timed 5km run and 3) a flexed-arm hang test. This assessment subsequently found favour and anecdotal support from the academic staff and EMC students at three of the HEIs offering the BHSc EMC programme. Despite its widespread adoption, the assessment had not been subjected to scientific scrutiny to validate its ongoing use. This study aimed to address this knowledge gap through an in-depth critical analysis and evaluation of the desired physical attributes and abilities of EMC students, linked to their unique curriculum and associated learning experiences. This would provide the foundational knowledge required for the development and validation of a tool for the assessment of the task-oriented physical preparedness of South African emergency medical care students.

1.3 PROBLEM STATEMENT

The BHSc EMC programme is unique in that an EMC student is required to master, not only the generic academic outcomes seen in all higher education programmes, but also specific occupational/vocational outcomes linked to the EMC and Medical Rescue modules. Emergency medical care students must, therefore, meet the associated task-oriented physical preparedness requirements to engage successfully in the physically strenuous learning outcomes associated with these modules. If such physically strenuous learning outcomes are included in the curriculum, then there should be a validated way of assessing whether students have indeed met the required levels of physical preparedness.

As mentioned above, international guidelines exist which speak to the minimum physical preparedness requirements for paramedics, fire fighters and police officers (Baek *et al.* 2018; Gumieniak, Gledhill and Jamnik 2018; Leyk *et al.* 2017; Stevenson *et al.* 2017). These assessments take the form of criterion-based norms and standards for these professions. However, the same is currently not true in the South Africa EMC context, as the researcher was unable to find any national guidelines that address the physical preparedness requirements of individuals who are required to undertake both emergency medical care and medical rescue as part of their academic programmes. The paucity of literature on this topic posed a challenge to the HEIs offering EMC programmes. Prior to this study, there was no current scientific benchmark or set standard for the minimum physical preparedness requirements for EMC students.

The Health Professions Council of South Africa (HPCSA) is a statutory body which was established in terms of the Health Professions Act in order to protect the public and guide the profession. The HPCSA, along with the 12 professional boards, one of which is the PBEC, is committed to promoting the health of the South African population; to determine standards of professional education and training; and to set and maintain standards of ethics and professional practice (Health Professions Council of South Africa 2018). The professional boards deal with matters relating to specific professions, and the PBEC is responsible for overseeing the emergency medical care profession. As part of its regulatory function, the PBEC prescribes the minimum standards for the BHSc EMC programme, which includes the 12 Medical Rescue modules. However, there are currently no regulated standards for physical preparedness requirements (Professional Board for Emergency Care 2019).

As indicated earlier in Section 1.2.4, the four HEIs currently offering the BHSc EMC programme all require a certain level of physical preparedness in their EMC students.

However, each HEI is utilising a different assessment tool, many of which are not scientifically validated and/or properly linked to the outcomes of the EMC and Medical Rescue modules. A physical preparedness assessment tool which was utilised as part of this study has been adopted by several universities and colleges offering EMC education and training. However, these approaches to assessing the physical preparedness of EMC students has never been the focus of robust scientific scrutiny. This created a problem when it came to defending the continued use of these, or any other, physical fitness assessment tools.

1.4 RESEARCH QUESTIONS

In light of the research context and problem described above, the central research questions became:

1. Which physically strenuous *learning outcomes* associated with the BHSc EMC programme require the emergency medical care student to be physically prepared?
2. What *components* of physical fitness are required to engage successfully with the physically strenuous learning outcomes associated with the BHSc EMC programme?
3. What is the *validity and reliability* of the current physical preparedness assessment tool which has been developed by an academic department offering emergency medical care, and which has been adopted by other HEIs nationally?
4. To what extent is the current physical preparedness assessment tool capable of producing valid results which accurately assess the emergency medical care student's ability to effectively engage in physically strenuous activities associated with the simulated emergency care and rescue working environment?
5. Is there *evidence* of a need to adjust and/or refine the current physical preparedness assessment tool and, if so, in what way?
6. Finally, is there evidence to support the need for the continued inclusion of physical preparedness and assessment of such within the BHSc EMC programmes?

1.5 AIM OF THE STUDY

To address the research problem and answer the questions outlined above, the central aim of the study was therefore to develop and validate a pragmatic tool that can be used to assess the task-oriented physical preparedness of South African emergency medical care students.

1.6 OBJECTIVES OF THE STUDY

In pursuit of the aim and research questions mentioned above, the following research objectives were derived:

1. Develop new knowledge and insights that describe the context of physical preparedness in the field of emergency medical care and medical rescue and how this relates to the BHSc EMC programme.
   This objective was achieved through the literature review (Chapter 3).

2. Investigate and describe views and opinions of academics and senior emergency medical care students regarding (a) the physical requirements/task-oriented activities linked to participation in the BHSc EMC programme; and (b) the extent to which they feel the current physical preparedness assessment tool adequately assesses their task-oriented physical preparedness.
   This objective was achieved using questionnaires, followed by focus group interviews (Chapter 5 and 6).

3. Investigate and describe the correlation between the performances of EMC students completing a battery of already recognised validated tests and the fitness tests associated with the current unvalidated physical fitness assessment tool.
   This objective was achieved through an assessment of physical preparedness (Chapter 7).

4. Finally, through triangulation and critical reflection on the new knowledge and outcomes flowing from completion of the above three research objectives, the researcher would develop and validate a pragmatic tool that can be used for the assessment of the task-oriented physical preparedness of South African

emergency medical care students. *The developed tool is described and defended in Chapter 8.*

1.7 DELIMITATION OF THE FIELD AND SCOPE OF THE STUDY

Full demarcation of the research problem is essential as this allows the researcher to set boundaries for the study in order to have a clear direction. In the process of demarcation, the researcher is required to determine the scope of the study, the variables involved, the methodology, and whether there are any practical constraints (Goddard and Melville 2001).

The scope of this study was, therefore, limited to the development of a validated tool for the assessment of the task-oriented physical preparedness of South African emergency medical care students. The implementation of the developed tool, as well as the determination of normative standards for the different components of the physical preparedness assessment, lie beyond the scope of this particular study and may provide an ideal opportunity for further research in this focus area.

1.8 RESEARCH DESIGN AND METHODS

A sequential exploratory mixed methods design was selected for this study. This design allowed for the integration of both qualitative and quantitative data to maximise the strengths and minimise the weaknesses of each type of data (Creswell and Plano Clark 2011). Due to the nature of the research questions, the researcher did not feel that a purely qualitative or quantitative design would adequately address the research problem.

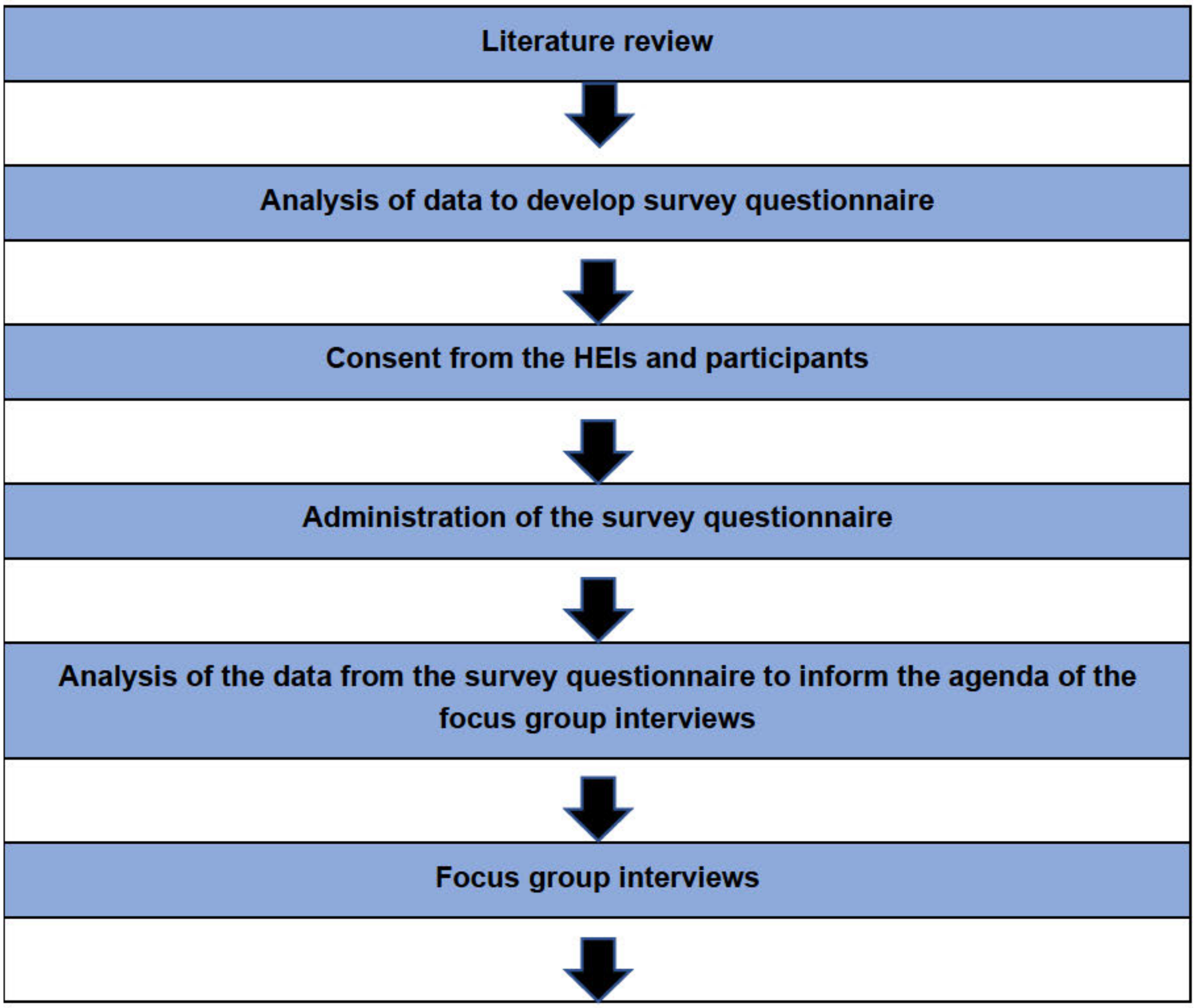
With this design in mind, four methods of data collection were utilised to investigate and gather data in an attempt to address the research questions and achieve the stated objectives, with the intention of accomplishing the aim of the study. The four methods of data collection included: 1) a literature review; 2) questionnaires; 3) focus group interviews, and 4) an assessment of physical preparedness.

A more in-depth description of the research paradigm; research design; population; sampling methods; data collection procedures; data analysis and ethical considerations is provided in Chapter 4. An overview of the study is provided in Figure 1.1.

1.9 THE RESEARCHER'S INTEREST IN THE FIELD

At the time of the study, the researcher was a registered Emergency Care Practitioner with the HPCSA and had been involved in the BHSc EMC programme as a lecturer at two of the HEIs accredited to offer the programme. The researcher was also an ordinary member of the HPCSA and PBEC where she served as part of the Professional Conduct Review Committee, the Education and Training Committee and the Clinical Advisory Committee.

The researcher has spent the last 22 years as an academic involved in emergency care education and training, with a specific interest in emergency medical care, medical rescue and physical preparedness. The researcher has played a key role in the development of the minimum standards and curriculum for the BHSc EMC programme, as well as in the accreditation of HEIs to offer the BHSc EMC programme.



Analysis of the data from the focus group interviews to develop the battery of fitness tests for the assessment of physical preparedness

↓

Assessment of students' performance in the battery of fitness tests

↓

Analysis and interpretation of the data from the assessment of physical preparedness

↓

Development of the validated tool for the assessment of task-oriented physical preparedness

Figure 1.1: Overview of phases of the study

1.10 SIGNIFICANCE AND VALUE OF THE STUDY

This doctoral study makes a valuable, important and unique contribution to the field of EMC and rescue education and training. The researcher's work provides a long-awaited validated tool and a potential benchmark for the industry at large, with regard to assessing the task-oriented physical preparedness levels of EMC students and possibly also operational emergency service workers.

In addition, the results of this study may further assist the PBEC as they seek to prescribe minimum standards for the task-oriented physical preparedness requirements of EMC students and providers registering with the HPCSA. This could, in turn, directly benefit the members of the South African public, as they would be attended to by emergency care providers who have been found to be physically capable of performing their operational duties.

1.11 OUTLINE OF THE THESIS

This thesis has been structured around nine chapters as follows:

Chapter 1: Overview of the Study

This introductory chapter contextualised the study by providing the background to the study, the problem statement and the aim and objectives of the study. The researcher also briefly described the research design and methods used in the study, as well as the significance of the study.

Chapter 2: Theoretical Framework

This chapter will present the theoretical framework underpinning this study.

Chapter 3: Literature Review

This chapter provides an in-depth review of the literature related to physical preparedness in general, as well as in the context of emergency medical care and medical rescue. Chapter 3 also deals with the relationship between task-oriented physical preparedness and the BHSc EMC programme.

Chapter 4: Research Methodology

In Chapter 4, the research methodology for the study is outlined.

Chapter 5: The Questionnaire

Chapter 5 presents a summary of the research methodology specific to the questionnaire, the results and analysis of the data from the questionnaire, as well as the discussion of these results.

Chapter 6: The Focus Group Interviews

This chapter describes the focus group interviews which were held with the academics and senior emergency medical care students. The chapter will include a summary of the research methodology, an analysis of the data, and the discussion of the results and findings.

Chapter 7: Assessment of Physical Preparedness

A summary of the methodology for the assessment of physical preparedness will be presented along with the results in Chapter 7. This will include the discussion of the results of the testing.

Chapter 8: A Physical Preparedness Assessment Tool for EMC Students

The chapter will present the proposed validated tool to assess task-oriented physical preparedness of South African emergency medical care students.

Chapter 9: Summary, Conclusion and Recommendations

This chapter provides an overview of the study, along with a discussion on the limitations of the study. The chapter concludes by offering recommendations.

1.12 CONCLUSION

This first chapter provided the background and context to the research problem statement as well as the research questions, aim and objectives of the study. The research design and methods were also briefly introduced. The theoretical framework that guided this study will be presented in Chapter 2.

CHAPTER 2: THEORETICAL FRAMEWORK

2.1 INTRODUCTION

This chapter provides an overview of the role of the theoretical framework within research, as well as providing a detailed explanation of the two theories which were relevant to this study linked to the aim, research questions and objectives.

2.2 THE ROLE OF A THEORETICAL FRAMEWORK IN RESEARCH

The role of the theoretical framework within this research was to: 1) connect the researcher to existing literature; 2) provide assumptions which guide the research process; 3) assist in the selection of appropriate research questions; 4) guide the choice of the most appropriate research design; 5) assist with the appropriate data collection methods; and 6) guide the researcher in the interpretation and analysis of the results, based on existing literature (Adom, Hussein and Agyem 2018; Burkholder *et al.* 2019).

2.3 THEORIES AND CONTEXT RELEVANT TO THIS RESEARCH

The Professional Board for Emergency Care (PBEC) drafted the minimum standards for the Bachelor of Health Sciences Degree in Emergency Medical Care (BHSc EMC) programme. The intention of this document was to be a guideline for any of the higher education institutions (HEIs) wishing to offer the BHSc EMC programme, to provide a clear understanding of what the minimum requirements were to offer the programme, and also what the minimum standards are that would allow a graduate from the programme to register as an Emergency Care Practitioner (ECP) with the Health Professions Council of South Africa (HPCSA). Within this document, physical preparedness is seen as a fundamental component of the programme, and the link to fitness is mentioned under two of the exit level outcomes. The first mention of fitness appears under Exit Level Outcome 1, which addresses the assessment criteria linked to the foundation modules of the BHSc EMC programme; one of which is Mental Health and Wellness. This module addresses the importance of mental health and wellness and the impact this has on job effectiveness in the context of emergency medical care. In addition to looking at the mental health and wellness aspect, this module also highlights the need to achieve and maintain operational fitness, which includes lifestyle, diet and exercise techniques to function effectively in the emergency medical care environment.

Physical preparedness features again in Exit Level Outcome 3, which addresses the 12 Medical Rescue modules which form part of the BHSc EMC programme. In Exit Level Outcome 3, the focus is on the appropriate level of physical preparedness and swimming proficiency required to safely and effectively take part in the academic activities associated with the 12 Medical Rescue modules (Professional Board for Emergency Care 2019; SAQA 2015). These minimum standards form the basis for the development of the curriculum for the BHSc EMC programme at the various HEIs intending to offer the programme.

Based on the above, and taking the aim, research questions and objectives into consideration, the theories of pedagogy as well as those of the biopsychosocial model were deemed to be contextually relevant to this study.

2.4 THEORIES OF PEDAGOGY

2.4.1 Curriculum development

The term 'curriculum' has several meanings and can be used to refer to only the content of a programme, or it can be used to include how the content of the programme is to be learned, the pedagogical approaches to be utilised by the academic staff presenting the programme, and the resources and assessment methods to be used. When designing a curriculum for a programme, the focus should be on the expected learning outcomes, or exit level outcomes, which reflect the expected result of the programme, instead of learning objectives which focus on the intent of the programme. The minimum standards for the BHSc EMC programme clearly define the exit level outcomes which are expected to form part of the curriculum development process (Professional Board for Emergency Care 2019). A four-dimensional curriculum development framework exists which addresses the why, the what, the how and the where, to be considered in the curriculum development process. The 'why' addresses the intention of the programme, which is often guided by the requirements relating to professional registration, which in the case of the BHSc EMC programme would be the HPCSA and the PBEC. The 'what' defines the capabilities of the graduates and focuses on the learning outcomes or exit level outcomes. The 'how' involves the core educational activities which are teaching, learning and assessment; and lastly, the ‘where’ considers the context in which the curriculum is developed and applied (Lee *et al.* 2013).

As highlighted in 2.3, above, the PBEC minimum standards for the BHSc EMC programme address the concept of operational fitness and physical preparedness under two of the exit level outcomes. Based on this, when HEIs develop their curriculums for the BHSc EMC programme, the concepts associated with operational fitness and physical preparedness, as prescribed by the PBEC, would need to be included within the curriculum. The students registered for the BHSc EMC programme at the three HEIs which are the focus of this research all register for a Physical Preparedness module, which is an annual module (DUT Faculty of Health Sciences 2023; NMU Faculty of Health Sciences 2023; UJ Faculty of Health Sciences 2023). This module is utilised to address the physical preparedness requirements of the BHSc EMC programme regarding general operational fitness and the unique physical preparedness requirements for the Medical Rescue modules. The ‘how’ within the curriculum development framework focuses on the pedagogical approach which will be utilised by the academic staff to present the programme content to the EMC students registered for the BHSc EMC programme, inclusive of the Physical Preparedness module.

2.4.2 Pedagogy theory

Pedagogy refers to the systematic organising of education and it is defined as the method academics utilise to teach in theory and in practice (Merriam-Webster 2023). Pedagogy comes into play when an academic staff member is tasked with teaching a specific curriculum to a student who assumes responsibility for learning that curriculum. As a theory, pedagogy provides a coherent process to suit the student’s needs (Zogla 2018). The quality of the teaching experience is dependent upon the pedagogical strategies applied by the educator, which emerge from the pedagogical theories. Theories of pedagogy help lecturers to expand their knowledge and understanding of different teaching methods, materials, and assessment approaches. Pedagogical theories suggest how the teaching should be implemented and how it will benefit students in perfecting their skills and abilities (Rutto 2017). As lecturers deepen their understanding of pedagogical theory, they will increase their awareness of the preparation, teaching-learning methods and materials, and instructional strategies required to promote student learning, which will enrich the educational experience (Kapur 2020a).

The three pedagogical learning theories forming the conceptual framework for teaching and learning are behaviourism, cognitivism, and constructivism (Rutto 2017). In behaviourism, the lecturer is considered the expert, and the student is expected to accept the knowledge imparted to them. In cognitivism, the lecturer is still expected to provide the tools that enable the student to learn and process information; therefore, this approach remains teacher-centred. Constructivism, on the other hand, is a student-centred approach as the lecturer facilitates learning based upon the student's behaviour and past experiences. The focus of constructivism is on the development of critical thinking skills (Halupa 2023). Within the scope of this research, the constructivist theory was deemed the most appropriate pedagogical approach as it emphasises the active participation of the student during the construction of knowledge (Rutto 2017). Students enrolled in the BHSc EMC programme play an active role in developing an appropriate level of physical preparedness to engage successfully with the physically strenuous practical outcomes of the associated modules.

A pedagogical approach to teaching is influenced by the learning outcomes to be achieved, the students' ages, interactive abilities, and personality traits, to name a few. There are five recognised pedagogical approaches to teaching style, feedback and assessment: 1) constructivist; 2) collaborative; 3) reflective; 4) integrative; and 5) inquiry-based (Kapur 2020b).

Inquiry-based learning is a process of active learning in which the student poses questions and scenarios to develop their knowledge alongside a facilitator. This pedagogical approach is well suited to the outcomes outlined in the BHSc EMC curriculum. It focuses on developing the knowledge, attitude, insight and skills required for graduates of the programme to function as independent clinical practitioners and rescue specialists within the pre-hospital emergency medical care context (SAQA 2015).

The integrative approach is better suited for the Physical Preparedness module as it allows students to connect the module's content with the practical learning outcomes they will encounter at different stages of the curriculum within the Emergency Medical

Care, Medical Rescue and Clinical Practice modules (Rutto 2017). This integrative approach allows the student to recognise the value in the outcomes of one module (Physical Preparedness), while successfully managing the physically strenuous learning outcomes in the other associated modules of the BHSc EMC programme.

Academic staff need to make use of meaningful teaching-learning methods, materials, and teaching strategies when imparting knowledge to EMC students regarding the academic concepts associated with the BHSc EMC curriculum. In addition, the academic staff need to be well versed in terms of the assessment strategies – the primary role of assessments is to determine how much the students have learned and whether the teaching-learning methods are enabling students to achieve the required exit level outcomes (Rutto 2017). Although the concepts of operational fitness and physical preparedness are addressed within two of the exit level outcomes in the PBEC minimum standards, specifics regarding the physical preparedness outcomes, which should be assessed as part of the BHSc EMC, are notably absent from the programme. However, it does include practical outcomes associated with the Emergency Medical Care, Medical Rescue and Clinical Practice modules that would require a student to be physically prepared. Taking this into consideration in terms of this research, EMC students register for a Physical Preparedness module, which forms part of BHSc EMC's curriculum. Therefore, it is critical that a valid assessment strategy is in place to determine whether students have met the required levels of physical preparedness to engage successfully with the physically strenuous practical outcomes of those modules that form part of the curriculum. Through collaboration between the EMC and Sport Sciences departments, a physical preparedness assessment tool was developed for EMC students (Vincent-Lambert, Coopoo and Van Nugteren 2022). This assessment found favour and anecdotal support from the academic staff and EMC students at three of the HEIs offering the BHSc EMC programme. Despite its growing adoption, the assessment has not yet been subjected to scientific scrutiny to validate its ongoing use. This study aimed to address this knowledge gap through an in-depth critical analysis and evaluation of the desired physical attributes and abilities of EMC students, linked to their unique curriculum and associated learning experiences. This would provide the foundational knowledge required for the development and validation of a tool for the assessment of task-oriented physical preparedness of South African emergency medical care students.

2.5 BIOPSYCHOSOCIAL MODEL

2.5.1 Defining the biopsychosocial model

The biomedical model focuses on disease as a separate entity, emphasising that every disease may have a specific causal internal or external factor that physically affects the human body (Beyera, O'Brien and Campbell 2021; Bolton 2023). In contrast, the biopsychosocial model, which was regarded as an improvement to the biomedical model, implies that mental and physical health is attributed to the interaction of three forces: 1) biological factors, 2) psychological factors and 3) social factors (Taukeni 2020). The effects of these three forces on health is seen as dynamic, as these influences on health are not fixed, but instead they interact with each other over time (Lehman, David and Gruber 2017). The biopsychosocial model was first proposed in 1977 by George L. Engel and Jon Romano of the University of Rochester. Engel's interpretation of the biopsychosocial model reflects the development of illness through the intricate interaction of biological, psychological and social factors (Taukeni 2020). As an example, a person may have a specific genetic predisposition which is a biological factor for a disease; however, certain social and/or cognitive factors may ease, worsen, or alter the course of the disease (Beyera, O'Brien and Campbell 2021; Taukeni 2020). The biopsychosocial model was adopted by the World Health Organization (WHO) in 2002. The World Health Organization defines health as a "a state of complete physical, mental and social well-being, and not merely the absence of disease"; and they define wellness as "a composite of physical, emotional, spiritual, intellectual, occupational and social health" (WHO 2020).

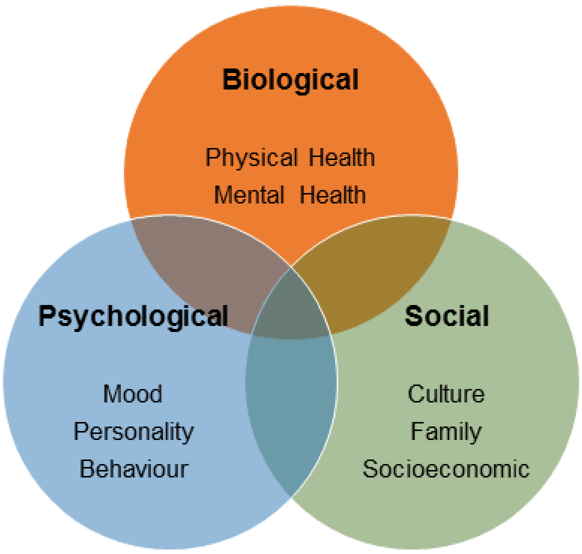


Figure 2.1: The biopsychosocial model (Taukeni 2020)

2.5.2 The relevance of the biopsychosocial model within emergency medical care

Over the past few years, mounting evidence suggests that both psychosocial and biological factors are implicated in the aetiology and clinical course of a wide range of health conditions (Bolton 2023; Taukeni 2020). Regular engagement in physical activity increases the likelihood of living a healthy life, and even minimal participation in any form of physical activity is associated with some physical and mental health benefits (Eime *et al.* 2013).

Physical activity guidelines often address the physical and mental health benefits of regular physical activity, but social health is frequently omitted from these guidelines. It is however suggested that the social support from taking part in physical activity can have a positive impact on psychosocial health, especially in relation to team-based physical activity (Di Bartolomeo and Papa 2019). Documented evidence from cross-sectional and observational studies suggests that the psychological and social benefits of physical activity include a reduction in symptoms of depression, improved self-esteem, and enhanced social interaction. Recent evidence suggests that physical activity may even be as effective in managing depression and anxiety as psychological and pharmacological treatments (Cooney *et al.* 2013; Stubbs *et al.* 2017). While physical activity has undeniably positive health benefits, individuals who are already healthy may be more predisposed to engage in physical activity (Eime *et al.* 2013).

Regular physical activity promotes good health and weight management, reduces the risk of cardiovascular disease, improves cognitive function, and aids in disease prevention (Di Bartolomeo and Papa 2019; Patterson *et al.* 2020). Empirical evidence also suggests that physical activity has a positive impact on life satisfaction, happiness, subjective well-being, mental health, and interpersonal relations. Sedentary behaviour, on the other hand, may increase the risk of chronic conditions such as diabetes and obesity, as well as a decline in physical function and higher overall mortality rates (Patterson *et al.* 2020).

Different types of physical activity have different effects on physical health. Aerobic physical activity assists with weight loss and weight maintenance, reduces the risk of metabolic syndrome, normalises blood lipids, and helps in managing cancer or cancer-related adverse effects. Muscle strengthening exercises minimise muscle atrophy, which lowers the risk of falling and osteoporosis in the elderly, prevents obesity, enhances cognitive performance, counteracts the development of neurodegenerative diseases, reduces the risk of metabolic syndrome, enhances bone density, and reduces pain and disability in joints (Malm, Jakobsson and Isaksson 2019)

As highlighted in the literature examined above, an individual's physical health is determined by the three factors of the biopsychosocial model: biological, psychological, and social. Because the focus of this research was on physical activity, which influences physical health, the additional benefits of physical activity on psychosocial health were not the focus of this research; however, they are worth noting.

The emergency medical care profession is a unique occupation, characterised by rapid transitions from periods of inactivity to strenuous physical activity when responding to emergencies (Barnekow-Bergkvist *et al.* 2004; Mthombeni, Coopoo and Noorbhai 2020a). The PBEC minimum standards for the BHSc EMC programme address the concept of operational fitness and physical preparedness, thereby supporting the benefits of physical activity on both the mental and physical well-being of the EMC student. An emergency care provider requires an appropriate level of physical preparedness to engage successfully with physically demanding job-related tasks. Some of the physically demanding stressors include chest compressions during cardiopulmonary resuscitation, heavy lifting when loading and unloading patients, pushing and pulling of stretchers, and carrying the equipment (Mthombeni, Coopoo and Noorbhai 2021). Musculoskeletal injuries, specifically back injuries, are quite common in emergency care providers if there is a mismatch between the emergency care provider's physical preparedness and the physical demands of the job (Aljaloud 2018; Meadley *et al.* 2020; Mthombeni, Coopoo and Noorbhai 2020a). These musculoskeletal injuries can result in absenteeism from work as well as early retirement (Sterud, Ekeberg and Hem 2006). Chapter 1 provided a brief overview of employee health and wellness and the positive impact of occupational fitness programmes on reducing the number and severity of injuries and resultant absenteeism from the workplace, along with increased work capacity (Reichard, Marsh and Moore 2011). Employees who are physically prepared for their specific work environments are more effective and less likely to suffer from fatigue (Claessens *et al.* 2003).

Emergency responders such as paramedics, firefighters, police officers and military personnel are also predisposed to occupational stress due to the nature of their work, which elicits both physical and emotional responses (Hegg-Deloye *et al.* 2014a). Based on this, emergency responders are at high risk of developing health symptoms such as anxiety; depression; burnout; post-traumatic stress disorder; obesity and sleep disorders (Hegg-Deloye *et al.* 2014a; Hegg-Deloye *et al.* 2014b; Roy *et al.* 2010; van der Ploeg and Kleber 2003). Sleep deprivation from shift work is also known to impact both the physical and psychological health of an emergency care provider (Sofianopoulos, Williams and Archer 2012). A reciprocal relationship exists between psychosocial stressors and chronic disease progression, where mental and emotional stress may lead to a chronic illness such as cardiovascular disease; thromboembolic stroke; hypertension; type II diabetes mellitus; osteoporosis or cancer (Roy *et al.* 2010). If the different components of the biopsychosocial model are poorly integrated, this may have a negative impact on the general health and well-being of emergency care providers. Physical activity is known to improve an individual's physical health, while also improving both psychological and social conditions (Di Bartolomeo and Papa 2019; Eime *et al.* 2013; Patterson *et al.* 2020; Wicks *et al.* 2022).

The content of the BHSc EMC programme, which the EMC students are exposed to, consists of various disciplines and learning environments which expose the students to a variety of physically demanding medical and rescue scenarios over the four years of the programme. Many of these experiences, although simulated, mirror the physical and emotional demands of an emergency care provider's real-world experience. Based on this context, the EMC student is at risk from the physical, psychological and social demands experienced by emergency care providers, as described above. This means that an EMC student would need to have and/or acquire the physical attributes required to function within the diverse environments they would encounter during their studies (Davies, Naidoo and Parr 2008). As discussed in the literature presented above regarding the biopsychosocial model, participation in physical activity has a positive influence on physical fitness, physical health, mental health, and social health.

Physical preparedness and its appropriate assessment are vital components of the BHSc EMC programme, and serve to ensure optimal physical health and mental well-being in EMC students. Therefore, minimum physical preparedness requirements should align with the level of physical preparedness required for a student to engage successfully with the programme's expected physically strenuous exit level outcomes. This clearly highlights the need for a valid physical preparedness assessment tool to determine whether the EMC student has acquired the appropriate level of physical preparedness needed to engage successfully with the physically strenuous learning outcomes associated with the BHSc EMC programme's content.

2.6 CONCLUSION

Chapter 2 presented the theoretical framework that was utilised to guide this study. The following two theories were identified: theories of pedagogy and the Biopsychosocial Model, after careful consideration of all aspects relating to the aim, research questions and objectives of the study. This study fits perfectly within the biopsychosocial model, supported by the teaching and learning pedagogy related to the understanding of the EMC student within the context of health and wellness. Chapter 3 will provide the literature review framing the study.

CHAPTER 3: LITERATURE REVIEW

3.1 INTRODUCTION

This literature review will begin by discussing the background to emergency medical care education within the South African context and the programme requirements of the Bachelor of Health Science Degree in Emergency Medical Care (BHSc EMC). The researcher will then provide an overview of physical fitness in general, and task-oriented physical preparedness, as well as the value of task-oriented physical preparedness in emergency responders. The literature provided will also offer an overview on the process of setting physical employment standards (PESs), the components of physical fitness, and how these relate to the assessment of task-oriented physical preparedness in emergency responders and BHSc EMC students. Lastly, the literature review will address the validity and reliability of a physical preparedness assessment used to assess task-oriented physical preparedness in BHSc EMC students.

3.2 SEARCH STRATEGY

The relevant literature was identified by searching predetermined electronic databases, namely: PubMed, EBSCOhost, MEDLINE, CINAHL, ResearchGate and ScienceDirect. Along with the principal search strategies, reference lists from existing sources were mined to identify other possible publications that may not have been identified by the primary literature search engines. The literature search remained a continual process throughout the study to ensure that the researcher was always informed about developing ideas and new knowledge related to this field.

The keywords and search terms included terms, and a combination of terms, relating to the physical preparedness of emergency care personnel. The keywords or search terms were '*physical fitness', 'operational readiness'* and '*physical preparedness*'. Other search terms included words such as '*paramedic*'; '*emergency care provider'; 'emergency medical care student'; 'firefighter*'; '*police*'; and '*military*'. These terms were searched for together, using the Boolean terms 'AND' and 'OR' during the literature search.

Eligibility for inclusion was based on the following criteria: all literature was accessible in English, the full text version of the article had to be accessible, and the studies had to be focused on adult humans. Due to the paucity of literature on this topic, no date range was set and both peer and non-peer reviewed articles were considered. The researcher read the abstracts of the articles that were retrieved through the various searches, and the full article was then downloaded for further reading to ensure relevance to the study. The researcher also looked at the references of the selected articles to widen the search for appropriate journal articles relevant to the topic. The researcher also included pertinent articles that were recommended by her supervisors throughout the study. In addition, the researcher made use of grey literature, such as dissertations and theses, which were available from the institutional repositories.

3.3 EMERGENCY MEDICAL CARE EDUCATION

Education and training for emergency care providers differs between different countries and emergency medical service (EMS) systems worldwide. The emergency care providers employed within the EMS systems will also have different levels of training and/or education, as well as different operational functions within the EMS system. This section of the literature will demonstrate the unique nature of the four-year BHSc EMC programme, which is the focus of this study as it requires a graduate to be proficient in both emergency medical care as well as medical rescue. This is unique, as most of the paramedicine degrees presented internationally only focus on the emergency medical care aspect.

3.3.1 Emergency medical care education internationally

The focus of emergency medical care degree programmes internationally is largely on the emergency medical care component with little-to-no focus on medical rescue. At Edge Hill University, which is situated in Ormskirk in north-west England, a three-year full-time degree is presented as a BSc (Hons) in Paramedic Practice. The three-year programme includes modules such as: Bioscience for Paramedics; Fundamentals of Professional Paramedic Practice; Principles of Assessment and Management in Paramedic Practice; Pathophysiology and Pharmacology for Paramedic Practice; and Paramedic Practice in Primary and Urgent Care (Edge Hill University 2023). As can be seen from the listed modules, medical rescue is not presented as part of the curriculum. At Liverpool’s John Moores University in the United Kingdom, the programme is also three years in duration with a focus on emergency medical care, and not medical rescue (Liverpool John Moores University 2023).

In New Zealand, at the Auckland University of Technology, a three-year Bachelor of Health Science is presented, and one of the majors that is available is that of Paramedicine. Similarly, the focus of the modules is on the emergency medical care aspect and includes modules such as: Human Anatomy and Physiology; Pathology and Pathophysiology; Clinical Assessment and Diagnostics; Ambulance Operations; and Integrated Clinical Practice (Auckland University of Technology 2023). There is no medical rescue in this curriculum. Australia has a similar model to New Zealand's, in that a student would need to complete a three-year bachelor's degree, majoring in paramedic science at an accredited university. The three-year programme is presented at various universities in Australia, such as Charles Sturt University; Western Sydney University; and the University of Southern Queensland (Charles Sturt University 2023; University of Southern Queensland 2023; Western Sydney University 2023). An Australian paramedicine degree enables graduates to apply for ambulance paramedic positions within the Australasian ambulance services, where they would work in multiple areas such as in an ambulance; intensive care paramedicine; emergency and disaster management; flight rescue services; or community education (University of Southern Queensland 2023). Medical rescue is not part of this three-year paramedicine degree in Australia, and the focus is again only on the emergency medical care content.

In the United States (US), a four-year Bachelor's Degree in Emergency Medical Services is presented at approximately 21 universities (NAEMT 2023). Students must first complete modules from the General Education Core and Pre-Professional Core before being eligible to apply for entry into the professional component (University of South Alabama 2023). The modules in the professional component of the degree focus on emergency medical care content and include: Emergency Medical Technician (EMT) Emergency Care; Medical Terminology; EMT Skills Lab; Human Systems/Pathophysiology; and Paramedic Emergency Care (University of South Alabama 2023; University of Texas Health Science Center at San Antonio 2021). Graduates from the Bachelor's Degree in Emergency Medical Services from any of the universities in the US do not undertake any medical rescue as part of their studies.

In reviewing international emergency medical care programmes, the researcher was unable to identify any undergraduate programme similar in nature to that of the BHSc EMC programme. The focus in these international programmes was largely on the medical component, and none of the programmes included a medical rescue element. The researcher found no evidence of the assessment of physical preparedness in these international programmes. Although literature on the assessment of the physical preparedness of firefighters, police officers and emergency care providers, internationally is available, no similar study has been undertaken on EMC students engaging in both emergency medical care and medical rescue, which was the rationale for this study. As such, this study conducted in South Africa could be classed as a first in the world.

3.3.2 Emergency medical care education within South Africa

The education and training related to emergency medical care in the South African context has historically consisted of vocational courses presented by accredited colleges, and formal higher education programmes which were presented at higher education institutions (HEIs). There were a number of challenges with these historical ‘short courses’ and HE programmes (Sobuwa and Christophers 2019). Through a process of stakeholder engagement driven by the Professional Board for Emergency Care (PBEC) and the National Department of Health, the education and training of emergency care providers was aligned to comply with the requirements of the South African Qualifications Authority (SAQA) and the National Qualifications Framework (NQF) (National Department of Health 2017). Currently there are three HE programmes which lead to professional registration with the Health Professions Council of South Africa (HPCSA) PBEC: a one-year Higher Certificate in Emergency Medical Care (NQF 5); a two-year Diploma in Emergency Medical Care (NQF 6); and a four-year Bachelor of Health Science Degree in Emergency Medical Care (NQF 8) (Vincent-Lambert 2011).

All emergency medical care (EMC) programmes presented at HEIs are accredited and quality-assured by various role players, including the PBEC, Council on Higher Education (CHE) and, to a certain degree, the Department of Higher Education and Training (Council on Higher Education 2016; Health Professions Council of South Africa 2018). The programmes also need to be compliant with SAQA requirements for the registration of qualifications on the NQF (Vincent-Lambert, Bezuidenhout and Jansen van Vuuren 2014). The education and training of emergency care providers is regulated by the PBEC, and HEIs wishing to offer the BHSc EMC qualification are required to comply with the minimum standards of the qualification, as stipulated by the PBEC (Professional Board for Emergency Care 2019). The programme which will form the focus area of this study is the four-year BHSc EMC programme.

The purpose and rationale of the BHSc EMC qualification, as well as the exit level outcomes, are provided by the SAQA document, as well as the PBEC minimum standards document (Professional Board for Emergency Care 2019; SAQA 2015). According to SAQA, a graduate from the BHSc EMC programme needs to be competent in the knowledge, attitude, insight and skills required for the emergency medical care and rescue professions. This purpose statement clearly reflects the dual nature of the BHSc EMC programme, in that a graduate is required to be competent in both emergency medical care and medical rescue. Over the four years of the BHSc EMC programme, graduates are exposed to 12 Medical Rescue modules as part of their studies, and they will be able to form part of specialised rescue teams on completion of the programme (Vincent-Lambert 2011).

The BHSc EMC programme is quite unique in that many of the internationally offered 'degree' programmes are more generic in nature, with the focus only being on emergency medical care, whereas the BHSc EMC focuses on both emergency medical care as well as medical rescue. As part of the four-year BHSc EMC, programme students are exposed to emergency medical care theoretical knowledge, and real-world care of ill and injured patients, in line with the list of capabilities of an Emergency Care Practitioner (ECP) (Professional Board for Emergency Care 2019).

As mentioned above, the Medical Rescue component of the BHSc EMC programme consists of 12 modules which are addressed within the BHSc EMC curriculum. These 12 modules include: 1) high angle I; 2) motor vehicle rescue; 3) fire search and rescue; 4) industrial and agricultural rescue; 5) high angle II; 6) wilderness search and rescue; 7) aquatic rescue; 8) aviation rescue; 9) hazardous materials rescue; 10) confined space rescue; 11) trench rescue and 12) structural collapse rescue. The Aquatic Rescue module is further subdivided into surface water rescue, small boat handling and swift water rescue (SAQA 2015). At present, there are four HEIs offering the BHSc EMC programme in South Africa: 1) the University of Johannesburg; 2) Nelson Mandela University; 3) the Durban University of Technology; and 4) the Cape Peninsula University of Technology.

As can be seen from the literature presented above, the BHSc EMC qualification is a unique programme, in that graduates are required to be proficient in both emergency medical care as well as medical rescue.

3.4 PHYSICAL FITNESS AND TASK-ORIENTED PHYSICAL PREPAREDNESS

Emergency medical care and medical rescue work, by nature are physically taxing, and place demands on the emergency care provider, both in terms of strength and endurance. Similarly, an EMC student would be exposed to physically strenuous tasks when engaging in simulated training exercises as part of the Emergency Medical Care and Medical Rescue modules. Examples of the type of strenuous activity the EMC student may be exposed to include cardiopulmonary resuscitation, carrying medical equipment, ascending a rope, or carrying a patient who has been located during a simulated wilderness search and rescue exercise on a stretcher. In order for an emergency care provider to operate successfully in the emergency medical care and medical rescue environments, they need to possess certain minimum levels of occupational physical preparedness to undertake these physically taxing tasks. Emergency care providers who are unfit may potentially have a negative impact on the emergency medical care and medical rescue of a patient (Vincent-Lambert, Coopoo and Van Nugteren 2022).

3.4.1 Physical fitness

Terminology such as ‘physical activity’, ‘exercise’ and ‘physical fitness’ is often used interchangeably. However, each of these terms has a specific definition when reviewing fitness terminology. Physical activity consists of any bodily movement which is produced by the contraction of skeletal muscles, resulting in an increase in caloric requirements. Exercise is a type of physical activity which consists of a planned, structured repetitive movement in order to improve or maintain the components of physical fitness (American College of Sports Medicine 2018). Physical fitness is largely defined as a state of good health and the ability to perform sports, occupations and daily activities (Tremblay *et al.* 2010).

An individual who is physically fit has the physiological capacity to perform normal everyday activities independently, and without excessive fatigue, leaving sufficient energy over for the individual to still cope with leisure activities and any unforeseen emergencies (Caspersen, Powell and Christenson 1985; Sheridan 2019). Another commonly accepted consequence of being physically fit is the positive impact this has on an individual's health in order to avoid injury and illness (Paoli and Bianco 2015). Although studies demonstrating the relationship between physical fitness and injuries in police officers and firefighters exist, the evidence in relation to emergency care providers is limited. A state of physical fitness is usually achieved by following proper nutrition, physical exercise and rest (Corbin and Pangrazi 2012). Physical fitness may be broadly divided into two categories: a) general physical fitness, which refers to an individual's general state of health and well-being; and b) task-oriented or sport-oriented fitness (Vinciguerra *et al.* 2013).

3.4.2 Task-oriented physical preparedness

Emergency care work is a unique occupation as it is characterised by occasional bouts of high physical strain, such as the lifting and carrying of patients, in an otherwise predominantly sedentary job (Barnekow-Bergkvist *et al.* 2004; LifeMark 2019). It is, therefore, essential that emergency responders have a sufficient level of physical fitness in order to cope with the extreme work demands, as and when these occur, without developing excessive fatigue (Hogya and Ellis 1990; Mthombeni, Coopoo and Noorbhai 2020a). Physical fitness underlies the ability of these emergency responders to perform the critical tasks associated with emergency care work, both safely and efficiently (Siddall *et al.* 2021).

Specific task-oriented fitness refers to the degree to which an individual is able to cope with the physical demands of their chosen profession without excessive fatigue (Vinciguerra *et al.* 2013). This study focuses predominantly on task-oriented fitness associated with the Emergency Medical Care and Medical Rescue modules in the BHSc EMC programme. Task-oriented fitness is required for the efficient saving of lives. This study uses the term 'task-oriented physical preparedness', which is to be read as an overarching term that includes task-oriented fitness.

Emergency medical care students registered for the BHSc EMC programme are exposed to several different disciplines and learning environments. This in turn means that the individual registered for the BHSc EMC programme would need to have and/or acquire those physical abilities and attributes required to participate successfully in each of the diverse environments they would encounter during the course of their training and after graduation (Davies, Naidoo and Parr 2008; Ružbarská and Turek 2010b; Thornton and Sayers 2014). This diversity is unique to the BHSc EMC programme, as a lifeguard, firefighter or police officer only needs to be physically prepared for a very focused job task with set physical demands.

3.5 VALUE OF PHYSICAL PREPAREDNESS FOR EMERGENCY RESPONDERS

3.5.1 Benefits associated with physical preparedness

The terms ‘health’ and ‘wellness’ are often utilised interchangeably, However, according to the World Health Organization (WHO), health is defined as “a state of complete physical, mental and social well-being, and not merely the absence of disease”; and wellness is defined as “a composite of physical, emotional, spiritual, intellectual, occupational and social health” (WHO 2020). A sedentary lifestyle is one of the leading causes of poor health and wellness, linked to both injuries and illness (Qureshi and Memon 2020). Poor health, in turn, has the potential to result in substantial financial implications for an organisation at which the individual is employed, due to poor productivity, absenteeism, presenteeism and additional costs related to part-time salaries and training (Gamble *et al.* 1991; Tzarimas *et al.* 2016). Employees who engage in regular physical activity have been shown to incur lower healthcare costs, with reduced absenteeism due to either illness or injury, and higher levels of productivity at work (Wang *et al.* 2004).

The physically demanding nature of the operational duties of emergency responders places them at risk for occupational injuries and illnesses (Lentz *et al.* 2018). Poor physical preparedness has been shown to increase the risk of emergency responders suffering an injury or developing an illness during the performance of their operational duties. The National Association of Emergency Medical Technicians (NAEMT) – in collaboration with the American Council on Exercise (ACE) – has developed physical fitness guidelines for emergency care providers to reduce the number of musculoskeletal injuries associated with operational tasks (Aljaloud 2018). These injuries and illnesses have the potential to negatively impact the emergency responder, the system in which they are employed, and the members of the public they are there to assist (Fischer *et al.* 2017). Emergency responders who do not have an appropriate level of physical preparedness are more likely to be injured, develop injuries from overuse, incur workman's compensation costs, and burden the employer with unnecessary costs (Ružbarská and Turek 2010b). Improving the physical preparedness of emergency responders has the potential to reduce the injury rates or health risks associated with the job; to reduce the severity of the injuries; and to improve outcomes for the return to work (Coffey, MacPhee and Fischer 2014; Cooper 2014; Fass 2016; Thornton and Sayers 2014).

3.5.2 Impact of physical preparedness on injury reduction

Police officers, firefighters and emergency care providers all respond to dynamic situations that can be physically demanding and are, therefore, associated with a high risk of job-related injuries, as well as premature job-related deaths (Claessens *et al.* 2003). Many of the tasks associated with emergency medical care and medical rescue work, which can result in an injury whilst on duty, are unalterable (Davies, Naidoo and Parr 2008). Fass (2016) stated that many of the work-related injuries incurred by emergency responders are linked to overexertion.

Some of these work-related injuries may be minor, where the employees cannot perform their regular duties, and as such either take time off work to recover, or are placed on modified duties (Lentz *et al.* 2018). Musculoskeletal injuries such as strains, sprains and tears are responsible for up to 84% of the minor injuries in emergency care providers, according to the US Department of Labour, and account for up to 50% of absenteeism from work (American Council on Exercise 2012; Gamble *et al.* 1991). These musculoskeletal injuries are mostly due to the lifting of stretchers (Lavender *et al.* 2000).

Emergency care providers are especially vulnerable to occupational injuries. In the US, the job-related injury rate for emergency care providers is higher than that of firefighters, police officers and other healthcare workers (Supples *et al.* 2022). In a retrospective review by Maguire *et al.* (2005) describing the epidemiology of occupational injuries among EMS personnel in the US, 489 case reports were reviewed – sprains, strains and tears was the leading category of injury with the back being the most prevalent body part. Similarly, in a study by Reichard, Marsh and Moore (2011), the most common non-fatal injuries were sprains and strains. Emergency care providers are prone to the development of back pain as they work under abnormal situations, such as accident scenes and a confined space in the back of an ambulance

(Adib-Hajbaghery and Zohrehea 2013). This abnormal work environment, along with the strenuous physical activity associated with the heavy lifting of patients, results in the high incidence of back pain and back injuries in emergency care providers (Maguire *et al.* 2014). In a study conducted in Kashan, a city in Iran, on the prevalence of back pain in emergency care providers, it was noted that 79.17% of the participants had experienced at least one episode of lower back pain within the previous six months before the time of data collection; and that 47.37% of the lower back pain was as a result of either lifting or transporting heavy objects or patients (Adib-Hajbaghery and Zohrehea 2013). In another study conducted by Hogya and Ellis (1990), 254 injuries were recorded between January 1980 and June 1983 in emergency care providers; and out of that total number of injuries reported, lower back strains were the most common, with a total of 93 (36%) reported. These back injuries often result in prolonged periods of absenteeism from work and may even result in early retirement (Aasa *et al.* 2005; Gamble *et al.* 1991; Pattani, Constantinovici and Williams 2001).

Another risk factor associated with poor physical fitness in emergency responders is cardiovascular disease (Buzga, Jirak and Buzgova 2015; Gamble *et al.* 1991). According to Grace (2012), in 2003, at least 45% of US firefighter on-duty deaths were related to cardiovascular disease. This is also supported by the National Fire Prevention Association (NFPA) statistics, which state that almost 50% of firefighter deaths are due to heart attacks (Grace 2012; NFPA 2000).

The increased incidence of obesity and lack of physical fitness are the two main contributing factors to work-related injuries and chronic diseases in emergency responders (American Council on Exercise 2012; Mthombeni, Coopoo and Noorbhai 2020b). Many of these work-related injuries would be preventable if emergency responders took the time to ensure that they were physically prepared for the rigours associated with their daily operational tasks (Fischer *et al.* 2017). Lentz *et al.* (2018) stated that an increased level of physical fitness can prevent injury. The NFPA also suggested that a proactive approach to health, and an appropriate level of task-oriented physical preparedness, has an impact on reducing the number of debilitating occupational injuries that occur annually (NFPA 2000). Research indicates that individuals who are physically fit, with a higher VO_{2max}, have less potential for fatigue; and they may also recover better from an injury than less-fit individuals (Poplin *et al.* 2014).

The researcher was unable to identify any experimental studies indicating a correlation between physical fitness and injury rates. However, several studies highlighted that many injuries could be prevented if emergency responders were better physically prepared to engage in their daily operational tasks (Aljaloud 2018; Michaelides *et al.* 2011; Siddall *et al.* 2021). If a well-designed physical fitness standard is set and achieved, it will reduce the number of injuries and it will improve work performance (Siddall *et al.* 2021). In order for this to be true, it is essential that the process of developing physical employment standards, as well as the components of physical fitness, are well understood. The physical preparedness requirements and components of physical fitness required to engage successfully with physically strenuous learning outcomes as an EMC student on the BHSc EMC programme have yet to be determined. One of the objectives of this study was to determine the important components of fitness required for an EMC student registered for the BHSc EMC programme.

3.6 THE PROCESS OF SETTING PHYSICAL EMPLOYMENT STANDARDS

A physical employment standard (PES) identifies a minimum level of physical fitness which is required in order to perform critical and essential profession-specific tasks (Siddall *et al.* 2021). A PES must be job-related, and it must be scientifically valid; that is, the test must measure what it is intended to measure (Cooper 2014; Rue *et al.* 2019; Siddall *et al.* 2021). Validity in the context of a PES, therefore, refers to whether the test is a reliable predictor of whether a person will be physically able to do the required operational tasks required of them (Busch 2013). Physical employment standards are essential when either recruiting, training or maintaining the operational effectiveness of personnel engaged in physically demanding jobs, such as lifeguards, firefighters, police officers and emergency care providers (Blacker *et al.* 2016; Fischer *et al.* 2017; Rue *et al.* 2019). According to The Cooper Institute (2014), a PES can also discriminate if job relatedness is well established and documented, as the purpose of the PES is to determine who can and who cannot perform the associated operational tasks.

There is a process which needs to be followed when establishing a PES which is legally defensible. This includes:

1) Conducting a job analysis to identify the physical demands associated with the key operational tasks (Blacker *et al.* 2016).
2) Developing safe and reliable simulations of these tasks that represent the actual job (Blacker *et al.* 2016).
3) Establishing the efficacy if using selection tests and/or generic fitness tests to assess personnel (Blacker *et al.* 2016).
4) Proposing an evidence-based PES (Blacker *et al.* 2016; Rue *et al.* 2019).

The physical demands description is a systematic procedure which is used to identify and quantify the physical demands associated with both the essential and non-essential operational tasks and these can be developed by using either a consensus or focus group-based methodology (Fischer *et al.* 2017).

The physical fitness of emergency responders can either be evaluated by task-simulated tests, or physical performance tests, which represent the components of fitness such as muscular strength, muscular endurance, flexibility and cardiovascular endurance. A task-simulated physical fitness test consists of a variety of profession-specific simulated tasks, such as a firehose drag and stair climb with a high-rise pack in order to assess operational-specific physical fitness in the context of firefighters; whereas physical performance tests make use of validated physical fitness tests to test the components of fitness such as cardiovascular endurance and muscular strength, which would be required to engage safely and efficiently in the operational tasks of a firefighter (Nazari *et al.* 2018). Blacker *et al.* (2016) reported that task-simulated tests are more appropriate predictors of criterion test performance when compared to a physical performance test, also known as a battery of general fitness tests. However, The Cooper Institute (2014) does not recommend the use of job-specific task-simulated tests when designing a PES to assess physical preparedness, as this is not as accurate and predictive of physical ability as a physical performance test. A task-simulated test, which could be in the format of an obstacle course or agility test, accounts for only 20–25% of performance for all the critical operational tasks and does not discriminate and/or predict fitness well (Cooper 2014). A physical performance test, which consists of a battery of fitness tests, is a far better predictive tool when assessing an individual's ability to perform critical and essential operational tasks; and it is also more defensible in the event of a legal challenge (Cooper 2014). It is important that the fitness tests which form part of the physical performance test are functionally specific and based on observations of the components of physical fitness required by emergency responders (Barnekow-Bergkvist *et al.* 2004).

3.6.1 Discrimination within physical employment standards

As reflected earlier in the literature review, The Cooper Institute (2014) states that a PES can discriminate if job relatedness is well established and documented. This statement, however, is in direct conflict with legislation. For example, in the United Kingdom (UK), the Equality Act 2010 lists nine protected characteristics which include sex, race, religion, age and disability (UK, Government Equalities Office and Equality and Human Rights Commission 2013). This UK legislation prohibits both direct and indirect discrimination against any of these protected characteristics (Blacker *et al.* 2016; Roberts *et al.* 2016). Similar legislation is also in place in Europe, the US and Australia. In South Africa, the Employment Equity Act 55 of 1998 protects workers from unfair discrimination and it also provides a framework for implementing affirmative action (Davies, Naidoo and Parr 2008; South Africa, Department of Labour 1998).

Direct discrimination occurs if an individual is treated less favourably due to one or more of the protected characteristics; for example, if a different standard is applied for males and females which is not defendable by law. Indirect discrimination occurs when a provision, criterion or practice (such as a physical preparedness assessment) places an individual from one of the protected groups at a disadvantage and it cannot be justified as being a proportional means of achieving a legitimate purpose. For example, if the physical preparedness assessment itself, or the pass requirements, are not a reflection of the operational tasks associated with the profession (Blacker *et al.* 2016).

The Civil Rights Act of 1991, Section 106, in the US, placed an emphasis on equality in employment practice (US, Equal Employment Opportunity Commission 1991). The Act stated that it was unlawful employment practice for a respondent to adjust the scores of, use different cut-off scores for, or alter the results of, employment-related tests based on race, colour, religion, sex or national origin. In 1993, gender was added to this statement. This change in The Act placed an emphasis on job-relatedness, and provided that this has been established and documented, the fitness tests, standards and programmes can discriminate against anybody in order to determine who can, and who cannot, do the job regardless of age, sex, race or disability (Cooper 2014;

Roberts *et al.* 2016). This change in legislation meant that the age- and gender-based norms were no longer as defensible in court.

In the past, age- and gender-based fitness norms were commonly utilised when setting standards for physical preparedness as there was no data to suggest an absolute standard. Age- and gender-based normative standards depend on an individual's age and sex, i.e. the fitness standard for a 20–29-year-old male would differ from that of a 20–29-year-old female. The advantage of this method was that there was no adverse impact on females, which avoided possible litigation and also assisted in ensuring diversity. The disadvantage associated with this method was that there was no defence that age-gender normative standards effectively identified who could and could not perform the essential job tasks. Absolute standards, however, require the same level of performance regardless of age and sex (same job, same standard). However, this may adversely impact females or individuals with any of the other protected characteristics. If an absolute standard is used, it is essential that the standards are validated and that the level of performance required clearly predicts who can and cannot do the job, in order for it to be upheld in court if challenged (Cooper 2014).

Another variable possibly requiring consideration when setting standards is genetics, with specific reference to fast- and slow-twitch muscle fibres. Skeletal muscles are composed of fibres with different morphological and physiological characteristics. These muscle fibres are most frequently classified according to twitch time: slow-twitch (Type-I) and fast-twitch (Type-IIa and Type IIb) fibres. There is a distinct difference in the ability of these fibres to demand and supply energy for contraction and thus withstand fatigue. Slow-twitch fibres are efficient and fatigue resistant, meaning they have a high capacity for aerobic energy supply, but they have a very limited potential for rapid force development and low anaerobic power. Fast-twitch fibres, on the other hand, are classified as inefficient and susceptible to fatigue with low aerobic power, but have rapid force development and high anaerobic power.

The type of muscle recruited is determined by its physiological characteristics. In distance running, the slow-twitch fibres are engaged to take advantage of their efficiency, endurance capacity, and fatigue resistance. In contrast, in a sprint race, the fast-twitch fibres are utilised to increase the pace; however, because these fibres tire quickly, this intensity is not sustainable for long. In an activity requiring near maximal performance, such as a one repetition maximum power clean, both slow- and fast-twitch fibres will engage. However, the fast-twitch fibres make the most significant contribution (National Strength and Conditioning Association 2016; Scott, Stevens and Binder-Macleod 2001).

Males have a greater area percentage of Type II (fast-twitch) muscle fibres and females have a greater area percentage of Type I (slow-twitch) muscle fibres. This sex difference in muscle fibre types between males and females may explain the greater muscular strength and power amongst males in comparison to the greater muscular endurance in females (Nuzzo 2024). The difference in muscle fibres between males and females may impact their performance in the different components of fitness, as a male student may perform better in any activity involving muscular strength, whereas a female student may have better flexibility.

Physical employment standards for emergency responders should make use of absolute standards which are based on a body of evidence concerning fitness for duty and workability. Workability refers to determinants such as health status, physical capacity, absenteeism, accidents and task performance. A PES in the context of life-saving professions is there to ensure that jobs which expose employees to heavy physical demands identify and exclude individuals who are deficient in the required strength capabilities, irrespective of any of the protected characteristics such as age, sex or race (Davies, Naidoo and Parr 2008). A physical preparedness assessment in the context of a PES represents the minimum level of fitness required in order to perform the associated job tasks safely and efficiently (Farrell 2017; Roberts *et al.* 2016). This is regarded as criterion-based norms.

Farrell (2017) stated that male and female police officers have the same job function and they are required to perform the same essential, critical job tasks. The literature states that a minimum physical performance standard should be applied to all firefighters, irrespective of age, race and sex, as the intensity of the physical demands associated with fire suppression activities remains consistent throughout a firefighter's career (Prieto *et al.* 2013; Sothmann *et al.* 2004). The Candidate Physical Ability Test (CPAT) is utilised in the US to assess the physical preparedness of firefighters and it applies the same criteria regardless of sex (Noh *et al.* 2018). In the army, the job-related physical demands also remain constant, regardless of who performs the task.

Therefore, applying age- and gender-based fitness norms is naturally inappropriate. Based on this, the army has revised the fitness test for infantry soldiers which applies the same minimum fitness standards across all ages and sexes. Although this may result in a reduced number of female infantry soldiers, a certain physical preparedness standard needs to be met in order to be able to perform the job-related tasks safely and efficiently (Tofari, Treloar and Silk 2013). Thornton and Sayers (2014) indicated that, although variables such as age, height, weight, strength, flexibility and fitness will vary greatly from one emergency care provider to another, the occupational task requirements remain the same.

Based on these findings, all individuals entering any of the life-saving professions, such as police officers, firefighters, lifeguards and emergency care providers, are held to the same minimum levels of physical preparedness as determined by the PES, irrespective of any of the protected characteristics. Females are generally smaller than males and that their aerobic capacity, as well as their strength performance, is lower than that of males (Barnekow-Bergkvist *et al.* 2004). These large differences in the strength and aerobic capacity of females may mean that they need to strain at near-maximal effort to achieve the same outcome that a male may achieve, well within a comfortable range of effort (Roberts *et al.* 2016; Thornton and Sayers 2014). Due to these physiological variations, personalised intervention strategies that focus on exercise, conditioning and resistance need to be considered and implemented to ensure that individuals entering into any of the life-saving professions are able to achieve the minimum physiological, fitness and strength profiles required of them to safely and efficiently execute the tasks associated with their chosen profession, irrespective of any of the protected characteristics (Davies, Naidoo and Parr 2008; Roberts *et al.* 2016).

3.7 COMPONENTS OF PHYSICAL FITNESS

Earlier in the literature review, the components of physical fitness were highlighted as an important factor to consider when determining minimum physical preparedness requirements in order to establish a PES. Physical fitness can broadly be divided into health-related and skill-related physical fitness. Health-related physical fitness includes the components of physical fitness which have a direct relationship with good health. These include body composition; cardiovascular endurance; flexibility;

muscular endurance and muscle strength. Skill-related physical fitness includes the components of physical fitness that form a relationship between motor skills and enhanced performance. These include agility; balance; co-ordination; power; speed and reaction time (American College of Sports Medicine 2018; Corbin and Pangrazi 2012).

Table 3.1: The 11 components of physical fitness (American College of Sports Medicine 2018)

Component	Brief definition
Body composition	Addresses the relative amounts of muscle, fat, bone and other vital body parts.
Cardiovascular endurance	Relates to the ability of the cardiovascular and respiratory systems to provide oxygen during sustained physical activity.
Flexibility	Relates to the range of motion available within a joint.
Muscular endurance	Relates to the ability of muscles to continue functioning without fatigue.
Muscular strength	Relates to the ability of the muscles to exert force.
Agility	Relates to the ability to quickly change the position of the body with accuracy and speed.
Balance	Relates to the preservation of equilibrium whilst either moving or stationary.
Co-ordination	Relates to the ability to use senses such as hearing and vision, together with the body, to perform motor tasks efficiently, smoothly and precisely.
Power	Relates to the ability or rate at which one can perform work.
Speed	Relates to the ability to perform a movement within a short period of time.
Reaction time	Relates to the time which elapses between the initial stimulation and the start of the reaction to it.

This section has provided a definition for the various components of physical fitness. But which of these components are required by emergency responders, such as police officers, firefighters and emergency care providers, to ensure that they are physically prepared for their task-oriented duties; and how are these different components assessed?

3.8 TASK-ORIENTED PHYSICAL PREPAREDNESS OF VARIOUS JOB SETTINGS

3.8.1 Introduction

Emergency responders, such as police officers, firefighters and emergency care providers, have unique workplace experiences and exposures. However, there are also common aspects relating to their emergency duties. These emergency responders may have long periods of relative inactivity followed by erratic bursts of very strenuous physical activity. This level of physical activity requires the emergency responders to have the appropriate level of task-oriented physical preparedness in order to undertake the tasks associated with each of the professions in a safe and efficient manner (Kales *et al.* 2009). This next section of the literature review will consider the different emergency responders and the components of physical fitness required for each of the professions.

3.8.2 Task-oriented physical preparedness in police officers

Law enforcement is a profession in which task-oriented physical preparedness is a key factor for the police officers to perform their daily duties. Within this profession, there are many sources of stress, and the police officer is often required to make a sudden switch between inactivity and vigorous activity. The following tasks, which have been linked to the components of physical fitness, have been identified as part of the physical preparedness requirements for police officers: 1) sustained pursuits (cardiovascular endurance); 2) sprints (cardiovascular endurance); 3) dodging (cardiovascular endurance and flexibility); 4) lifting, carrying, dragging, pushing and pulling (muscular endurance, muscle strength and cardiovascular endurance); 5) jumping and vaulting (cardiovascular endurance and leg power); 6) crawling (body composition, flexibility and muscular endurance); and 7) force (cardiovascular endurance, muscular strength and muscular endurance) (Cooper 2014).

Each of these physically demanding job-related tasks has been allocated a specific fitness test to measure the underlying fitness area. As an example: in order to assess muscular endurance, the one-minute push-up and one-minute sit-up tests are utilised;

and to assess flexibility, the sit-and-reach test is used. The Cooper Institute (2014) recommended a physical performance test, or a battery of fitness tests, to assess task-oriented physical preparedness in police officers, as they are far more predictive of the individual's ability to perform critical and essential job-specific tasks. However, criterion-based norms are fairer to both sexes.

3.8.3 Task-oriented physical preparedness in firefighters

Firefighting is one of the most physically demanding jobs, as the type of work that firefighters are exposed to involves operational tasks which place them under considerable physical strain (Blacker *et al.* 2016). Firefighters have an extreme workload in very hot, polluted and humid environments; and the additional weight of the personal protective equipment, which weighs approximately 23kg, can increase energy expenditure during operational tasks by up to 33% (Claessens *et al.* 2003; Kales *et al.* 2007; Kales and Smith 2017; Michaelides *et al.* 2011).

The primary task of a firefighter is to save human life; and therefore a firefighter needs to be competent in the firefighting skills required to perform their operational tasks (Munir *et al.* 2012; von Heimburg, Rasmussen and Medbo 2006). The operational tasks which have been identified as the most physically demanding for a firefighter include: 1) raising ladders; 2) climbing stairs and ladders; 3) forcible entry; 4) operating a charged hose line; 5) carrying heavy equipment; 6) victim evacuations and 7) fire suppression activities (Blacker *et al.* 2016; Kales *et al.* 2007). A high level of physical fitness will enable the firefighter to perform these physically demanding tasks more efficiently, with less risk of overexertion and injuries, whilst on duty (Martin *et al.* 2019; Michaelides *et al.* 2011). Michaelides *et al.* (2011) conducted an experiment involving 90 professional male firefighters, 23 of whom failed to complete all the measurements. The purpose of the study was to identify the relationship between various fitness parameters and performance in a set of simulated firefighting tasks. The study was divided into two phases: in the first phase, the firefighters performed the selected simulated firefighting tasks, and in the second phase two weeks later, they completed a fitness assessment. The fitness tests selected measured fitness in the areas of body composition, flexibility, muscular endurance, muscular strength, and anaerobic power. The results of this experiment revealed a positive correlation between fitness and performance, indicating that higher performance in the selected fitness tests was associated with a faster completion time for the selected simulated firefighting tasks. A firefighter may also be required to assist in motor vehicle accidents in order to extricate patients from the vehicles, and the tasks associated with this extrication also require considerable muscular strength and endurance due to the weight of the tools required to cut the vehicles (Blacker *et al.* 2016).

The components of physical fitness which have been identified in order for a firefighter to perform their operational tasks successfully include: 1) dynamic strength; 2) static strength; 3) agility; 4) total body co-ordination; 5) cardio-respiratory endurance; 6) muscular endurance; 7) eye–hand co-ordination 8) flexibility; and 9) total body speed (Claessens *et al.* 2003; Lindberg *et al.* 2013; Lockie *et al.* 2022; Noh *et al.* 2018; Stevenson *et al.* 2017).

Several validated PESs exist to determine whether a firefighter is physically prepared to engage effectively with the operational tasks associated with the profession. Some of these assessments make use of job-simulated tasks and others make use of a battery of fitness tests which address the different components of physical fitness. A study undertaken by Stevenson *et al.* (2017) compared job-simulated tasks against gym-based physical fitness tests to determine a PES for UK firefighters. A task analysis was utilised to identify the most physically demanding generic tasks used by UK firefighters, with a specific focus on muscular strength and muscular endurance. Once these had been identified, a gym-based physical fitness test was identified to correspond with each task. The job-simulated tasks were completed in full firefighter turnout gear, whereas the physical fitness tests were conducted in gym clothes. The results of this study confirmed that the gym-based fitness tests (seated shoulder press, single seated rope pull-down and seated repeated rope pull-down) were commensurate with the minimum acceptable performance requirements required for the essential job-specific tasks of UK firefighters, such as a ladder lift, lower or extension (Stevenson *et al.* 2017).

The physical preparedness assessment utilised to assess the task-oriented physical preparedness of Seoul firefighters also makes use of a battery of physical fitness tests instead of job-simulated task assessments, including grip strength; back strength; the sit-and-reach test; standing long jump; sit-ups and shuttle runs (Noh *et al.* 2018). The EUROFIT test battery, which was used by Claessens *et al.* (2003) to measure the basic motor capacity of 95 professional Belgian firefighters, included the flexed-arm hang test as part of the battery of physical fitness tests.

In a study by Michaelides *et al.* (2011), a comparison was undertaken between six job-simulated tasks and a battery of fitness tests to determine which of the fitness parameters were related to a high level of performance in the job-simulated tasks. The job-simulated tasks consisted of a stair climb; rolled hose lift and move; Keiser sled; hose pull and hydrant hook up; 82kg rescue manikin drag; and charged hose advance. The results of this study demonstrated that high performance results in upper body muscular strength, abdominal muscular strength, muscular endurance and anaerobic power were related to a high performance in the six job-simulated tasks (Michaelides *et al.* 2011). Williford *et al.* (1999) also undertook a comparison between a number of simulated job-related tasks and a battery of physical performance tests. In this study, grip strength, sit-ups and the standing long jump were good predictors of physical work capacity in the simulated job-related tasks (Williford *et al.* 1999).

3.8.4 Task-oriented physical preparedness in emergency care providers

The work of an emergency care provider entails substantial psychological and physical demands which are characterised by rapid transitions from sedentary behaviour to emergencies which can involve intense activity above the anaerobic threshold. Based on this, emergency care providers should have a certain minimum level of physical preparedness which equates to their physical work capacity (Buzga, Jirak and Buzgova 2015; Paakkonen, Ring and Kettunen 2018).

The physical work capacity of an emergency care provider is closely related to the physically demanding tasks associated with their daily operational duties. A number of different authors have listed these as: 1) lifting patients from awkward positions; 2) loading and unloading a stretcher from an ambulance; 3) carrying emergency medical care equipment; 4) pushing and pulling stretchers; 5) carrying a patient on a stretcher up-or-down stairs; and 6) cardiopulmonary resuscitation (CPR) (Barnekow-Bergkvist *et al.* 2004; Gamble *et al.* 1991; Lad *et al.* 2018; Leyk *et al.* 2007; Morales *et al.* 2016; Thornton and Sayers 2014). Fischer *et al.* (2017) stated that an emergency care provider may lift in excess of 90kg in a single lift and Coffey *et al.* (2016) stated that the weight of a lift can range anywhere from 1.4kg to 200kg.

The high level of physical exertion during prolonged CPR is one of the main physical stressors experienced by emergency care providers (Dainty and Gregory 2017). Higher survival rates in out-of-hospital cardiac arrest depend on effective chest compressions, early defibrillation, and advanced life support (López-Gonzalez *et al.* 2016). The criteria for effective chest compressions are: 1) the force and rate of the compressions; 2) full recoil of the chest wall after each compression; and 3) minimal interruptions (Hansen *et al.* 2012). The American Heart Association (AHA) recommends five cycles of CPR at two-minute intervals, with each cycle comprising 30 effective chest compressions. If an advanced airway is in place, continuous chest compressions are recommended at a rate of 100–120 compressions per minute (Nayak *et al.* 2020).

Fatigue during cardiopulmonary resuscitation affects the depth of chest compressions, and a decrease in chest compression depth reduces coronary perfusion pressure, which lowers the possibility of restoring spontaneous circulation (Cho *et al.* 2020). The development of fatigue may develop as early as one minute after the initiation of CPR (Gutwirth, Williams and Boyle 2009; McDonald *et al.* 2013). As fatigue can present quite early, due to the required rate and depth of compressions, the emergency care providers should rotate every two minutes to limit the impact of fatigue which develops when compressions are performed for longer than three minutes (Cho *et al.* 2020; Riera *et al.* 2007). Five minutes of CPR with high quality compressions is equal to maximum muscular strength for an individual (Hansen *et al.* 2012). In a study by Otsuka *et al.* (2014), which assessed the quality of uninterrupted chest compressions performed by 25 emergency physicians and medical students, the results demonstrated that, although the compression rate remained constant over seven minutes, the number and percentage of correct compressions declined after three minutes, with the depth of compressions significantly reducing after two minutes.

Physical fitness is vital for performing optimal CPR, especially for extended periods (Muştu Özyakan and Saraç 2018). Nayak *et al.* (2020) conducted a study involving 35 health care providers trained in AHA basic life support whose physical activity levels were assessed using the global physical activity questionnaire (GPAQ version 2). An initial set of baseline haemodynamic parameters was recorded for all participants. Thereafter, the participants were expected to perform continuous chest compressions on a CPR manikin until they perceived fatigue, which was assessed using the Modified

Borg's rating of perceived level of exertion (Borg 1998). An audible click was utilised to ensure that an adequate depth was reached with each compression, and a metronome ensured a set rate of 100 compressions per minute. Immediately after the compressions, the participants were required to rest for two minutes, and the haemodynamic parameters were reassessed. A statistically significant difference was observed for the chest compression duration provided by participants with high levels of physical activity in comparison to those with moderate levels of physical activity. This study demonstrated that fitness levels influence the duration of effective chest compressions, as the higher the participants' level of physical activity, the lower the level of fatigue and the longer the duration of effective compressions (Nayak *et al.* 2020).

Another manikin-based study involving university students in Turkey aimed to explore the effect of physical activity levels on the quality of CPR. The one group of participants were physically active physical education teacher candidates taking a compulsory Health Education and First Aid course, and the other group of students were physically inactive second-year university students enrolled in an elective undergraduate First Aid course. The physical education and sports major university students participated in regular physical activity and therefore had high levels of physical fitness. Each participant was required to perform 10 sets of CPR (one set was equal to 30 chest compressions and two ventilations), and data was collected on the quality of the ventilations and compressions making use of the Laerdal Resusci® Anne SkillReporter™ manikin. The results showed that the physically active participants (both male and female) performed better CPR when compared to the physically inactive participants (Muştu Özyakan and Saraç 2018).

The literature presented above demonstrates that an emergency care provider's fitness levels may have an effect on the quality of chest compressions. A study by Chapman *et al.* (2015) determined that a high level of aerobic capacity will allow for more prolonged efforts at CPR, with a faster recovery time between efforts. Studies by Lucía *et al.* (1999) and Russo *et al.* (2011) both demonstrated that emergency care providers who are physically fit perform better chest compressions at a lower intensity of exercise, with a higher resistance to fatigue. A study by Cho *et al.* (2020) explored which muscles are utilised during kneeling and standing positions when performing CPR, and which exercises can be performed to enhance the muscular endurance of the specific muscles that experience fatigue in the two different positions.

When designing a valid task-oriented physical preparedness assessment for emergency care providers, the components of physical fitness required for different physically strenuous tasks need to be considered. These include aerobic endurance; anaerobic endurance; muscular strength; muscular endurance and flexibility (National Health Service 2006; Rue *et al.* 2019; Thornton and Sayers 2014). An emergency care provider may be required to work at levels well above anaerobic threshold for up to eleven minutes at a time (Barnekow-Bergkvist *et al.* 2004; Thornton and Sayers 2014). An emergency care provider may also be required to carry equipment up steps, which loads the trunk and torso and requires single leg strength (Busch 2013). Isometric back endurance and grip are important predictors of the development of fatigue during the carrying of a loaded stretcher (Barnekow-Bergkvist *et al.* 2004; Leyk *et al.* 2007).

The task-oriented physical preparedness of an emergency care provider may either be assessed by job-simulated tasks, which are functionally specific to address the tasks which occur frequently, or by a battery of physical fitness tests (Barnekow-Bergkvist *et al.* 2004). The literature that was found, pertaining to the assessment of task-oriented physical preparedness of emergency care providers, included examples of both types of assessment.

As can be seen from the literature, the nature of the work of an emergency care provider is physically demanding and requires an individual to be physically fit to engage with the physical tasks associated with this profession. The assessment of this physical preparedness can either be via a job-simulated task assessment or via a battery of physical fitness tests, provided the assessment is functionally specific to address the tasks frequently performed.

3.8.5 Task-oriented physical preparedness in other emergency responders

Some of the physically demanding tasks for military personnel have been identified as running between points of cover, negotiating obstacles and rescuing casualties. Based on these physically demanding tasks, an appropriate physical preparedness assessment for military personnel should include tests that assess aerobic power, muscular strength and muscular endurance (Tofari, Treloar and Silk 2013). Linked to these components of physical fitness, Harman *et al.* (2008), undertook a study to determine whether field-expedient physical fitness tests could be utilised to predict simulated, physically demanding, battlefield performance. The field-expedient physical fitness tests were completed with the participants wearing shorts, a T-shirt and running shoes, and the tests consisted of 1) the number of push-ups in two minutes; 2) the number of bent leg sit-ups in two minutes; 3) a 3.2km run at maximal speed; 4) a standing vertical jump; and 5) a standing horizontal jump. For the simulated battlefield physical performance, the participants were kitted out in battledress uniform (boots, Kevlar helmet, armoured vest and dummy rifle) and they were required to complete the following: 1) a timed 400m run; 2) a timed obstacle course; 3) timed 30m rushes and 4) a simulated 80kg casualty rescue. The results of this study demonstrated that high scores in the 3.2km run and jumps equated to better performance results in the 400m run, 30m rushes, the obstacle course and the casualty rescue (Harman *et al.* 2008).

Mining rescue personnel are expected to engage in hazardous material rescue incidents; fire search and rescue incidents; vertical ascents; and vehicle extrication, as part of their daily operational tasks. These tasks require muscular strength, muscular endurance and cardiovascular endurance. The physical capacity of mining rescue personnel can either be assessed through a battery of physical fitness tests or through simulated rescue tasks, such as an incremental carry, coal shovel and hose drag (Stewart *et al.* 2008).

According to Reilly, Wooler and Tipton (2006), lifeguards undertake physically demanding tasks as part of their daily operational tasks. These include handling a casualty onto a rescue boat or board which requires strength; sea swimming while towing a casualty; board paddling with a casualty; and beach running, which all require cardiovascular endurance (Reilly, Wooler and Tipton 2006).

3.9 TASK-ORIENTED PHYSICAL PREPAREDNESS FOR BSC EMC STUDENTS

From the literature provided, the researcher has determined that the components of physical fitness and the physical preparedness requirements of firefighters, police officers and emergency care providers are quite specific, and are well documented. There are also a number of validated physical preparedness assessments for these emergency responders. The physically demanding tasks associated with being a firefighter or emergency care provider are very specific to each domain of work. As an example, an emergency care provider would not be expected to perform fire suppression activities or operate a charged hose line; similarly, a firefighter would not routinely be exposed to loading and unloading stretchers from an ambulance or carrying emergency medical care equipment. However, students registered for the BHSc EMC programme are exposed to various physically demanding activities throughout the programme, requiring them to engage in both emergency medical care and medical rescue learning outcomes. Given the unique nature of this programme, minimal literature exists on the components of physical fitness and the physical preparedness assessments required for an emergency care provider who engages in the physically demanding activities characteristic of both emergency medical care and medical rescue. The physically demanding nature of the practical learning outcomes on the BHSc EMC programme means it is essential that the EMC student is adequately physically prepared to achieve success when engaging in these learning outcomes.

3.9.1 Training and assessment of task-oriented physical preparedness for BHSc EMC students

As indicated earlier in the background to the study, current practices in South Africa are that all four of the HEIs offering the BHSc EMC programme ensure that the EMC students undergo some form of physical preparedness training. At three of the HEIs, the students register for a stand-alone Physical Preparedness module as part of the academic programme, where periods on the academic timetable have been specifically allocated to physical training. At the fourth HEI, the physical preparedness has been incorporated into the Medical Rescue module in each of the four academic years. All the HEIs offering the BHSc EMC programme do, however, ensure that the students undergo a physical preparedness assessment to ensure that their students are suitably prepared to undertake the Emergency Medical Care and Medical Rescue modules successfully. These assessments are not standardised, however, and most are not designed to address the specific physical requirements and components of fitness linked to this unique programme. One undergraduate study indicated that there is no literature available to determine whether the current physical preparedness programmes and assessments adequately address the needs and physical preparedness requirements of the EMC students (Bean 2011).

3.9.2 Physical preparedness assessment at HEI ‘A’

Emergency medical care students registered for the BHSc EMC programme at HEI ‘A’ register for a stand-alone Physical Preparedness module from their first year of study.

At this HEI, the physical preparedness assessment tool has changed at least three times over the past four years and the assessment criteria and ratings for these three different assessments will be presented in Table 3.2 (Louw 2019), Table 3.3 (Rowland 2021) and Table 3.4 (Allan 2023). The Physical Preparedness module is assessed by continuous assessment and, at the end of each academic term, the students are required to complete a physical preparedness assessment. In total, the students will undergo four physical preparedness assessments throughout the academic year, with the weighting of these assessments increasing throughout the academic year (Allan 2023; Louw 2019; Rowland 2021). In order to pass the module, students must obtain a minimum of 50% by year-end. However, in the 2019 version of the physical preparedness assessment, students also had to obtain a minimum average of 50% for the length swimming component of the assessment (Louw 2019).

Table 3.2: Assessment criteria and ratings for the physical preparedness assessment for the 2019 academic year at HEI 'A' (Louw 2019)

1. MAX BENCH PRESS			
3-Rep max as a percentage of your body weight			
Score	**Rating**	**Male**	**Female**
6	Excellent	> 1.08	> 0.66
5	Good	1.01–1.07	0.62–0.65
3	Average	0.86–1.00	0.53–0.61
2	Fair	0.79–0.85	0.49–0.52
1	Poor	< 0.78	< 0.48
2. MAX LEG PRESS			
3-Rep max as a percentage of your body weight			
Score	**Rating**	**Male**	**Female**
6	Excellent	> 5	> 4.5
5	Good	4.0–5.0	3.5–4.5
3	Average	3.0–4.0	2.5–3.4
2	Fair	2.0–3.0	2.0–2.4
1	Poor	< 2.0	< 2.0

3. MAX PULL-UPS

Palms must face away from the bars

Score	Rating	Male	Female
6	Excellent	> 16	> 8
5	Good	13–16	7–8
4	Above average	9–12	5–6
3	Average	6–8	3–4
1	Below average	3–5	1–2
0	Poor	< 3	0

4. MAX 1-MINUTE PUSH-UPS

Females may do push-ups from their knees

Score	Rating	Male	Female
6	Excellent	> 50	> 56
5	Good	41–50	47–56
4	Above average	31–40	35–46
3	Average	21–30	24–34
2	Below average	10–20	14–23
0	Poor	< 10	< 14

5. MAX 1-MINUTE SIT-UPS

Score	Rating	Male	Female
6	Excellent	> 50	> 50
5	Good	46–50	46–50
4	Above average	38–45	38–45
3	Average	30–37	30–37
2	Below average	20–29	20–29
0	Poor	< 20	< 20

6. BLEEP TEST			
Score	**Rating**	**Male**	**Female**
6	Excellent	> 12/9	> 11/5
5	Good	10/7–12/9	9/5–11/5
4	Above average	8/10–10/6	7/8–9/4
3	Average	7/10–8/9	6/6–7/7
2	Below average	6/6–7/9	5/3–6/5
1	Poor	5/2–6/5	3/8–5/2
0	Very poor	< 5/2	< 3/8
7. 200m SWIM FOR FIRST-YEARS			
Any style of swimming may be used			
Score	**Rating**	**Male**	**Female**
0	Poor	> 6min	> 6min
3	Acceptable	5–6min	5–6min
5	Good	4–5min	4–5min
6	Excellent	< 4min	< 4min
7. 300m SWIM FOR SECOND-YEARS			
Any style of swimming may be used			
Score	**Rating**	**Male**	**Female**
0	Poor	> 8min	> 8min
3	Acceptable	7–8min	7–8min
5	Good	6–7min	6–7min
6	Excellent	< 6min	< 6min
7. 400m SWIM FOR THIRD- AND FOURTH-YEARS			
Any style of swimming may be used			
Score	**Rating**	**Male**	**Female**
0	Poor	> 10min	> 10min
3	Acceptable	8–10min	8–10min
5	Good	7–8min	7–8min
6	Excellent	< 7min	< 7min

8. UNDERWATER SWIM			
Only 1 attempt			
Score	**Rating**	**Male**	**Female**
0	Poor	< 15m	< 15m
3	Acceptable	15–20m	15–20m
4	Good	20–25m	20–25m
5	Very good	Touch wall	Touch wall
6	Excellent	Turn around & kick off	Turn around & kick off
9. OBJECT RETRIEVAL FROM BOTTOM OF POOL			
Collect 5 objects spread across the width of the pool			
Score	**Rating**	**Male**	**Female**
0	Poor	Cannot do	Cannot do
3	Acceptable	3 or more attempts	3 or more attempts
4	Good	2 attempts	2 attempts
6	Excellent	1 attempt	1 attempt
10. TREAD WATER FOR FIRST-YEARS			
Any technique may be used to stay afloat			
Score	**Rating**	**Male**	**Female**
0	Poor	< 8min	< 8min
3	Acceptable	8–15min	8–15min
6	Excellent	> 15min	> 15min
10. TREAD WATER FOR SECOND- TO FOURTH-YEARS			
Head must be kept above water and at 8 minutes, hands must be above the water			
Score	**Rating**	**Male**	**Female**
0	Poor	< 6min	> 6min
3	Acceptable	6–8min	6–8min
5	Very good	9–10min	9–10min
6	Excellent	> 10min	> 10min

In the 2021 academic year, the head of department (HOD) in the Department of Emergency Medical Care at HEI 'A' felt that some of the components within the physical preparedness assessment presented in Table 3.2 were too challenging for the EMC students to achieve. Based on this, a revised physical preparedness assessment was implemented (Rowland 2021). This revised assessment is presented in Table 3.3.

Table 3.3: Assessment criteria and ratings for the physical preparedness assessment for the 2021 academic year at HEI 'A' (Rowland 2021)

COMPONENT A: 5km RUN (CARDIORESPIRATORY ASSESSMENT)				
From	**To**	**Score**	**Percentage**	**Outcome**
> 32:30	N/A	1	25%	Unsatisfactory
27:31	32:30	2	50%	Satisfactory
22:30	27:30	3	75%	Good
< 22:29	22:29	4	100%	Excellent
COMPONENT B: 200m SWIM (SWIMMING COMPETENCY ASSESSMENT)				
From	**To**	**Score**	**Percentage**	**Outcome**
> 06:00	N/A	1	25%	Unsatisfactory
05:00	06:00	2	50%	Satisfactory
03:00	04:59	3	75%	Good
< 03:00	N/A	4	100%	Excellent

COMPONENT C: 1 REP MAX DEADLIFT (LEG AND BACK STRENGTH)			
Equipment needed: barbell and weight plates			
Kilograms lifted for 1RM	**Score**	**Percentage**	**Outcome**
0–39	1	25%	Fail
40–59	2	25%	Fail
60–79	3	25%	Fail
80–99	4	50%	Pass
100–119	5	75%	Pass
≥ 120	6	100%	Pass

COMPONENT D: 1 REP MAX BENCH PRESS (UPPER BODY STRENGTH)			
Equipment needed: barbell, weight plates and a bench with a rack			
Kilograms lifted for 1RM	**Score**	**Percentage**	**Outcome**
0–19	1	25%	Fail
20–33	2	25%	Fail
30–39	3	25%	Fail
40–49	4	50%	Pass
50–59	5	75%	Pass
≥ 60	6	100%	Pass

COMPONENT E: 1 REP MAX SHOULDER PRESS (TESTING ABILITY TO LIFT HEAVY OBJECTS OR EQUIPMENT ABOVE ONE'S HEAD)			
Equipment needed: barbell and weight plates or seated machine with weights			
Kilograms lifted for 1RM	**Score**	**Percentage**	**Outcome**
0–9	1	25%	Fail
10–19	2	25%	Fail
20–29	3	25%	Fail
30–39	4	50%	Pass
40–49	5	75%	Pass
≥ 50	6	100%	Pass

COMPONENT F: FARMERS WALK: MAXIMUM DISTANCE COVERED IN 60 SECONDS (CARRYING CAPACITY STRENGTH TEST)			
Equipment needed: 20kg kettlebells / dumbbells x 2 and a stopwatch			
Protocol: Students are required to carry 2 weights in a straight line. They may place the weights down and pick them up again during their attempt. The maximum distance reached is recorded after 60 seconds has elapsed.			
Distance (metres)	**Score**	**Percentage**	**Outcome**
≤ 59	1	25%	Fail
60–69	2	25%	Fail
70–79	3	25%	Fail
80–89	4	50%	Pass
90–99	5	75%	Pass
≥ 100	6	100%	Pass

In the assessment presented in Table 3.3, in order for a student to pass the Physical Preparedness module, the student had to: a) achieve a final overall mark of 50% or more for the module, and b) have passed at least two of the four assessments (i.e. passed all six components) during the same assessment opportunity.

The physical preparedness assessments presented in Table 3.2 and Table 3.3 were vastly different to the physical preparedness assessment being utilised by the other HEIs offering the BHSc EMC programme, and in the 2023 academic year, the HOD at HEI 'A' attempted to align the physical preparedness assessment with that of HEIs 'B' and 'C', which were both utilising the physical preparedness assessment tool which is the focus of this study. The only difference in the 2023 physical preparedness assessment at HEI 'A', from that at HEIs 'B' and 'C', is that the student has the option of either performing the flexed-arm hang test or a kneeling lateral pulldown test for the muscular endurance component of the test (Allan 2023). The 2023 physical preparedness assessment for HEI 'A' is presented in Table 3.4.

Table 3.4: Assessment criteria and ratings for the physical preparedness assessment for the 2023 academic year at HEI 'A' (Allan 2023)

COMPONENT A: 200m SWIM (SWIMMING COMPETENCY ASSESSMENT)				
From	**To**	**Score**	**Percentage**	**Outcome**
> 06:00	N/A	1	25%	Unsatisfactory
05:00	06:00	2	50%	Satisfactory
03:00	04:59	3	75%	Good
< 03:00	N/A	4	100%	Excellent
COMPONENT B: FLEXED-ARM HANG TEST OR KNEELING LATERAL PULL-DOWN TEST (MUSCULAR ENDURANCE)				
FLEXED-ARM HANG TEST				
From	**To**	**Score**	**Percentage**	**Outcome**
< 30 seconds	N/A	1	25%	Unsatisfactory
30 seconds	49 seconds	2	50%	Satisfactory
50 seconds	59 seconds	3	75%	Good
> 60 seconds	N/A	4	100%	Excellent

COMPONENT B: FLEXED-ARM HANG TEST OR KNEELING LATERAL PULL-DOWN TEST (MUSCULAR ENDURANCE)		
KNEELING LAT. PULL-DOWN TEST		
Scoring: To pass the kneeling lateral pull-down test, the student must hold 80% of their body weight for at least 30 seconds.		
Note: Students cannot achieve a mark greater than 50% for the kneeling lateral pulldown test as this test is lower than the industry standard and is the easier adapted variation of the pull-up test and flexed-arm hang test.		
Time	**Percentage**	**Outcome**
< 30 seconds	25%	Unsatisfactory
≥ 30 seconds	50%	Satisfactory

COMPONENT C: 5km RUN (CARDIORESPIRATORY ASSESSMENT)				
From	**To**	**Score**	**Percentage**	**Outcome**
> 32:30	N/A	1	25%	Unsatisfactory
27:31	32:30	2	50%	Satisfactory
22:30	27:30	3	75%	Good
< 22:29	22:29	4	100%	Excellent

3.9.3 Physical preparedness assessment at HEIs 'B' and 'C'

In 2015, in an attempt to design a more scientific and defendable physical preparedness assessment, academic staff from one of the South African HEIs offering both Emergency Medical Care and Sport and Movement Studies analysed the physical preparedness requirements of the BHSc EMC programme, and a physical preparedness assessment tool was developed that utilised absolute standards. The new tool sought to cater for the specific needs of the EMC Department at the South African university. This specific physical preparedness assessment comprises three components: 1) a timed 200m swim as a swimming competency assessment; 2) a timed 5km run to assess cardiovascular endurance; and 3) a flexed-arm hang test to evaluate muscular endurance. Each student registered for the BHSc EMC is required to take part in four physical preparedness assessments which are scheduled at the end of each academic term; and the weightings of these assessments increase throughout the academic year. Each of the three components of the assessment are completed sequentially, and to pass the assessment, students are required to deliver a satisfactory performance in all three of the components. The assessment criteria and ratings for the assessment utilised by HEIs 'B' and 'C' for the 2022 academic year are shown in Table 3.5. The assessment is completed in the following order, with a maximum rest time of 15 minutes between each component: swim, run and flexed-arm hang test (Vincent-Lambert, Coopoo and Van Nugteren 2022).

Table 3.5: Components and assessment rubric for the physical preparedness assessment for the 2022 academic Year at HEI 'B' and HEI 'C' (Vincent-Lambert, Coopoo and Van Nugteren 2022)

COMPONENT A: 200m SWIM (SWIMMING COMPETENCY ASSESSMENT)				
From	**To**	**Score**	**Percentage**	**Outcome**
> 06:00	N/A	1	25%	Unsatisfactory
05:00	06:00	2	50%	Satisfactory
03:00	04:59	3	75%	Good
< 03:00	N/A	4	100%	Excellent
COMPONENT B: 5km RUN (CARDIORESPIRATORY ASSESSMENT)				
From	**To**	**Score**	**Percentage**	**Outcome**
> 32:30	N/A	1	25%	Unsatisfactory
27:31	32:30	2	50%	Satisfactory
22:30	27:30	3	75%	Good
< 22:29	22:29	4	100%	Excellent
COMPONENT C: FLEXED-ARM HANG TEST (MUSCULAR ENDURANCE)				
Time	**Outcome**			
< 30 seconds	Unsatisfactory			
≥ 30 seconds	Satisfactory			

In the 2023 academic year, HEI 'B' implemented minor changes to the weightings of the assessments and the scoring system. However, the components of fitness and selected tests remained unchanged. The revised assessment for HEI 'B' is presented in Table 3.6.

Table 3.6: Components and assessment rubric for the physical preparedness assessment for the 2023 academic year at HEI 'B' (Van Nugteren 2023)

COMPONENT A: 200m SWIM (SWIMMING COMPETENCY ASSESSMENT)			
Swim should be completed using a recognised stroke. No walking is permitted in the shallow end and students who walk will be cautioned and may be disqualified from the swim. Any student who requires assistance in the water will automatically be required to stop swimming and will be awarded a "did not finish" result. The mark is assumptive that the student completes the 200m in the times depicted.			
Descriptor	**Maximum of range**	**Minimum of range**	**Percentage**
Required assistance, disqualified or unable to swim 100m	Not applicable		0%
Can stay afloat	Minimum of 100m swum in time limit		13%
Rudimentary achievement	07:00	06:46	25%
Partial achievement	06:45	06:01	38%
Meets minimum standards	06:00	05:16	50%
Acceptable performance	05:15	04:31	63%
Good performance	04:30	03:46	75%
Superior performance	03:45	03:01	88%
Excellent performance	03:00	Less than 03:00	100%
COMPONENT B: 5km RUN (CARDIORESPIRATORY ASSESSMENT)			
Students are required to run a predetermined route. There are several potential routes that are linked to venues that are often dependent on swimming pool availability. These routes are similar in elevation gain and times are not adjusted from one route to another. No pacing is permitted. Pacing refers to the deliberate assistance by someone for a student taking part in a physical assessment. Pacing includes the act of tailing a runner to help them stick to their time plan, encouraging them or providing any other form of assistance. No person not involved in the assessment may run on the route with any of the students and only staff officiating or assisting with the assessment may drive the route.			
Descriptor	**Maximum of range**	**Minimum of range**	**Percentage**
Does not finish	Did not finish		13%
Rudimentary achievement	37:30	35:01	25%
Partial achievement	35:00	32:31	38%

Meets minimum standards	32:30	30:01	50%
Acceptable performance	30:00	27:31	63%
Good performance	27:30	25:01	75%
Superior performance	25:00	22:31	88%
Excellent performance	22:30	Less than 22:30	100%

COMPONENT C: FLEXED-ARM HANG TEST (MUSCULAR ENDURANCE)

The student is required to hold their own body weight using a flexed-arm hang for a minimum of 30 seconds. Given that 30 seconds is the determinant of competency, a pass is allocated 100%. Inability to achieve the outcomes is assigned a sliding scale below 50%. The table below depicts the mark allocation for the flexed-arm hang.

Descriptor	Minimum of range	Percentage
Unable to hold own weight	Less than 10 secs	0%
Limited ability to hold own weight	11–19 seconds	25%
Inadequate ability to hold own weight	20–29 seconds	38%
Able to hold own weight	30 secs or more	100%

The components of fitness and the selected fitness tests presented in Table 3.5 and Table 3.6 have found favour and anecdotal support from the academic staff and emergency medical care students at three of the HEIs offering the BHSc EMC programme as they address some of the commonly recommended components of physical fitness relating to the physical preparedness of emergency care providers, which are muscular endurance and cardiovascular endurance. The one additional component which has been included is that of swimming. The ability to swim is a life skill and should be deemed an essential skill for all emergency care providers, especially those expected to engage in aquatic rescue (U.S. News 2023). According to WHO (2016), drowning is the third leading cause of unintentional injury and death worldwide, with an estimated 372 000 drowning deaths worldwide, annually. Despite its growing adoption by the HEIs presenting the BHSc EMC programme, the physical preparedness assessment tool and its components presented in Table 3.5 and Table 3.6 has not yet been scientifically validated.

3.9.4 Physical preparedness assessment at HEI ‘D’

A fourth HEI is accredited to offer the BHSc EMC programme, and although this HEI did not consent to take part in this research, the students registered on the BHSc EMC programme at HEI ‘D’ are exposed to physical preparedness during their studies. At HEI ‘D’, the students do not register for a standalone Physical Preparedness module. Instead, physical preparedness is incorporated into the Medical Rescue modules over the four years of the BHSc EMC programme. The assessment of physical preparedness was only implemented for the first time in 2019 at HEI ‘D’, and the assessment consisted of four components which were equally weighted. During the course of the academic year, the students were required to take part in two assessments (de Waal 2019). The components of the physical preparedness assessment, as well as the assessment rubric of the 2019 physical preparedness assessment, is presented in Table 3.7.

Table 3.7: Components and assessment rubric for the physical preparedness assessment for the 2019 academic year at HEI 'D' (de Waal 2019)

PUSH-UPS (TO EXHAUSTION) ASSESSMENT RUBRIC (MALE)							
Men	**Very poor**	**Poor**	**Fair**	**Average**	**Good**	**Very good**	**Excellent**
20–29yrs	**< 4**	**4–9**	**10–16**	**17–29**	**30–39**	**39–46**	**> 47**
Score (%)	0–8% (2%/PU)	9–20% (2.2%/PU)	21–34% (2.2%/PU)	35–70% (3%/PU)	71–89% (2%/PU)	90–99% (1%/PU)	100%
30–39yrs	**< 2**	**2–7**	**8–12**	**13–24**	**25–33**	**34–43**	**> 43**
Score (%)	0–8% (4%/PU)	8–20% (2.2%/PU)	21–34% (2.6%/PU)	35–70% (3%/PU)	71–89% (2%/PU)	90–99% (1.2%/PU)	100%
40–49yrs	**0**	**1–5**	**6–10**	**11–20**	**21–28**	**29–33**	**> 34**
Score (%)	0	0–20% (4%/PU)	21–34% (2.6%/PU)	35–68% (3.5%/PU)	70–86% (2.25%/PU)	86–99% (2.6%/PU)	100%

PUSH-UPS (TO EXHAUSTION) ASSESSMENT RUBRIC (FEMALE)							
Females may use the 'bent knee' position							
Women	**Very poor**	**Poor**	**Fair**	**Average**	**Good**	**Very good**	**Excellent**
20–29yrs	**0–1**	**2–6**	**7–11**	**12–22**	**23–29**	**30–35**	**> 36**
Score (%)	0–4% (4%/PU)	4–20% (3.2%/PU)	21–34% (2.6%/PU)	35–70% (3.1%/PU)	71–86 (2.5%/PU)	87–99% (2%/PU)	100%
30–39yrs	**0**	**1–4**	**5–9**	**10–21**	**22–30**	**31–36**	**> 37**
Score (%)	0	0–20% (5%/PU)	21–34% (2.6%/PU)	35–70% (3%/PU)	71–89% (2%/PU)	90–99% (1.5%/PU)	100%
40–49yrs	**0**	**1–3**	**4–7**	**8–17**	**18–24**	**25–30**	**> 31**
Score (%)	0	0–20% (6.6%/PU)	21–34% (3.3%/PU)	35–69% (3.5%/PU)	70–87% (2.7%/PU)	88–99% (1.8%/PU)	100%

SIT-UPS (1-MINUTE) ASSESSMENT RUBRIC (MALE)							
Men	**Very poor**	**Poor**	**Fair**	**Average**	**Good**	**Very good**	**Excellent**
20–29yrs	**< 25**	**25–30**	**31–34**	**35–38**	**39–43**	**44–49**	**> 50**
Score (%)	0	0–20% (3.3%/SU)	21–34% (3.3%/SU)	35–70% (8.75%/SU)	71–89% (3.6%/SU)	89–99% (2%/SU)	100%
30–39yrs	**< 22**	**22–28**	**29–30**	**31–34**	**35–39**	**40–45**	**> 46**
Score (%)	0	0–20% (2.8%/SU)	21–34% (6.5%/SU)	35–70% (8.75%/SU)	71–89% (3.6%/SU)	90–99% (1.5%/SU)	100%
40–49yrs	**< 17**	**17–22**	**23–26**	**27–29**	**30–34**	**35–41**	**> 42**
Score (%)	0	0–20% (3.3%/SU)	21–34% (3.25%/SU)	35–70% (11.6%/SU)	71–86% (3.6%/SU)	87–99% (1.7%/SU)	100%

SIT-UPS (1-MINUTE) ASSESSMENT RUBRIC (FEMALE)							
Women	**Very poor**	**Poor**	**Fair**	**Average**	**Good**	**Very good**	**Excellent**
20–29yrs	**< 18**	**18–24**	**25–28**	**29–32**	**33–36**	**37–43**	**> 44**
Score (%)	0	0–20% (3.3%/SU)	21–34% (3.35%/SU)	35–70% (8.75%/SU)	71–89% (4.5%/SU)	89–99% (1.4%/SU)	100%
30–39yrs	**< 13**	**13–20**	**21–24**	**25–28**	**29–32**	**33–39**	**> 40**
Score (%)	0	0–20% (2.5%/SU)	21–34% (3.25%/SU)	35–70% (8.75%/SU)	71–89% (4.5%/SU)	90–99% (1.3%/SU)	100%
40–49yrs	**< 7**	**7–14**	**15–18**	**19–22**	**23–26**	**27–33**	**> 34**
Score (%)	0	0–20% (2.5%/SU)	21–34% (3.25%/SU)	35–70% (8.75%/SU)	71–89% (4.5%/SU)	89–99% (%/SU)	100%

MULTI-STAGE FITNESS TEST ASSESSMENT RUBRIC (MALE)							
Also known as the 'beep' or 'bleep' test							
Men	**Very poor**	**Poor**	**Fair**	**Average**	**Good**	**Very good**	**Excellent**
18–25yrs	**< 5/2**	**5/2–7/1**	**7/2–8/5**	**8/6–10/1**	**10/2–11/5**	**11/6–13/10**	**> 13/10**
Score (%)	0	0–18% (0.95%/Sh)	19–33% (1.07%/Sh)	34–68% (1.94%/Sh)	69–87% (1.2%/Sh)	87–97% (0.35%/Sh)	97–100% (0.35%/Sh)
26–35yrs	**< 5/2**	**5/2–6/5**	**6/6–7/9**	**7/10–8/9**	**8/10–10/6**	**10/7–12/9**	**> 12/9**
Score (%)	0	0–20% (1.5%/Sh)	21–34% (1.08%/Sh)	35–70% (3.5%/Sh)	71–89% (1.06%/Sh)	90–99% (0.38%/Sh)	100%
36–45yrs	**< 3/8**	**3/8–5/3**	**5/4–6/4**	**6/5–7/7**	**7/8–8/9**	**8/10–11/3**	**> 11/3** **100%**
Score (%)	0	0–20% (1.54%/Sh)	21–34% (1.3%/Sh)	35–68% (2.7%/Sh)	69–86% (1.5%/Sh)	87–96% (0.33%/Sh)	86–100% (0.33%/Sh)

MULTI-STAGE FITNESS TEST ASSESSMENT RUBRIC (FEMALE)							
Also known as the 'beep' or 'bleep' test							
Women	**Very poor**	**Poor**	**Fair**	**Average**	**Good**	**Very good**	**Excellent**
18–25yrs	**< 4/5**	**4/5–5/7**	**5/8–7/2**	**7/3–8/6**	**8/7–10/1**	**10/2–12/7**	**> 12/7**
Score (%)	0	0–20% (1.7%/Sh)	21–34% (1.08%/Sh)	35–70% (2.5%/Sh)	71–89% (1.06%/Sh)	90–97% (0.31%/Sh)	100%
26–35yrs	**< 3/8**	**3/8–5/2**	**5/3–6/5**	**6/6–7/7**	**7/8–9/4**	**9/5–11/5**	**> 11/5**
Score (%)	0	0–20% (1.7%/Sh)	21–34% (1.08%/Sh)	35–70% (2.9%/Sh)	71–89% (1.2%/Sh)	90–99% (0.4%/Sh)	100%
36–45yrs	**< 2/7**	**2/7–3/7**	**3/8–5/3**	**5/4–6/2**	**6/3–7/4**	**7/5–9/5**	**> 9/5**
Score (%)	0	0–20% (2.2%/Sh)	21–34% (1.1%/Sh)	35–70% (4.38%/Sh)	71–89% (1.5%/Sh)	90–99% (0.45%/Sh)	100%

BASIC SWIMMING PROFICIENCY - ASSESSMENT RUBRIC		
Category	**Satisfactory (100%)**	**Unsatisfactory (0%)**
Front & back float	**Back Float:** While holding the side, the student should back away from the wall until they are leaning back into it diagonally with their arms straight. Tell them to straighten their legs and let go of the wall. The student is required to float for 2 minutes **Front Float:** While holding the side, the student should back away from the wall until they are leaning into it diagonally with their arms straight. Tell them to take a big breath and put their face in the water so only the back of their head is exposed and let go of the wall. Have them hold that position until they need to take a breath (> 30s).	The student is unable to float in the correct position or maintain the position for the required duration of time.

BASIC SWIMMING PROFICIENCY - ASSESSMENT RUBRIC		
Category	**Satisfactory (100%)**	**Unsatisfactory (0%)**
5-minute water tread	The student is able to tread water unaided and without holding on to the side for 5 minutes). Two infringements will lead to disqualification: i.e. one warning on the first infringement, and disqualification on the second infringement. The following constitute infringements: - The body must be vertical (upright) during the water tread. Any loss of this position will be an infringement. - Submersion (head going under the water). - Touching the bottom of the pool, the side of the pool and/or another student	The student is unable to tread water unaided and without being disqualified for 5 minutes)

BASIC SWIMMING PROFICIENCY - ASSESSMENT RUBRIC		
Category	**Satisfactory (100%)**	**Unsatisfactory (0%)**
50m freestyle / breaststroke (unaided)	The student is able to swim 50m (2x25m lengths) unaided using either Breaststroke or Freestyle without being disqualified. Two infringements will lead to disqualification: i.e. one warning on the first infringement, and disqualification on the second infringement The following constitute infringements: - Swimming any stroke other than Breaststroke or Freestyle - Standing in the pool - Hanging on the side of the pool - Resting by floating for more than 30 seconds - Resting at the end of a length (if using a 25m pool) for more than 30 seconds	The student is unable to swim the required distance without being disqualified.

In 2022, HEI ‘D’ implemented a physical preparedness assessment which is specifically utilised to assess a student’s level of physical preparedness for entry into the rescue module in each of the academic years. The assessment consists of six components, and the minimum pass requirements for the assessment varies, depending on the academic year. If a student is unsuccessful in achieving the minimum pass requirements for this physical preparedness assessment, which is utilised as an entry assessment for the rescue module, the student is afforded a supplementary assessment opportunity; and if they are still unsuccessful, the student is required to deregister from the rescue module for that specific academic year (Millar 2022). This assessment is presented in Table 3.8.

Table 3.8: Components and assessment rubric for the physical preparedness assessment for the 2022 academic year at HEI ‘D’ (Millar 2022)

<table>
<tr><th colspan="2">1. 2.4km RUN</th></tr>
<tr><td colspan="2">The 2.4km run is a measurement of endurance and aerobic fitness.
The run is a continuous 2.4km loop on the tar road.</td></tr>
<tr><td>Males</td><td>Females</td></tr>
<tr><td>Must complete the distance within 16 minutes</td><td>Must complete the distance within 19 minutes</td></tr>
<tr><th colspan="2">2. PUSH-UPS</th></tr>
<tr><td colspan="2">This is a measurement of upper body strength.
Males: Use the standard ‘military style’ push-up technique. The starting position is facing down with your weight distributed on the hands and feet, arms straight. The body is rigid and straight, and the hands are placed approximately shoulder width apart. Lower your body until your chest nears the floor at the bottom of the movement, and then return up to the starting position. This is one repetition.
Females: May use the ‘bent knee’ technique. To do this, kneel on the floor, hands on either side of the chest and keep your back straight. Lower the chest down towards the floor, always to the same level each time, either till your elbows are at right angles or your chest touches the ground.</td></tr>
<tr><td>Males</td><td>Females</td></tr>
<tr><td>Must score a minimum of 10 continuous push ups.</td><td>Must score a minimum of 5 continuous push ups.</td></tr>
</table>

3. SQUATS	
This is a measurement of lower body strength. *To perform the squat, stand with your feet at shoulder width apart. Place your hands on your hips. Squat down until your knees are at right angles (90 degrees). Your heels should remain on the floor during the squat.*	
Males	**Females**
Must score a minimum of 24 in one minute.	Must score a minimum of 20 in one minute.
4. DEADWEIGHT CARRY	
This is a measurement of total body strength. *To perform the dead lift carry, walk 75 metres with the weights.* *Males: Are allowed a maximum of one stop for 20 seconds duration* *Females: Are allowed a maximum of 2 stops of 20 seconds duration each.*	
Males	**Females**
Must carry a 16kg weight in each hand.	Must carry a 12kg weight in each hand.
5. SIT-UPS	
This is a measurement of core strength. *Lie on a cushioned floor with your knee bent at approximately right angles (90 degrees), with feet flat on the ground. Your hands should be resting on your thighs. The feet are not anchored. Squeeze your stomach, push your back flat and raise high enough for your shoulders to be over the line of your hips. Don't pull with your neck or head and keep your lower back on the floor. Then return to the starting position.*	
Males	**Females**
Must score a minimum of 22 in one minute.	Must score a minimum of 13 in one minute.
6. SWIM	
This is a measurement of swimming proficiency. *Students can swim any stroke. Students may not wear a wetsuit, PFD or make use of any other swimming float or aid. Students may not hang onto the swimming lanes or side of the pool or stand/walk in the shallow end.*	
Males & Females	
Must be completed in 6 minutes or less.	

PASS REQUIREMENTS
First Year
To successfully pass the assessment, the student must achieve the minimum standard of the following: • 2.4km run • Deadweight carry • Any 2 of the remaining physical components (squats, push-ups, sit-ups, swim)
Second Year
To successfully pass the assessment, the student must achieve the minimum standard of the following: • 2.4km run • Push-ups • Squats • Deadweight carry • Sit-ups
Third Year
To successfully pass the assessment, the student must achieve the minimum standard of the following: • 2.4km run • Push-ups • Squats • Deadweight carry • Sit-ups **Students must pass an extended swim assessment prior to registration for Aquatic Rescue.**
Fourth Year
To successfully pass the assessment, the student must achieve the minimum standard of the following: • 2.4km run • Push-ups • Squats • Deadweight carry • Sit-ups

The physical preparedness assessments which have been presented in Tables 3.2; 3.3; 3.4; 3.5; 3.6; 3.7 and 3.8 are all in the format of a physical performance test as a battery of fitness tests which have been selected to represent different components of fitness. Three of the physical preparedness assessments (Table 3.2, Table 3.7 and Table 3.8) utilise age and gender-based fitness norms as part of the assessment criteria. As discussed under 3.6.1, absolute standards are preferred when determining minimum levels of physical preparedness in establishing a validated PES (Tofari, Treloar and Silk 2013). These physical preparedness assessments were designed by academics from the emergency medical care departments, with some assistance from academics in the sports science field. However, the selected fitness tests were not based on any research specific to emergency medical care students registered for the BHSc EMC programme and the selected physical fitness tests are not all validated tests of the different components of fitness. The three fitness tests, namely the 200m swim, 5km run and flexed-arm hang test, which form part of the physical preparedness assessment tool presented in Table 3.5 and Table 3.6, formed part of the testing during the assessment of physical preparedness (Chapter 7) for this research.

3.10 VALIDITY AND RELIABILITY OF A PHYSICAL PREPAREDNESS ASSESSMENT

One of the research questions associated with this study was to determine to what extent the current physical preparedness assessment tool presented in Table 3.6, and utilised by the three participating universities offering Emergency Medical Care in South Africa, could produce valid and reliable results which accurately assess the EMC student's ability to engage successfully in physically strenuous learning activities associated with the content of the Medical Rescue and Emergency Medical Care modules. When establishing a physical preparedness assessment which will function as a PES, the assessment tool must be scientifically valid, and it must be reliable.

Validity (in this context) is the extent to which the assessment tool measures what it claims to measure. When determining validity, it is important to determine the construct, content and face validity. Construct validity is defined as the degree to which an assessment measures what it is intended to measure (Polit and Beck 2012). Content validity evaluates the degree to which the content of the assessment matches the content domain associated with the construct (Creswell *et al.* 2016). Lastly, face validity is the degree to which an assessment appears to measure certain principles; but there is no guarantee that the assessment actually measures occurrences within that domain. There is a very close relationship between face and content validity (Gravetter and Forzano 2015). It is important to remember that, in order for a task-oriented physical preparedness assessment to be scientifically valid, the PES must be job-related, and it must measure what it is intended to measure. A PES can discriminate if job-relatedness is well established and documented, as the purpose of the PES is to reliably predict whether a person is physically able to perform the associated operational tasks required of them (Busch 2013; Cooper 2014).

Reliability refers to the stability, as well as the consistency, of the assessment and the assessment tool. Stability, in the context of this study, refers to the degree to which the assessment and assessment tool are able to be repeated on separate occasions; whereas consistency refers to the degree to which the assessment and assessment tool measure the constructs of interest. The form of reliability that this study will investigate is inter-rater reliability, which refers to the ability of the assessment tool to be able to yield similar results when used by more than one assessor to assess the same student (Creswell *et al.* 2016).

3.11 CONCLUSION

There are a number of national and international studies and recommendations on the task-oriented physical preparedness requirements of emergency responders such as firefighters, police officers and emergency care providers. However, there is a paucity of literature on the physical preparedness requirements and the assessment thereof for EMC students engaged in both emergency medical care and medical rescue as part of their studies. This study addressed this knowledge gap through an in-depth critical analysis and evaluation of the desired physical attributes and abilities of EMC students, linked to the unique curriculum and associated learning experiences. This allowed for the development and validation of a tool for the assessment of physical preparedness of South African EMC students. The development of this tool is an important and unique contribution to the field of emergency medical care and rescue. The results of this study may inform the assessment of EMC students and also serve as a benchmark for the industry at large, with regard to assessing task-oriented physical preparedness levels of operational emergency responders in South Africa.

CHAPTER 4: RESEARCH METHODOLOGY

4.1 INTRODUCTION

Chapter 4 focuses on providing a detailed description of the method and approach utilised to gather, analyse, and interpret data for the study, which focused on the development and validation of a tool to assess the task-oriented physical preparedness of South African emergency medical care (EMC) students. The chapter begins with a discussion of the research paradigm, followed by a detailed description and defence of the selected design. The methods and procedures that were applied to source and analyse the data for the survey questionnaire and focus group interviews, and the assessment of physical preparedness, are described in detail. Also included in this chapter is an overview of the measures taken by the researcher to enhance the validity, reliability and trustworthiness of the findings of the study. The chapter concludes with a discussion of the ethical considerations applicable to the study.

4.2 RESEARCH PARADIGM

The research paradigm provides the framework within which the theories and practices of the selected research focus area are situated, facilitating the development of the research plan. The research paradigm guides all areas of the study, including the aim, objectives, research questions, methodology, and data analysis (Yong, Huslin and Kamarudin 2021). According to Scotland (2012), a research paradigm consists of four elements: ontology, epistemology, methodology and axiology. These four elements comprise the basic assumptions, beliefs, norms and values of each of the different paradigms. Therefore, allocating a particular paradigm to research implies that the researcher will uphold and be guided by the assumptions, beliefs, norms and values of the selected paradigm (Kivunja and Kuyini 2017). Each research paradigm will have different ontological and epistemological views which will inform the methodological approach of the study.

In research of a quantitative nature, the paradigm which is most commonly applied is the positivist approach (Yong, Huslin and Kamarudin 2021). The ontological position of positivism is realism and the epistemology is objectivism. A positivist is an individual that will discover absolute knowledge about an objective reality. Research of a qualitative nature utilises the constructivist paradigm. The ontological position of constructivism is relativism, and the epistemology is one of subjectivism. A constructivist researcher attempts to understand a phenomenon from an individual's perspective (Scotland 2012). When adopting a paradigm for a mixed methods research study, three possible positions could apply: the a-paradigmatic stance, the multiple paradigm stance, and the single paradigm stance (Hall 2013).

In this mixed methods research study, the researcher selected a single research paradigm that addressed both the quantitative and qualitative methodology applied (Hall 2013). The research paradigm considered most suited for this type of study was that of pragmatism. The pragmatic approach to research is outcome-oriented and interested in determining the meaning of things; but most importantly, it places primary emphasis on the research question. A pragmatic researcher is capable of maintaining critical subjectivity in their own reflections and objectivity during the data collection and analysis process (Shannon-Baker 2016). The pragmatic paradigm advocates a relational epistemology, a non-singular reality ontology, a mixed methods methodology and a value-laden axiology (Kivunja and Kuyini 2017). The pragmatic paradigm was appropriate for this research study as both quantitative and qualitative data were collected to assist in the development of a validated tool for the assessment of the task-oriented physical preparedness of South African emergency medical care students.

4.3 THEORETICAL PERSPECTIVES ON THE RESEARCH DESIGN

4.3.1 Theory building

The selection of an appropriate research design is one of the most important components of the research process. The research design refers to the approach that is selected to incorporate the different components of a study in a rational way in order to ensure that the research problem is addressed. Therefore, the appropriate research design is determined by the research problem (De Vaus 2001). There are two main recognised research designs: quantitative and qualitative (Rutberg and Bouikidis 2018).

Quantitative research designs utilise a systematic and objective process of collecting and analysing numerical data which is then generalisable to a population. The relationship between an independent and dependent variable is determined.

Quantitative research is either descriptive or experimental, where descriptive research establishes associations between variables, and experimental research allows the researcher to establish a connection (Muijs 2010). Elements in this research project require the quantitative approach.

In contrast to quantitative designs, qualitative research is primarily exploratory research and it is used to gain an understanding of underlying reasons, opinions and motivations. It involves the collection, analysis and interpretation of non-quantitative data through discussions, interviews and observations. However, the results are not generalisable to a population (Creswell *et al.* 2016). Types of qualitative research include phenomenology, grounded theory, historical research, ethnography and case studies. Qualitative research is flexible in nature as it adapts to new information, based on data that has already been collected, and the researcher becomes entrenched in the investigation (Rutberg and Bouikidis 2018).

A third type of research design is one which builds on both quantitative and qualitative designs and has become known as a 'mixed methods' design. In the mixed methods approach, both numerical and text data are collected, analysed and then integrated to explore the research problem in order to address the research questions. Proponents of mixed methods argue that the integration of both the quantitative and qualitative data maximises the strengths and minimises the weaknesses of each type of data (Creswell and Plano Clark 2011). The reasons for using mixed methods research were first classified by Greene, Caracelli and Graham in 1989. This classification is still in use today, and identifies five reasons/requirements: 1) triangulation; 2) complementarity; 3) development; 4) initiation; and 5) expansion (Schoonenboom and Johnson 2017).

After careful consideration of the above-mentioned theories, in the context of the research questions and objectives of this study, it was determined that a mixed methods design would be most appropriate.

4.3.2 Types of methods

Four main research methods were used in this study. The first consisted of a literature review which is presented in Chapter 3. The purpose of the literature review was to present an overview of a large and diverse body of literature pertaining to a broad topic. This type of research method is commonly utilised to examine the scope, variety and nature of research activity within a specific research focus area. It can also assist in identifying gaps in the existing literature (Pham *et al.* 2014).

The second research method utilised was a survey questionnaire. Quantitative survey questionnaires are defined as objective questions utilised to obtain detailed insights from respondents about a survey research topic. A quantitative survey questionnaire was utilised to measure the characteristics of the population with statistical precision (Apuke 2017).

The third method was focus group interviews, which are a method for collecting qualitative data. There has been an increase in the popularity of focus group interviews, especially in the context of healthcare research over the last 20 years (McLafferty 2004). Focus group interviews are performed according to a planned agenda and with a small group of people, usually six to nine participants. The interview is conducted by a moderator (the researcher) and the participants are purposely sampled from the study population. Focus group interviews are a useful method to explore the attitudes, perceptions, feelings and ideas of the participants on a set topic (Dilshad and Latif 2013).

The fourth and final method applied in this study was a cross-sectional observational assessment of physical preparedness in the format of a physical performance test. Testing was conducted utilising a standardised procedure, under controlled conditions, where precise measurements were possible. The location, timing, population and circumstances of the testing were determined by the researcher (Creswell *et al.* 2016).

4.3.3 The research design in this study

An exploratory sequential mixed methods design was selected for this study to best address the specific aims and objectives. This design allowed the researcher to assess both the qualitative and the quantitative data in an attempt to answer the research questions (Schoonenboom and Johnson 2017). A sequential design was utilised, as the researcher first needed to gather and analyse qualitative data from the literature review, before making use of this qualitative data to develop the survey questionnaire, which was of a quantitative nature. The quantitative data from the survey questionnaire was then analysed to inform the agenda for the focus group interviews which would, in turn, produce qualitative data to assist in the development of the test for the assessment of physical preparedness.

In an exploratory sequential mixed methods design, the quantitative results are augmented by qualitative data (Gogo and Musonda 2022). This integration of quantitative and qualitative data can enhance the value of mixed methods research, which can be applied across various stages of the research process, including design, methodology, and interpretation. Specifically, in an exploratory sequential design, the researcher starts by collecting and analysing qualitative data (literature review and focus group interviews). This qualitative phase informs the subsequent quantitative data collection process (survey questionnaire and assessment of physical preparedness).

At the methodology level, integration can occur by linking the data collection method and analysis using techniques such as connecting, building, merging, or embedding. Integration through building was utilised in this research, as the results from one data collection phase informed the data collection approach for the next phase.

Lastly, integration extends to the interpretation and reporting levels, which can be achieved through narrative, data transformation, or joint display techniques. This study employed a narrative approach to present the qualitative and quantitative findings in a series of reports. Each phase of the data collection process is represented by a dedicated chapter within this thesis, in the form of a narrative report (Fetters, Curry and Creswell 2013). Figure 4.1 shows the four different methodologies utilised to gather the data needed to address the aim and objectives of this research.

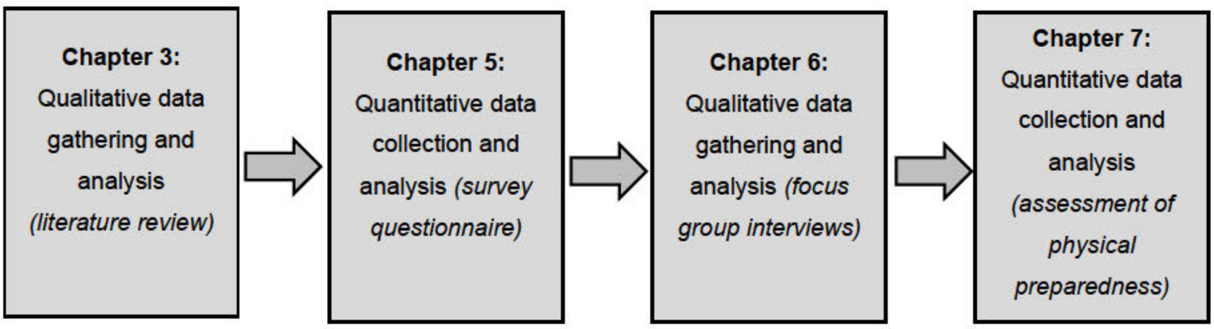


Figure 4.1: The sequential exploratory research design (Creswell and Plano Clark 2011)

4.4 METHODS USED IN THE SURVEY QUESTIONNAIRE

4.4.1 Approach

In this quantitative phase of the research study, the researcher made use of a purpose-designed survey questionnaire (Appendices 5A and 5B). The main aim of the questionnaire was to probe understanding and elicit feedback from emergency medical care students and academic staff specifically involved in the Medical Rescue and Physical Preparedness education and/or assessment components of the Bachelor of Health Sciences Degree in Emergency Medical Care (BHSc EMC) programmes at the three participating higher education institutions (HEIs). The knowledge gained from the literature review on the current practice of assessing physical preparedness of emergency responders such as such as police officers, firefighters and emergency care providers was utilised to assist in the development of the questions for the survey questionnaire.

The survey consisted, in the main, of closed questions with preset response options, thus making it a quantitative data gathering tool. Quantitative research is utilised to explain phenomena by collecting numerical data that is then analysed using statistics (Apuke 2017). The purpose of a survey questionnaire is to describe and interpret 'what is' (Creswell *et al.* 2016). As highlighted above, the intention of the questionnaire was to investigate and describe the opinions of the academics and emergency medical care students regarding the physical requirements/task-oriented activities linked to participation in the BHSc EMC programme, and the extent to which they feel that their current physical preparedness assessment tool adequately assesses task-oriented physical preparedness. The knowledge and information gained from the literature review was used to develop the content for the online survey questionnaire.

4.4.2 Participants

4.4.2.1 Population

This study's population comprised all EMC students and academic staff involved in physical preparedness across all HEIs offering BHSc EMC programmes. The target population specifically included academic staff engaged in the education and/or assessment of medical rescue and/or physical preparedness in the BHSc EMC programme, along with emergency medical care students registered for the BHSc

EMC programme at HEIs within South Africa. The accessible population included academic staff and emergency medical care students from the three HEIs that agreed to participate in the study.

4.4.2.2 Inclusion and exclusion criteria

The inclusion criteria for the accessible population were clearly defined to ensure that the participants had the relevant background knowledge in order to engage meaningfully with the content of the survey questionnaire.

The inclusion criteria for participants were as follows:

1. The academic staff had to be engaged in the teaching of the Medical Rescue and/or Physical Preparedness modules for the 2020 academic year on the BHSc EMC programme at one of the three HEIs included in the study.
2. The students had to be registered for either their third or fourth year of study on the BHSc EMC programme in the 2020 academic year.
3. Participants of all ages were eligible to participate in the study, as no minimum or maximum age criterion was applicable.

The exclusion criteria were:

1. Academic staff who were not involved with the teaching of the Medical Rescue and/or Physical Preparedness modules on the BHSc EMC programme at one of the three HEIs.
2. Students registered for either the first or second year of the BHSc EMC programme at one of the three HEIs. The first- and second-year students of the BHSc EMC programme were excluded as the first-year students would not have engaged in any of the Medical Rescue modules, as the Medical Rescue modules only commence from the second year of study on the BHSc EMC programme. The second-year students were also excluded as they would only have engaged with four out of the 12 Medical Rescue modules and would therefore also have had very limited exposure to medical rescue, which was the main focus of the questionnaire.

A cross-sectional design was utilised for this phase of data collection and the approach to sampling was purposive in nature, as the participants were purposefully selected from the three participating HEIs, based on set characteristics to address the objectives of the study. All the participants that met the inclusion criteria from this accessible population were included as part of the study. The aim was to obtain a 100% response rate from the academic staff as there were a limited number of academic staff at the three HEIs that met the inclusion criteria. Using the Raosoft Sample Size Calculator, with a population size of 14 academics, a minimum sample size of 14 was calculated with a 5% margin of error and a 95% confidence interval. The population size for the third- and fourth-year students was 131. Making use of the Raosoft Sample Size calculator, a minimum sample size of 98 students was calculated with a 5% margin of error and a 95% confidence interval (Raosoft 2004).

The application of the approaches described above resulted in a final response rate of 89.3% (117/131) for student respondents and 85.7% (12/14) for academic staff.

4.4.3 Data collection procedure

After ethical clearance (IREC 058/19) to conduct the study had been received from the Durban University of Technology's (DUT) Institutional Research Ethics Committee (IREC) (Appendix 1), the researcher obtained Gatekeeper Clearance from the three HEIs (Appendices 2A, 2B and 2C). Once approval was received from the three HEIs, the heads of department (HODs) at the three participating HEIs were contacted to assist with the distribution of the research information. The HODs and year co-ordinators, assisted with the distribution of the introductory email and information letter (Appendix 3) to both the academic staff and the third- and fourth-year emergency medical care students. This measure was taken as the researcher was mindful of the fact that students remain a vulnerable population. The introductory email included a brief overview of the study as well as the intended aim of the study. The introductory email also highlighted that participation was voluntary and that respondents could withdraw from the study at any stage without any negative consequences.

The online questionnaire was accessed by respondents clicking on a link that was available in the introductory email that had been sent. All of the questions in the questionnaire were compulsory as respondents had to answer each question before being able to proceed to the next question. Once the questionnaire had been completed by the respondents, they were no longer able to withdraw from the study due to the anonymous nature of the online database. The online survey questionnaire was administered over a period of three months with several reminder emails circulated in an attempt to improve the response rate.

The survey questionnaire was made up of four sections which consisted of purpose-designed questions to address the aim and objectives of the study. When designing a questionnaire, there are seven different types of questions to select from. These are broadly divided into open (unstructured) and closed (structured) questions (Creswell *et al.* 2016). The survey questionnaire for this study consisted of the following types of questions: main biographical-type variables; dichotomous; four-point Likert scale; ranking, and an open question. The online platform QuestionPro® (https://www.questionpro.com) was utilised to administer the questionnaire to both the academic staff and senior students. An information letter (Appendix 3) and consent form (Appendix 4) were included as part of the online survey questionnaire. Respondents had to read the information letter and agree to participate in the study before being allowed to proceed with the questionnaire on the online platform.

The questionnaire for both the student respondents and the academic staff (Appendices 5A and 5B) was divided into four sections: 1) demographics; 2) background content; 3) physical training; and 4) assessment of physical preparedness. The purpose of the first section of the questionnaire was to gather data on the demographic profile of the student respondents and the academic staff. Data relating to age and sex were collected for both the students and the academic staff. The year of study and at which HEI the student respondents were registered was collected for the students; and the modules lectured and/or facilitated, and at which HEI, were collected for the academic staff.

The second section of the questionnaire addressed the background content relating to task-oriented physical preparedness in the context of the BHSc EMC programme. The purpose of this section of the questionnaire was to gather information relating to current practice at the different HEIs regarding task-oriented physical preparedness as well as to investigate and describe the opinions of the academic staff and emergency medical care students regarding the physical requirements/task-oriented activities linked to participation in the BHSc EMC programme.

The third section of the questionnaire focused specifically on physical training and whether these training sessions were structured. For the purpose of this study, the term ‘structured physical training’ referred to physical training sessions which were formally scheduled on the academic timetable every week of the academic year; and these physical training sessions were led by a dedicated lecturer with clear aims and objectives that linked to the content of the BHSc EMC programme and the components of physical fitness which formed part of the physical preparedness assessment utilised by the three different HEIs.

The fourth and last section of the questionnaire focused specifically on the opinions of the academic staff and student respondents on the assessment of physical preparedness at the three different HEIs, and which components of fitness should form part of the physical preparedness assessment.

4.4.4 Statistical analysis

The service of a professional statistician was used to assist with the analysis of the raw data from the survey questionnaire (Appendix 14). The computer programme utilised by the statistician was IBM Statistical Package for the Social Sciences (SPSS Statistics) Version 25.0. The statistical component of the research consisted of both descriptive and inferential statistics. The data from the questionnaire was analysed by utilising one of the following methods:

- Descriptive statistics
- Analysis of variance (ANOVA)
- Binomial test
- One sample t-test
- Independent samples t-test
- Manual coding of the free responses to the open question

4.5 METHODS USED IN THE FOCUS GROUP INTERVIEWS

4.5.1 Approach

In this qualitative phase of the research study, the researcher made use of a purposefully and carefully constructed agenda for two focus group interviews, which was informed by the results of the questionnaire (Appendices 9A and 9B). The main aim of the focus group interviews was to further probe the understanding and elicit detailed feedback from both the emergency medical care students and academic staff specifically involved in the Medical Rescue and Physical Preparedness education and/or assessment components of the BHSc EMC programmes at the three participating HEIs on specific areas of interest that arose out of the results of the questionnaire.

This step in the data collection process followed a qualitative, exploratory, descriptive, phenomenological design. This design was appropriate for this step in the data collection process as it allowed the researcher to further explore, describe and understand the meaning of common themes identified about the phenomenon being studied. Qualitative research utilises open, exploratory research questions, instead of closed-ended questions, to obtain a better understanding of a phenomenon (Elliott and Timulak 2007). Qualitative research depends on linguistic rather than numerical data in order to extract meaning from the data (Hesse-Biber and Leavy 2011). The focus with this research design is on the meaning that certain lived experiences have for the participants; in other words, to determine what an experience means to that specific person through a comprehensive description of the experience (Hunter, McCallum and Howes 2018). As there was limited data available on the views and opinions of emergency medical care students and academic staff on the physical requirements/task-oriented activities linked to participation in the BHSc EMC programme and the extent to which they felt that their current physical preparedness assessment tool adequately assessed task-oriented physical preparedness, the phenomenological design was the most appropriate research design for this phase of the data collection process (Poggenpoel, Myburgh and Van der Linde 2006).

4.5.2 Participants

The same academic and emergency medical care students that completed the questionnaire were all eligible to take part in the focus group interviews. The focus group interview participants needed to be seen as representative of each of the HEIs. For this reason, a purposive sampling strategy was utilised to identify participants for the two focus group interviews. Purposive sampling allows the researcher to select participants with the aim of representing a phenomenon, group, incident, location or type in relation to the key focus area of the study (Creswell *et al.* 2016). The inclusion criteria were applied in terms of the purposive selection of the participants in order to promote the trustworthiness of the data (Creswell 2007). The inclusion criteria for the accessible population were clearly defined to ensure that the participants had the relevant background knowledge to engage meaningfully in the focus group interviews.

The inclusion criteria for the participants for the focus group interviews were as follows:

1. The academic staff had to be engaged in the teaching of the Medical Rescue and/or Physical Preparedness modules for the 2021 academic year on the BHSc EMC programme at one of the three HEIs included in the study.
2. The students had to be registered for their fourth year of study on the BHSc EMC programme in the 2021 academic year.
3. Participants of all ages were eligible to participate in the study as there was no minimum or maximum age criterion applicable.

For the interview with the students, the researcher included nine participants (three from each of the HEIs) and all nine of the students were fourth-year students. The reason for this was that they would have had the most experience with the medical rescue training and physical preparedness assessments. For the academic staff focus group interview, two staff members were invited from each of the HEIs, totalling six participants. In order for a focus group interview to produce in-depth qualitative data about a group's perceptions, attitudes and experiences on a defined topic, the group should consist of between five to 12 people (Creswell *et al.* 2016). Taking these views into consideration, the researcher feels that the sample size for the two focus group interviews was appropriate.

4.5.3 Data collection procedure

4.5.3.1 Data collection method

Focus group interviews were selected as the data collection method for this phase of the study as it is believed that group interactions produce a broader range of responses, with the additional benefit of the group discussion triggering the participants to recall forgotten details of experiences (Creswell *et al.* 2016). In this group interview setting, the participants engage in a discussion with each other rather than with the moderator and this allows the participants to build on each other's experiences and provide a more detailed view on the phenomenon. This level of engagement and detailed view is not always achievable in individual interviews (Qu and Dumay 2011). The advantage of focus group interviews is that they are convenient to administer for both the interviewer and interviewees. In addition, there is less risk of bias as the interviewer does not have an active role to play in leading the discussion. Instead the interviewer takes on the role of a moderator to guide the discussion and clarify aspects (Creswell *et al.* 2016; Qu and Dumay 2011). The limitations associated with focus group interviews are the small sample size and the risk of information bias as a result of group processes, such as dominance by outspoken individuals, 'groupthink' and limited input from less confident participants (Creswell *et al.* 2016).

4.5.3.2 Data collection tool

The agendas for the focus group interviews (Appendices 9A and 9B) were purposefully and carefully constructed by the researcher and they were informed by the findings of the questionnaire. The agendas were constructed in English as this was the medium of instruction utilised at the three participating HEIs. The use of one language (English), which was the medium of instruction at the three participating HEIs, ensured that all participants were able to clearly understand the conversation during the focus group interview process. Furthermore, it guaranteed that statements were made in a language understood by all participants. The agendas consisted of four focus areas, which consisted of purpose-designed questions to address the aim and objectives of the study. The agenda opened with a welcome, introduction and briefing of the participants by addressing the following areas: 1) introduction of the research team; 2) establishment of informed consent; 3) confirmation that the focus group interview would be recorded; 4) defining the purpose of the focus group interview; 5) explaining the ground rules for the focus group interview; 6) clarity seeking questions; and 7) introduction of the participants.

The next section of the agenda focused on addressing the four focus areas that arose as topics of interest after completion of the analysis of the data from the questionnaires. The four focus areas were: 1) the current physical preparedness assessment tool; 2) task-simulated tests versus physical performance tests; 3) physically strenuous components of the BHSc EMC programme; and 4) the components of physical fitness. The last section of the agenda addressed the conclusion of the agenda, which allowed participants an opportunity to reflect on the main ideas from the focus group interview and to share any additional thoughts.

4.5.3.3 Pilot testing of the agenda

Prior to the focus group interviews being conducted, a pilot interview was conducted by the researcher with one emergency medical care student and one academic staff member to determine whether any changes were required to the structure of the agenda and to the researcher's interview technique. Neither of these two participants were part of the selected participants for the scheduled focus group interviews, and the data from these two interviews was not included in the final analysis. No changes were required to the focus group agenda or the researcher's interview technique after this pilot testing.

4.5.3.4 Identification of participants

As previously stated, purposive sampling was utilised to select the participants for the focus group interviews. Two academic staff that were directly involved in the teaching of the Medical Rescue and/or Physical Preparedness modules for the 2021 academic year on the BHSc EMC programme at the three participating HEIs were purposefully selected to form part of the panel for the focus group interview with the academic staff. The HODs assisted with the purposeful selection of three fourth-year emergency medical care students from each of the participating HEIs, as the researcher was mindful of the fact that students remain a vulnerable population; and the HODs were also more familiar with the students in order to assist with the purposive sampling.

Once the participants had been confirmed for the two focus group interviews, an introductory email was sent to each participant which contained an information letter (Appendix 6), consent form (Appendix 7) and consent for audio recording (Appendix 8). The participants were all aware that the focus group interviews formed part of the researcher's post-graduate studies.

4.5.3.5 Focus group interview proceedings

The focus group interviews were conducted by the researcher via the online Microsoft Teams® platform. This approach was selected as face-to-face interviews were not possible with the COVID-19 restrictions in place at the different HEIs at the time that the focus group interviews were conducted. The researcher was aware of the limitations of this approach as the researcher was not able to capture non-verbal cues. During the initial introduction phase of the focus group interviews, all participants were required to make use of their video camera feature so that all participants had a visual introduction to each other. Once this introductory process had been completed, only audio was utilised with no video.

The interviews were recorded via the Microsoft Teams® platform and an additional recording was made with the use of a Philips DVT1100 digital recording device suitably positioned next to the researcher's laptop to capture the audio. Both supervisors were present for the focus group interviews to assist with the moderation of the interview process. The interviews were unstructured in that the researcher posed the open-ended formatted questions to the participants. However, thereafter, the participants were able to freely lead the discussion on the various focus areas. When necessary, the researcher would ask probing questions or repeat reflective statements in order to encourage open dialogue (Creswell 2007; Qu and Dumay 2011; Shenton 2004). This approach allowed for uninhibited exploration of the phenomenon. As the researcher was familiar with some of the participants, a good rapport was felt during the interview process.

4.5.3.6 Transcription from audio to written format

The audio recordings of the focus group interviews were transcribed by a professional transcription service (SureType, http://www.suretype.co.za). The recordings were transcribed verbatim by the transcription service and to ensure accuracy of the transcription, the researcher relistened to the audio recordings whilst checking both transcriptions. The transcribed text was set out in such a way that the researcher was marked as 'interviewer' in the left-hand margin, and each of the participants was marked as 'respondent' with their initials to assist with the participant coding.

4.5.4 Data analysis

Content analysis is the strategy of choice for qualitative descriptive studies as it utilises systematic coding and categorisation to explore large volumes of textual information, such as transcripts, to determine trends and patterns of words used, their frequency, and their relationships (Hesse-Biber and Leavy 2011; Vaismoradi, Turunen and Bondas 2013). Conventional content analysis was employed to analyse the transcripts from the two focus group interviews – an ideal approach for studies aiming to explore a phenomenon supported by limited research.

The researcher refrained from using pre-defined categories by creating categories as they emerged from the analysed data. This was achieved by: 1) reading the data repeatedly and engaging thoroughly with its content; 2) highlighting key thoughts and concepts; 3) generating labels directly from the data; 4) creating categories and sub-categories; and 5) developing the categories and sub-categories with identified examples from the data (Creswell *et al.* 2016; Humble and Mozelius 2022). The main aim of this process was to formulate an understanding of the meaning/s of the content of the data set.

Qualitative data coding is broadly defined as the process of systematically transforming the transcribed data into outcomes which represent the data and address the research questions (Adu 2021). When undertaking coding, either deductive or inductive coding can be utilised (Creswell *et al.* 2016). Deductive (a priori) coding utilises pre-established codes which are created prior to the researcher engaging with the transcribed data. The advantage associated with deductive coding is that it allows the researcher to approach the analysis with a very focused lens in order to quickly identify relevant data. However the disadvantage associated with this approach is that the researcher may miss valuable insights due to the predetermined focus (Creswell *et al.* 2016).

During inductive coding, the codes used to label the data are created during the coding process, based on the content of the transcripts. In inductive coding, the researcher engages with the transcribed data in order to develop codes based on the findings within the data. Inductive content analysis is better suited when there is limited pre-existing research on the focus area as the development of the content categories is inductive, in that the categories are developed from the data itself and not from pre-existing research (Creswell *et al.* 2016; Vears and Gillam 2022).

The process of inductive coding creates categories and sub-categories instead of themes. The content categories are often closely linked to the open-ended questions posed by the researcher during the focus group interview (Vears and Gillam 2022). Themes are better suited to thematic analysis and are generally more abstract than a content category. A third approach to coding is that of a hybrid coding approach which combines both deductive and inductive coding. With this approach, the researcher will begin their analysis with a set of deductive codes and then add new (inductive) codes as the researcher works through the transcribed data (Creswell *et al.* 2016).

Considering the above, a decision was taken to adopt a hybrid content analysis approach to the analysis of the transcribed data from the two focus group interviews. This involved the researcher reading through the two transcripts to become familiar with the content prior to undertaking any coding. NVivo® software was utilised to assist with the identification of categories and sub-categories. The categories linked quite closely to the core content of the different focus areas of the focus group interviews and the sub-categories arose where the responses from the participants indicated a specific element within a main category. The categories and sub-categories will be presented in Chapter 6.

4.6 METHODS USED IN THE ASSESSMENT OF PHYSICAL PREPAREDNESS

4.6.1 Approach

In this last phase of data collection, an assessment of physical preparedness was conducted in the form of a physical performance test. The components of the physical performance test were determined from the analysis of the results from both the questionnaire and focus group interview. The data from the questionnaire and focus group interview highlighted which activities associated with the BHSc EMC programme require the emergency medical care student to be physically fit for work readiness and which components of physical fitness are required to engage successfully in the physically strenuous learning outcomes associated with the BHSc EMC programme. The purpose of the test was to determine to what extent the current physical preparedness assessment tool (Table 3.6 in Chapter 3), which is being utilised by the HEIs to assess physical preparedness, can produce valid results which accurately assess the emergency medical care student's ability to effectively engage in activities associated with the BHSc EMC programme. Based on these findings, the testing also highlighted whether there was a need to adjust and/or refine the current physical preparedness assessment tool, based on evidence.

The research design utilised for the data collection process in the assessment of physical preparedness was that of a quantitative cross-sectional descriptive prospective design. This design was appropriate for this phase of the research as it allowed the researcher to collect quantifiable data from the participants to conduct an unbiased objective inquiry (Mohajan 2020). A cross-sectional study design is one in which data is collected from many different individuals at a single point in time and selected variables are observed without influencing the variables (Setia 2016). The testing was prospective in nature as the researcher designed a physical performance test which consisted of validated fitness tests which assessed the required components of fitness as determined by the data from the questionnaire and focus group interview. The participants were expected to complete the physical performance test designed by the researcher, as well as the components of the current physical preparedness assessment (Table 3.6 in Chapter 3), in order to determine to what extent the current physical preparedness assessment (Table 3.6 in Chapter 3) is able to produce valid results which accurately assess the emergency medical care student's ability to effectively engage in activities associated with the BHSc EMC programme, and whether there was a need to adjust and/or refine the current physical preparedness assessment tool based on evidence.

4.6.2 Participants

4.6.2.1 Population

The study population was all EMC students registered at any of the HEIs offering the BHSc EMC programme.

4.6.2.2 Target population

The target population was EMC students registered for the BHSc EMC programme at HEIs within South Africa.

4.6.2.3 Accessible population

The accessible population was the EMC students from the three HEIs who agreed to participate in this phase of data collection.

4.6.2.4 Inclusion and exclusion criteria

The inclusion criteria for the accessible population were clearly defined to ensure that the participants had the relevant basic experience in physical preparedness to engage meaningfully with the selected physical preparedness tests.

The inclusion criteria for participants were as follows:

1. The participants had to be registered as students for either their third or fourth year of study on the BHSc EMC programme at one of the three HEIs in the 2023 academic year.
2. The participants had to be 18 years or older to take part in the testing. However there was no maximum age limit to take part.
3. The participants needed to be healthy and free from any clear contra-indications for exercise testing, as determined by the American College of Sports Medicine (American College of Sports Medicine 2018).

The exclusion criteria were:

1. Participants who were registered as students for either the first or second year of the BHSc EMC programme at one of the three HEIs.
2. Participants who were younger than 18 years of age.

A purposive sampling method was utilised to determine the participants. Purposive sampling is a non-probability sampling technique in which the researcher purposefully selects a sample of participants that have particular characteristics which are most likely to provide data that will address the research question (Campbell *et al.* 2020). All the participants that met the inclusion criteria from the accessible population were invited to participate in the testing (n = 112).

4.6.3 Data collection procedure

The HODs were contacted via email to assist with the distribution of the introductory email and information letter (Appendix 10) when recruiting participants for this phase of the study. This measure was taken as the researcher was mindful of the fact that students remain a vulnerable population. As per the information letter (Appendix 10), interested participants were required to confirm their participation with the researcher, and any further communication occurred directly between the researcher and interested participants. This approach was adopted to remove any coercion from the HOD and academic staff, and to ensure that student participation in the testing was voluntary. Interested participants were provided with the dates for the data collection, which were scheduled at times which were convenient for the students.

On arrival on the first day of the data collection process for the assessment of physical preparedness, interested participants were required to sign a hard copy of the consent form (Appendix 11). Once the participants had provided informed consent, they were required to complete a Physical Activity Readiness Questionnaire (PAR-Q) which assessed whether they were healthy and free from any absolute contra-indications for exercise testing (Appendix 12). The potential for harm and/or risk to participants in this study was slightly above minimal risk as all the participants that engaged in the testing phase of the study were registered senior students on the BHSc EMC programme at one of the three participating HEIs. As part of the initial recruitment and application process for the BHSc EMC programme, each of the participants had been subjected to both a medical and fitness assessment to determine that they were healthy and had no illnesses or injuries that could predispose them to any risk of harm or injury. If any of the participants had an acute injury or illness at the time of the study that could have resulted in injury or harm, they were excluded from participating in the study. The participants also engage in physical preparedness and medical rescue activities as part of the BHSc EMC programme, therefore their risk profile for injury was low as they do not represent sedentary, physically unfit, individuals.

Testing was conducted at the departments accredited to offer the BHSc EMC programme at the three participating HEIs, with the assistance of the academic staff and student assistants from the Sports Science Department. The sporting facilities (athletics tracks, swimming pools and gym areas) that the departments utilised to administer their current physical preparedness assessments were utilised for data collection. This assisted with ensuring that participants were familiar with the environments in which they would be tested. Testing was conducted over six days, two days at each of the three participating universities. The programme for the two days is presented in Table 4.1.

Table 4.1: Programme for administration of physical performance test

DAY 1	DAY 2
Complete consent form	
Complete the Physical Activity Readiness Questionnaire (PAR-Q)	

DAY 1	DAY 2
Capture the following demographic information:	
- *sex* - *age* - *HEI* - *frequency of physical training* - *year of study*	
Capture the following anthropometric measurements: - *weight* - *height* - *skinfold measurements*	
Perform the modified sit-and-reach test	
Swimming assessment: - *400m swim*	Swimming assessment: - *200m swim*
Rest for 15 minutes	
Cardiovascular endurance: - *Cooper 12-minute run test*	Cardiovascular endurance: - *5km run*
Rest for 15 minutes	
Muscular strength & endurance: - *Maximum push-up test* - *7-stage abdominal strength test* - *Grip strength test*	Muscular endurance: - *Flexed-arm hang test*

The following section will provide the detail for each of the different physical fitness tests that formed part of the data collection procedure in the assessment of physical preparedness.

4.6.4 Data Collection Tool

4.6.4.1 Physical Activity Readiness Questionnaire (PAR-Q)

The Physical Activity Readiness Questionnaire (Appendix 12) was administered to all participants who provided their informed consent to take part in the testing phase of the study at the start of the first day of data collection. The PAR-Q is a self-screening tool that is utilised to determine the safety or possible risks of a person undertaking exercise based on an individual's health history, current symptoms, and risk factors.

The questionnaire has been endorsed by the American College of Sports Medicine (ACSM) and it was created by the British Columbia Ministry of Health and the Multidisciplinary Board on Exercise. The PAR-Q contains seven yes/no questions to determine an individual's readiness to exercise. If an individual answers no to all the PAR-Q questions, it can be reasonably assumed that it is safe for that individual to exercise. If an individual answers yes to one or more of the PAR-Q questions, they should consult with a medical doctor before engaging in physical activity. The participant number, and not the name of the participant, was captured on the PAR-Q questionnaire to ensure anonymity of the participants.

4.6.4.2 Demographic information

The participants that successfully passed the Physical Activity Readiness Questionnaire (Appendix 12), were required to complete the demographic information on the data collection template (Appendix 13). This section of the data collection template required the participant to record their year of study, HEI, sex, age and physical training frequency. Again, no identifying data was captured on the data collection template as the participants were provided with a participant number which was recorded on the data collection template.

4.6.4.3 Anthropometric measurement

The anthropometric measurements were captured on the data collection template (Appendix 13). One of the components of fitness which was identified as important by both the academic staff and the emergency medical care students was that of body composition. The capturing of these anthropometric measurements would allow the researcher to determine if there was any correlation between an emergency medical care student's performance in the different components of the physical preparedness assessment and their body composition.

Weight:

Component tested: Weight (mass)

Purpose: The weight of the participants was measured to determine the mass of the participants.

Equipment required: 2003A calibrated glass diagnostic digital scale that measures in kilograms.

Description of the test: The participant was required to wear gym shorts and a T-shirt, with no shoes. The participant was required to step onto the scale and stand as tall and still as possible. The weight was captured as soon as the electronic scale had registered the participant's weight. The weight was recorded in kilograms (kg) to the nearest 0.1kg. The participant was then asked to step off the scale and once the scale had zeroed, the participant was requested to step back onto the scale for a second measurement (American College of Sports Medicine 2018; Hoffman 2006; National Strength and Conditioning Association 2016).

Scoring of the test: The lowest of the two readings was captured on the data collection template in kilograms (kg) to the nearest 0.1kg (Appendix 13).

Height:

Component tested: Height (stature)

Purpose: The height of the participants was measured to determine the stature of the participants.

Equipment required: Tape measure mounted on the wall that measures in centimetres.

Description of the test: The participant was required to wear gym shorts and a T-shirt, with no shoes. The tape measure was secured to the wall and the participant was requested to stand with their back against the wall. A clipboard was placed on the top of the participant's head to record the corresponding height (American College of Sports Medicine 2018; Hoffman 2006; National Strength and Conditioning Association 2016).

Scoring of the test: The height was recorded in centimetres (cm) to the nearest half a centimetre on the data collection template (Appendix 13).

Body mass index:

Component tested: Body mass index (BMI)

Purpose: Body mass index is a simple tool utilised to calculate the amount of tissue (muscle, bone and fat) in order to determine if an individual is at a healthy body weight for their height. Based on the calculated BMI score, the participant was then classified as either underweight, normal weight, overweight or obese.

Equipment required: A digital calculator to calculate the BMI utilising the following formula: BMI = body mass (kg) / height squared (m^2).

Description of the test: Once the participant's height and weight had been recorded, these two values were utilised to calculate the BMI using the following formula: BMI = body mass (kg) / height (m^2) (American College of Sports Medicine 2018; Hoffman 2006).

Scoring of the test: The calculated BMI score was captured on the data collection template (Appendix 13) and, based on the calculated BMI score, the participant was then classified as either underweight, normal weight, overweight or obese (Table 4.2).

Table 4.2: World Health Organization (WHO) classification of weight status (WHO 2022)

Weight status	Body mass index (BMI), kg/m^2
Underweight	< 18.5
Normal range	18.5–24.9
Overweight	25.0–29.9
Obese	≥ 30
Obese Class I	30.0–34.9
Obese Class II	35.0–39.9
Obese Class III	≥ 40

Skinfold measurements:

Component tested: Subcutaneous fat

Purpose: To evaluate the subcutaneous body fat percentage through the measurement of skinfold thickness, as part of the anthropometric measurements

Equipment required: Slim guide skinfold fat calliper to measure skinfolds in millimetres

Description of the test: Skinfold measurement utilises different anatomical sites around the body. However, for the purpose of this study, four upper body sites were utilised: biceps, triceps, subscapularis and suprailiac. The right side was measured for consistency and once the initial site of measurement had been identified at the four sites, a mark was placed with a marking pen to ensure that the measurements were repeated in the exact same location. The four sites measured were (National Strength and Conditioning Association 2012):

1. Biceps: vertical fold over the belly of the bicep muscle on the anterior aspect of the arm.
2. Triceps: vertical fold on the posterior midline of the upper arm, midway between the scapular's acromion process and the inferior part of the olecranon process at the elbow.
3. Subscapular: at the diagonal fold at a 45° angle, 2cm below the inferior angle of the scapula.
4. Suprailiac: diagonal fold in line with the natural angle of the iliac crest, at the mid-axillary line.

The participants were asked to relax fully while the measurements were being taken. The skin was pinched at the appropriate site to raise a double layer of skin and the adipose tissue, excluding the muscle. The skinfold calliper was then applied 1cm below the tester's fingers, and at right angles, to pinch the skinfold; and a reading in millimetres (mm) to the nearest 0.5mm was taken within three seconds of releasing the calliper grip. Two measurements were taken at each site and the mean of those two measurements was recorded. If there was a difference greater than 3mm between the two readings, a third measurement was taken, and then the median value was recorded (Wood 2008b). All readings were recorded on the data collection template (Appendix 13). The Durnin and Womersley (1974) equation was then utilised to calculate the sum of all of the skinfolds in order to determine the total body fat percentage for each of the participants (National Strength and Conditioning Association 2012).

Scoring of the test: The final score was the total body fat percentage (%) as calculated by the Durnin and Womersley equation. The percent body fat classifications are represented in Table 4.3.

Table 4.3: Percent body fat classifications (National Strength and Conditioning Association 2012)

Rating age group (years)	Male 18–25	Female 18–25	Male 26–35	Female 26–35	Male 36–45	Female 36–45	Male 36–45	Female 36–45
Very lean	4–7	13–17	8–12	13–18	10–14	15–19	12–16	18–22
Lean	8–10	18–20	13–15	19–21	16–18	20–23	18–20	23–25
Leaner than average	11–13	21–23	16–18	22–23	19–21	24–26	21–23	26–28
Average	14–16	24–25	19–21	24–26	22–24	27–29	24–25	29–31
Slightly high	18–20	26–28	22–24	27–30	25–26	30–32	26–28	32–34
High	22–26	29–31	25–28	31–35	27–29	33–36	29–31	36–38
Obese	> 28	> 33	> 30	> 36	> 30	> 39	> 32	> 39

4.6.5 Selected fitness tests

One of the core focus areas of the focus group interviews was to determine which components of fitness both the academic staff and emergency medical care students felt were important for the students to engage successfully with the physically strenuous content of the BHSc EMC programme. Figure 4.2 represents the important components of fitness as determined by the academic staff and Figure 4.3 represents those determined by the emergency medical care students.

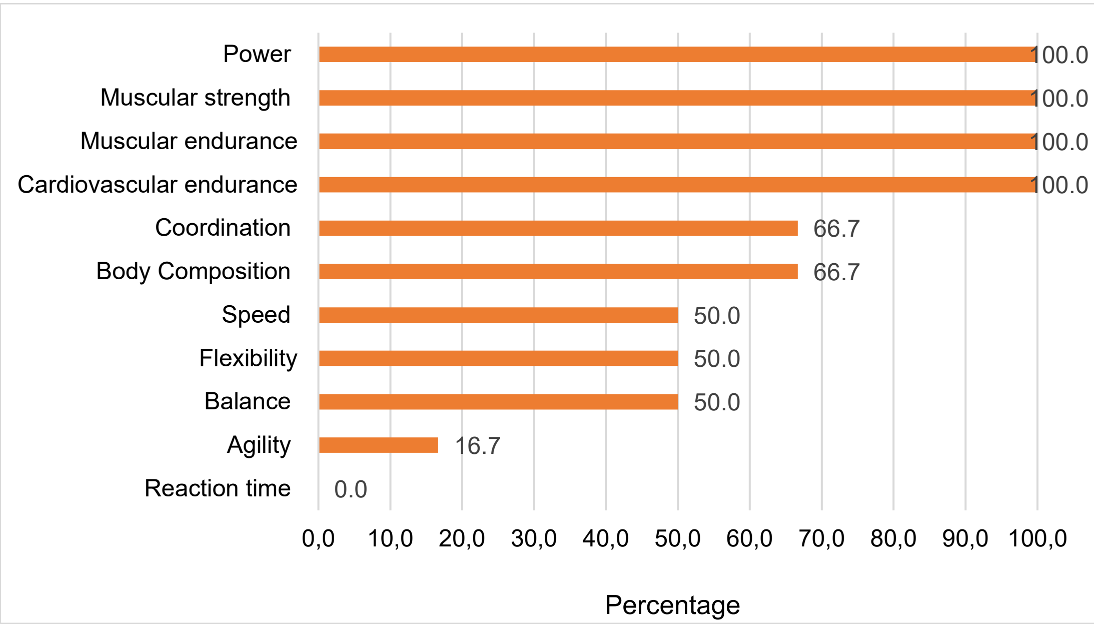


Figure 4.2: Academic staff – Components of fitness required

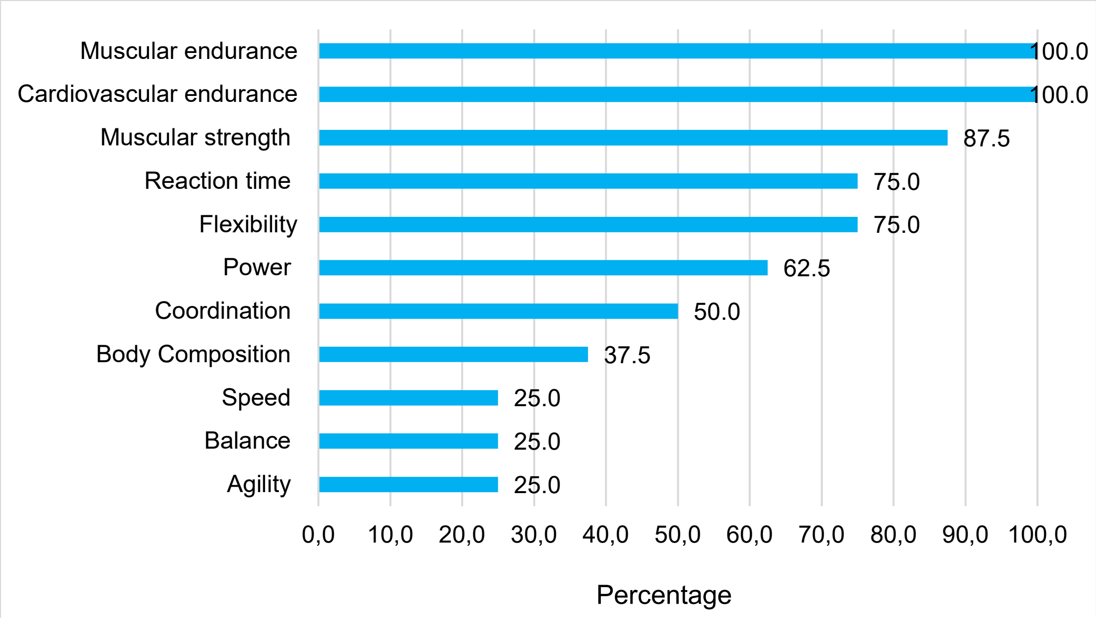


Figure 4.3: Emergency medical care students – Components of fitness required

The fitness tests for the assessment of physical preparedness were selected based on the views and opinions of the academic staff and emergency medical care students from the focus group interviews. The selected fitness tests are universally recognised as valid and reliable fitness tests of the various selected components of fitness. The main components of fitness tested were: 1) cardiovascular endurance (aerobic capacity); 2) muscular endurance; 3) muscular strength; and 4) flexibility. In addition, swimming aerobic capacity was assessed.

4.6.5.1 Fitness tests for Day 1 of the data collection procedure

The newly selected, universally recognised, fitness tests were administered on the first day of the data collection procedure, immediately after the anthropometric measurements had been captured. There were six fitness tests in the physical performance test which assessed the four identified components of fitness, inclusive of a swimming aerobic capacity assessment. All the participants were required to wear fitness attire that was appropriate for the different tests. The equipment required to administer and measure the different fitness tests from the first day of data collection is presented in Table 4.4.

Table 4.4: Equipment utilised for the fitness tests on Day 1 of data collection

Measurement	Purpose	Equipment
Modified sit-and-reach test	To measure lower back, hip and hamstring flexibility	Sit-and-reach box with a 30cm ruler
400 metre swim test	To measure swimming aerobic capacity	25m or 50m swimming pool, whistle, Fluir FL075 stopwatch
Cooper 12-minute run test	To measure cardiovascular endurance (aerobic capacity)	Rotosure 32cm measuring wheel, whistle, Fluir FL075 stopwatch
Maximum push-up test	To measure upper body muscular endurance	Nil
7-Stage abdominal strength test	To measure abdominal muscular endurance	2.5kg weight plate, 5kg weight plate
Grip strength test	To measure muscular grip strength	Takei 5401 digital hand dynamometer measuring in kilograms

Flexibility:

Selected Test: Modified sit-and-reach Test (MSR)

Fitness component tested: Flexibility of the lower back, hips and hamstrings

Purpose: Flexibility assesses an individual's ability to move muscles through a range of motion at a joint. This specific test (MSR) is an indirect measure of flexibility, and it is easily assessed and reported in centimetres. The test is utilised to assess lower back, hip and hamstring flexibility (Hoffman 2006). The MSR is a variation of the traditional sit-and-reach test, as one of the limitations of the traditional test was that it did not allow for differences in limb length or proportional differences between the legs and arms (Hoffman 2006).

Equipment required: Sit-and-reach box with a ruler.

Description of the test: The participant was required to remove their shoes and wear comfortable clothing that would not restrict their movement. The participant was required to sit on the floor with their back and head against a wall with their hip joint at a 90° angle. The participant's legs were straight with their knees flat against the floor and their feet flat against the sit-and-reach box. The sit-and-reach box was placed in position by the researcher. While remaining seated against the wall, the participant placed one hand over the other while keeping in contact with the wall. At this point, the researcher moved the measurement scale along the top of the box so that the zero point was at the tip of the participant's fingertips. Once the zero point had been established, the participant was required to inhale and exhale slowly and whilst exhaling, the participant was required to slowly reach as far forward as they possibly could, while pushing the sliding measurement scale along the top of the box. It was critical that the participant's knees did not lift off the ground during this movement. The participant was also not allowed to jerk or bounce to reach further. The full reach position was held for a period of two seconds. At this point the researcher captured the score. The same procedure was repeated three times (American College of Sports Medicine 2018; Hoffman 2006; Wood 2022f).

Scoring of the test: The distance reached for the three attempts was recorded to the nearest centimetre on the data collection template (Appendix 13), and the final score recorded was the average of the three attempts.

Swimming:

Selected Test: 400m Swim Test

Fitness component tested: Swimming aerobic capacity

Purpose: The purpose of this assessment was to assess the swimming aerobic capacity of the participants at a level which was appropriate to engage successfully with the content of the Aquatic Rescue module.

Equipment required: 25m or 50m swimming pool, whistle, and a Fluir FL075 stopwatch.

Description of the test: The participants were informed that the recommended maximum completion time for the 400m swim was eight minutes in total. The participants were required to line up on one side of the pool and they were expected to start the swim test from in the water. They were not allowed to dive at the start of the test. On the sound of the whistle, the stopwatch was started, and the participants started swimming at their own pace. The participants were able to swim any stroke, although freestyle was recommended as it would maximise speed and the participants were also allowed to make use of any turn, provided they touched the wall before turning. The students were allowed to swim until they had completed the 400m distance and no drafting was allowed (American Aquatics and Safety Training 2022; International Life Saving Federation 2007).

Scoring of the test: The distance completed in metres in eight minutes, as well as the time taken to complete the 400-metre swim distance, was recorded in minutes and seconds on the data collection template (Appendix 13).

Cardiovascular endurance:

Selected Test: Cooper 12-minute run test

Fitness component tested: Aerobic capacity

Purpose: This test assesses aerobic capacity, which is an indicator of an individual's ability to perform sustained, high-intensity exercise. This test also allows for the calculation of the VO_{2max}, which reflects the point at which oxygen uptake plateaus with an increase in workload. A field test was selected as it is more efficient when having to test large groups (Hoffman 2006).

Equipment required: 400m athletics track with non-slippery surface, or a level surface with markers every 50m, Rotosure 32cm measuring wheel, whistle and Fluir FL075 stopwatch.

Description of the test: The test was administered on a 400m athletics track with a non-slippery surface at HEI 'A' and on a level surface with cones utilised to mark the distance every 50 metres at HEIs 'B' and 'C'. The participants were allowed to warm up by completing a five-minute light jog. Once the participants had warmed up, they lined up at the start/finish line and waited for the researcher to blow the whistle signalling the start. The researcher recorded the number of laps completed within the 12-minute time by each participant on the data collection template (Appendix 13) as they passed the start/finish line. Once the 12-minute time limit was reached, the researcher signalled with the whistle for the participants to stop and remain in that position, whilst the researcher measured the additional distance covered from the start/finish line for each participant. The number of laps completed was multiplied by the distance per lap and any additional distance that was completed after the start/finish line was added to calculate the total distance completed by each participant. Once the total distance covered was known, this value was then utilised to calculate the estimated maximum oxygen uptake (VO_{2max}) with the following formula: VO_{2max} = (22.351 x distance in kilometres) – 11.288. This provides the estimated VO_{2max} in ml/kg/min (Hoffman 2006; Wood 2022b).

Scoring of the test: The test was scored according to the total distance covered in metres in the 12-minute timeframe and the VO_{2max} was calculated utilising this distance.

Muscular endurance:

Selected Test: Maximum push-up test

Fitness component tested: Upper body muscular endurance

Purpose: This test assesses endurance of the upper body musculature (pectoralis major, anterior deltoids and triceps). Muscular endurance assesses the ability of a muscle or a group of muscles to move repeatedly against a submaximal resistance without undue fatigue (Hoffman 2006).

Equipment required: None.

Description of the test: The participants attempted to complete as many push-ups as they could, with no time limit, until failure (Wood 2022e). The starting position for the push-up started with the participant in a prone position with their hands and toes touching the floor (Figure 4.4). The participant's body and legs had to be kept in a straight line and the arms were shoulder width apart with the fingers pointing forwards and the elbows pointing backwards. Ensuring that the back and knees were kept straight, the participant was required to lower themselves down until their chest touched the clenched fist of an assistant which resulted in a 90° angle at the elbows (Figure 4.5). Once this position in Figure 4.5 was achieved, the participant pushed back up into the starting position with their arms in full extension (Figure 4.4). The elbows were required to lock with each extension. This action was repeated without rest until the participant could not perform any more push-ups, or their push-up form was no longer correct. Participants were allowed two no-touch warnings, and on their third no-touch the test was stopped. The push-up was performed with the same technique for both male and female participants (American College of Sports Medicine 2018; Hoffman 2006; Wood 2022g).

Scoring of the test: The score was the number of repetitions completed and the repetitions were counted when the participant was in the starting (up) position

(Figure 4.4). The total repetitions performed were captured on the data collection template (Appendix 13).

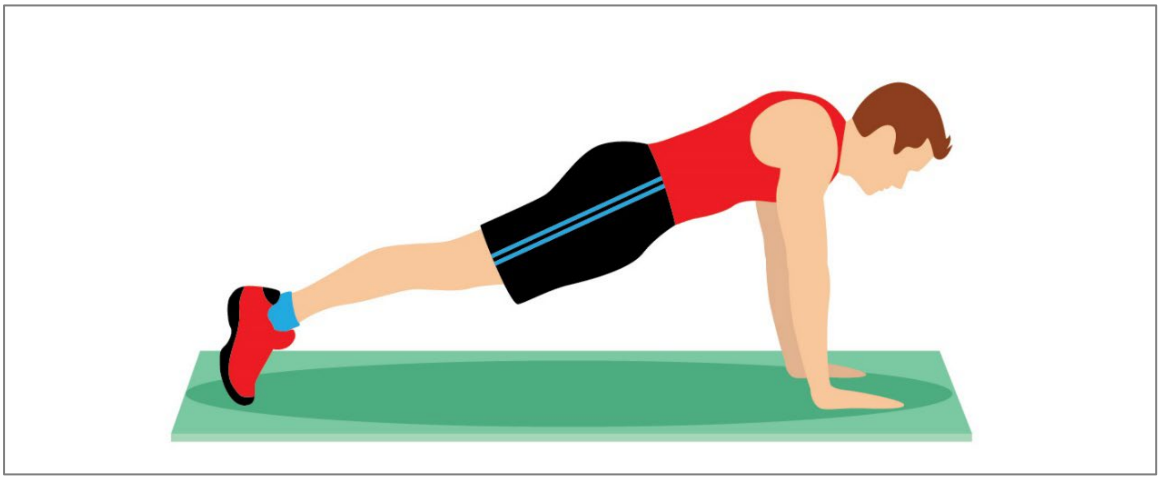


Figure 4.4: Push-up position – starting (up) position (Vecteezy 2023)

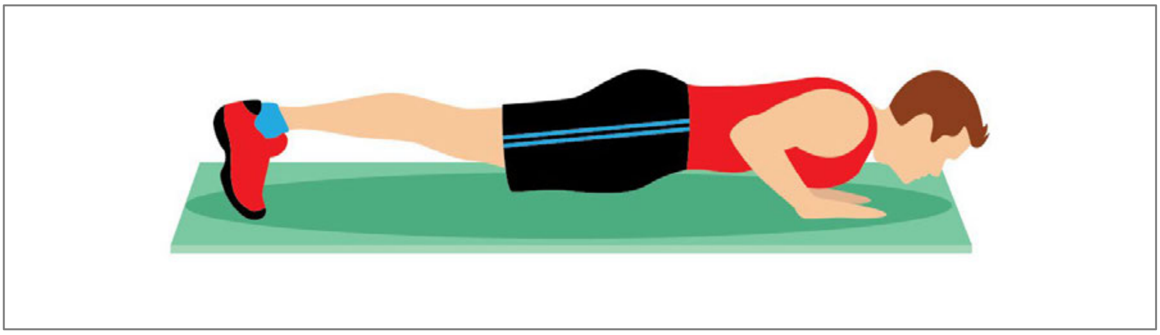


Figure 4.5: Push-up position – down position (Vecteezy 2023)

Selected Test: 7-stage abdominal strength test

Fitness component tested: Abdominal muscular endurance

Purpose: This test assesses abdominal muscular endurance, which is important in the context of core stability and back support. This test has replaced the one-minute sit-up test as, in a curl-up when the participant's feet are held, there is an increased involvement of the hip flexor muscles, which impacts the validity of the test to assess abdominal muscular endurance.

Equipment required: 2.5kg and 5kg weight plate.

Description of the test: The participant was required to lie supine on a flat surface with their knees flexed at right angles and their feet flat on the floor. The participant attempted one complete sit-up at each of the different levels (Table 4.5) in the prescribed manner, starting at Level 1. A level was passed if the participant performed a single sit-up in the prescribed manner without their feet lifting off the floor. A participant was allowed up to three attempts at a level before the test was stopped (Wood 2022a).

Scoring of the test: The highest-level sit-up out of the eight levels which was correctly performed by the participant was recorded on the data collection template (Appendix 13).

Table 4.5: Levels for the seven-stage abdominal strength test (Wood 2022a)

Level	Description
0	Cannot perform Level 1
1	With arms extended, the participant curls up so that their wrists reach their knees
2	With arms extended, the participant curls up so that their elbows reach their knees
3	With the arms held together across abdominals, the participant curls up so that their chest touches their thighs
4	With the arms held across the chest, holding the opposite shoulders, the participant curls up so that their forearms touch their thighs
5	With the hands held behind the head, the participant curls up so that their chest touches their thighs
6	As per Level 5 with a 2.5kg weight held behind the head, chest touching the thighs
7	As per Level 5 with a 5kg weight held behind the head, chest touching the thighs

Muscular strength:

Selected Test: Grip strength test

Fitness component tested: Muscular strength

Purpose: This test is utilised to measure the maximum isometric strength of both the hand and forearm muscles (Hoffman 2006).

Equipment required: Takei 5401 digital hand dynamometer measuring in kilograms.

Description of the test: The handgrip dynamometer was calibrated prior to the test being conducted. The participant was required to dangle their hands straight down next to the sides of their body ensuring that their hands did not touch the rest of their body. The participant was then required to squeeze the handgrip dynamometer as hard as they possibly could for approximately three seconds. During this test, no other body movement was allowed, inclusive of any movement in the elbow joint. This test was then repeated with the opposite hand. Participants had two attempts per hand. However, if the scores differed by more than 5kg, the handgrip test was repeated for a third time on both hands (Hoffman 2006; Wood 2022d).

Scoring of the test: All scores were captured on the data collection template (Appendix 13). However, the final score was calculated as the average score of the two or three attempts, in kilograms.

4.6.5.2 Fitness tests for day two of the data collection procedure

On the second day of the data collection procedure, the physical preparedness assessment tool that is currently being utilised by the HEI's offering the BHSc EMC programme (Table 3.6 in Chapter 3) was administered (Van Nugteren 2023; Vincent-Lambert, Coopoo and Van Nugteren 2022). This physical preparedness assessment consisted of three fitness tests in total, which assessed two components of fitness: 1) cardiovascular endurance (aerobic capacity) and 2) muscular endurance. The third fitness test was a test of swimming aerobic capacity. All the participants were required to wear fitness attire that was appropriate for the different tests. The equipment required to administer and measure the different fitness tests for the second day of data collection is presented in Table 4.6.

Table 4.6: Equipment utilised for the fitness tests on Day 2 of data collection

Measurement	Purpose	Equipment
200m swim test	To measure swimming aerobic capacity	25m swimming pool, whistle, Fluir FL075 stopwatch
5km run test	To measure cardiovascular endurance (aerobic capacity)	Rotosure 32cm measuring wheel, whistle, Fluir FL075 stopwatch
Flexed-arm hang test	To measure upper body muscular endurance and strength	Horizontal overhead bar, Fluir FL075 stopwatch, chair

Swimming:

Selected Test: 200m swim test

Fitness component tested: Swimming aerobic capacity

Purpose: The purpose of this assessment was to assess the swimming aerobic capacity of the participants.

Equipment required: 25m or 50m swimming pool, whistle, and a Fluir FL075 stopwatch.

Description of the test: The participants were informed that the recommended maximum completion time for the 200m swim was six minutes in total. The participants were required to line up on one side of the pool and they were expected to start the swim test in the water. They were not allowed to dive at the start of the test. On the sound of the whistle, the stopwatch was started, and the participants started swimming at their own pace. The participants were able to swim any stroke, although freestyle was recommended as it would maximise speed and the participants were also allowed to make use of any turn, provided they touched the wall before turning. The students were allowed to swim until they had completed the 200m distance and no drafting was allowed (Vincent-Lambert, Coopoo and Van Nugteren 2022).

Scoring of the test: The distance completed in metres in six minutes, as well as the time taken to complete the 200m swim distance, was recorded in minutes and seconds on the data collection template (Appendix 13).

Cardiovascular endurance:

Selected Test: 5km run test

Fitness component tested: Aerobic capacity

Purpose: This test was selected to assess aerobic capacity.

Equipment required: 400m athletics track with non-slippery surface or suitable route on a road with limited elevation, Rotosure 32cm measuring wheel, whistle and Fluir FL075 stopwatch.

Description of the test: The test was administered on a 400m athletics track with a non-slippery surface at HEI ‘A’ and on an appropriate 5km route with limited elevation at HEIs ‘B’ and ‘C’. At HEI ‘A’, the participants were required to complete 12.5 laps of the 400m athletics track to complete the 5km distance. The participants were informed that the recommended maximum completion time for the 5km run was 32 minutes and 30 seconds in total. The participants lined up at the start line and waited for the researcher to blow the whistle signalling the start. At HEI 'A', the completed laps were marked off on the data collection template (Appendix 13) as the student crossed the finish line marker. The students were allowed to run until they had completed the 5km distance (Vincent-Lambert, Coopoo and Van Nugteren 2022).

Scoring of the test: The distance completed in metres in 32 minutes and 30 seconds, as well as the time taken to complete the 5km run distance, was recorded in minutes and seconds on the data collection template (Appendix 13).

Muscular strength and muscular endurance:

Selected Test: Flexed-arm hang test

Fitness component tested: Upper body muscular strength and endurance

Purpose: This test is a posture-specific isometric test and it is used to test arm and shoulder girdle strength, upper body muscular endurance and weight-relative muscular endurance (Clemons *et al.* 2004). The underhand grip was selected over that of the overhand grip, as this grip has been demonstrated to have a stronger relationship with relative strength.

Equipment required: Horizontal overhead bar, Fluir FL075 stopwatch and chair/step (optional)

Description of the test: The horizontal overhead bar had to be higher than the participant's standing height. The participant was required to grasp the bar with an underhand grip (palms facing towards the body) wrapping their thumbs around the bar. With the assistance of spotters or the use of a chair/step, the participant was raised to a height at which their arms were flexed and their chin was above, but not touching, the bar (Figure 4.6). The participant's legs were required to hang straight down, and they were not allowed to swing, bend their knees, or kick their feet (Figure 4.7). The stopwatch was started as soon as the participant was hanging in the correct position without any support. The participant was required to hang without support for as long as possible. The participants were informed that the recommended minimum time for the flexed-arm hang test was 30 seconds. The time was stopped as soon as the participant's chin touched, or dropped below, the bar (National Strength and Conditioning Association 2012; Vincent-Lambert, Coopoo and Van Nugteren 2022; Wood 2022c). The participant was only allowed one attempt.

Scoring of the test: The score, which was the total time in minutes and seconds, was captured on the data collection template (Appendix 13).

Figure 4.6: Chin and hand position for the flexed arm hang test (The Maharaja Bhupinder Singh Punjab Sports University 2020)Figure 4.7: Leg position for the flexed-arm hang test (Sandalis 2023)

4.6.6 Administration of the fitness test

4.6.6.1 Briefing of participants

On the first day of the data collection procedure, a brief familiarisation session was held with all the participants. This session brie fly addressed the following topics: 1) the purpose of the different tests; 2) explanation of how each test was to be performed; 3) demonstration of the movement standards for each test; 4) recommended warm-up routine for the different tests; and 5) scoring of the different tests (National Strength and Conditioning Association 2016). Once this briefing had taken place, participants were afforded an opportunity to ask any clarifying questions.

4.6.6.2 Testing sequence

The testing sequence refers to the order in which the selected tests were performed. It is generally accepted that the least fatiguing tests should be performed first to ensure that one test did not affect the performance of subsequent tests (National Strength and Conditioning Association 2016). Based on this, the sequence of the selected tests over the two days was as follows:

Day 1:

1) Modified sit-and-reach test
2) 400m swim test
3) Cooper 12-minute run test
4) Maximum push-up test
5) 7-stage abdominal strength test
6) Grip strength test

Day 2:

1) 200m swim test
2) 5km run test
3) Flexed-arm hang test

4.6.6.3 Testing a large group

When testing a large group, as was the case in the context of assessing the emergency medical care students, several testing stations ran simultaneously, and the students rotated through the different testing stations. The participants were afforded, at least, a fifteen-minute rest between the different testing stations, which allowed for sufficient time for the phosphagen energy system to restore (Hoffman 2006; National Strength and Conditioning Association 2016).

4.6.7 Statistical analysis

The service of a professional statistician was used to assist with the analysis of the raw data from the testing (Appendix 14). All the data collected and captured on the data collection template (Appendix 13) from the testing was captured on a Microsoft Excel® spreadsheet. The statistician made use of the SPSS Statistics Version 25.0 computer programme. A p value of less than 0.05 indicates significance at a 95% level. The data from the questionnaire was analysed by utilising one of the following methods:

- Descriptive statistics
- Regression analysis
- Pearson's correlation
- Independent sample t-test
- Mann-Whitney test

Each of the above methods will be explained in more detail below.

Descriptive statistics were utilised to summarise the data by describing the relationship between variables within the population in an organised manner. Absolute frequency was reported, along with the measurements of central tendency (mean, median and mode) and variation (standard deviation) (Kaur, Stoltzfus and Yellapu 2018).

Linear regression analysis was measured by the coefficient of determination in order to determine the relationship between one dependent and one independent variable (Creswell *et al.* 2016). Linear regression analysis was utilised to determine the effect of the anthropometric measurements such as weight, height, body mass index and body fat percentage.

Pearson's correlation was utilised to measure the strength of the linear relationship between two quantitative variables. In the context of this study, this was utilised to assess for correlations between the different physical fitness tests that were selected. The Pearson correlation coefficient was denoted by *r* and had a minimum of –1 and maximum of +1. Values that were close to a +1 or –1 reflected a strong linear relationship and values close to zero reflected a weak linear relationship (Creswell *et al.* 2016). Correlation was significant at the 0.01 level (2-tailed).

The independent sample t-test was utilised to determine if any of the results from the different physical fitness tests differed across the sexes.

The Mann-Whitney test is a non-parametric alternative to the independent t-test. This test was utilised specifically in the context of the 7-stage abdominal strength test when attempting to determine if the results differed between the male and female participants, as there was some deviation from normality (Creswell *et al.* 2016).

4.7 VALIDITY AND RELIABILITY

4.7.1 Validity and reliability in the questionnaire

Content validity refers to the extent to which the theoretical construct of the questionnaire is representative of what it was designed to assess (Heale and Twycross 2015). In this study, to deal with content validity the questions were formulated by engaging with subject matter experts on the construct being measured. A pilot test of the survey questionnaire was also conducted prior to the commencement of the main study. Construct validity, on the other hand, is the extent to which the survey questionnaire measures the theoretical construct which it was intended to measure (Heale and Twycross 2015). Again, in order to determine construct validity, a pilot test of the survey questionnaire was conducted. Fourteen participants from outside the intended study population were recruited to take part in the pilot test. The fourteen participants consisted of eleven second-year BHSc EMC students from the three different HEIs, and three academics who were not involved in the teaching and/or assessment of the Medical Rescue and/or Physical Preparedness modules. The purpose of the pilot test was to ensure that the questions contained within the questionnaire were representative of what they were designed to assess, that the questions were clearly understood by the participants, and whether any adjustments needed to be made to the questionnaire. The results of the pilot test assured the researcher that both the processes and procedure for the questionnaire were appropriate for the study, as no changes were suggested by the pilot test participants. The time taken to complete the survey questionnaire was, on average, 20 minutes. The data and results of this pilot test were not included in the main study.

4.7.2 Validity and reliability in the assessment of physical preparedness

Content validity in the context of the assessment of physical preparedness was the degree to which the selected physical fitness tests measured the components of fitness they were intended to measure. Criterion validity was the degree to which a physical fitness test correlated with a measurement that was validated. In the assessment of physical preparedness, Pearson's correlation (*r* value) was utilised to determine if there were any correlations between the validated physical fitness tests and the physical fitness tests in the current physical preparedness assessment tool (Table 3.6 in Chapter 3) (Rikli and Jones 1999).

Inter-rater reliability is a measure of consistency, and it is the degree to which different raters or scorers agree on the result for the selected physical fitness test over time, or on repeated occasions. In the context of this study, a clearly defined scoring system was provided for each of the physical fitness tests, and the scorers were carefully briefed by the researcher on how to score each of the different selected tests on the data collection template (Appendix 13) (National Strength and Conditioning Association 2016)

4.8 TRUSTWORTHINESS

Validity and reliability are replaced by trustworthiness in qualitative research. In order to ensure trustworthiness of the data from the focus group interviews, which was the qualitative phase of data collection, the framework of Guba was applied in order to seek: 1) credibility; 2) transferability; 3) dependability; and 4) confirmability (Creswell and Plano Clark 2011; Shenton 2004).

4.8.1 Credibility

Credibility was addressed by the researcher through ensuring triangulation of the data by making use of the focus group interviews, along with field notes which were written during the data collection process. The researcher also practised the interview technique by piloting the agenda prior to the scheduled focus group interviews. Member checking, independent re-coding, and ongoing reflection were undertaken by the researcher throughout this phase of data collection (Creswell and Plano Clark 2011).

4.8.2 Transferability

The sampling method, data collection procedure and data analysis has been described in detail to allow evaluation of the transferability of the research, however it is important to note that generalisation is quite limited in qualitative research (Creswell and Plano Clark 2011). In addition, the background, and contextual elements relevant to this study have been explored and described.

4.8.3 Dependability

A full description has been provided of the data collection methods, as well as the data analysis and interpretation. Some of these practices included triangulation, independent re-coding, and purposive sampling. The overlapping of the different data collection methods will ensure trustworthiness (Creswell *et al.* 2016; Creswell and Plano Clark 2011).

4.8.4 Confirmability

This refers to the objectivity of the research findings and the extent to which the findings are representative of the participants' views and not those of the researcher (Shenton 2004). This is achieved through reflexivity and triangulation of the data, while also ensuring member checking, along with ongoing reflection throughout the data collection and analysis processes (Anney 2014).

4.9 ETHICAL CONSIDERATIONS

Participation in this study was voluntary and participants in the survey questionnaire, focus group interviews and assessment of physical preparedness were provided with a background to the study and invited to participate (Appendices 3, 6 and 10). All participants signed consent forms (Appendices 4, 7, 8 and 11) stating that they agreed to take part in the study. The names and identities of individual participants are not stated by the researcher, and they do not form part of the data that has been presented. Data was stored in an electronic format in a password-protected file that only the researcher and supervisors had access to.

Ethical approval was granted by the DUT IREC (Appendix 1). The study was conducted following the guidelines, as detailed in the policy document outlining the ethical considerations for the conduct of research within the Faculty of Health Sciences at the Durban University of Technology. There are four principles which guide ethics in research, namely: 1) beneficence; 2) non-maleficence; 3) respect for human dignity; and 4) justice (Bennett-Woods 2005).

4.9.1 Beneficence

Beneficence refers to the responsibility on the part of the researcher to ensure that the participants are treated in an ethical manner by protecting them from harm and ensuring their well-being throughout data collection (Varkey 2019). The researcher was mindful of the fact that students remain a vulnerable population and, based on this, a number of steps were taken to ensure the students' voluntary participation in the study. The researcher engaged with the HODs of all three HEIs, and not directly with the students, when distributing the information letters for the different phases of the study, to ensure that all the students were aware that participation in all of the phases was voluntary and that they were able withdraw at any stage of the study, without prejudice. The information letter also clearly highlighted that there would be no direct benefit to the participating students. The participants were required to complete a consent form prior to taking part in any of the phases of the study; and in addition, participants were required to provide consent for the voice recordings in the focus group interviews. The researcher also ensured that all raw data was managed confidentially, as no identifying data was captured and precautions were taken to safeguard the anonymity and confidentiality of the participants in the focus group interviews, as no names were captured during the transcription of the recordings. Participants were also assigned participant codes in all phases of the data collection process.

4.9.2 Non-maleficence

Non-maleficence requires that no harm comes to others, with particular reference to avoidable or intentional harm (Gillon 1994; Varkey 2019). In the questionnaire phase of data collection, the data was collected via an online survey questionnaire. Therefore, no harm could occur during this phase of data collection. During the focus group interviews, the interviews were conducted online via the Microsoft Teams platform®. Based on this approach, no explicit risks were identified during this qualitative phase of data collection. During the assessment of physical preparedness, the obligation of the researcher was to avoid, prevent or reduce harm and this was achieved by ensuring that the participants were not placed under any unnecessary duress during the study. There were no direct benefits to any of the participants taking part in any of the phases of the study.

4.9.3 Respect for human dignity

Respect for human dignity is critical when conducting research (Ashcroft *et al.* 2007). No identifying data for either the academic staff or senior students was recorded at any stage, during any of the data collection processes. All the raw data that was collected was anonymised and only the researcher had access to this raw data. When the audio recordings were transcribed for the focus group interviews, each participant was provided with a participant code. This was done to ensure that the participants remained anonymous and only the researcher had access to the original voice recordings.

4.9.4 Justice

Lastly, the principle of justice refers to the equitable selection of participants (Bennett-Woods 2005). All academic staff and senior students from the three HEIs who met the inclusion criteria were able to voluntarily participate in all of the phases of the study. Therefore, there was no prejudice in the selection of participants. In addition, all participants were treated with complete fairness, with no judgment of any of their opinions.

4.10 PERMISSION TO CONDUCT RESEARCH

Once ethical approval had been obtained from the DUT IREC (Appendix 1), gatekeeper permission was obtained from the three higher education institutions (Appendices 2A, 2B and 2C). The researcher was mindful of the fact that students remain a vulnerable population, but due to the nature of the study, their participation was critical to the study. Based on this, a number of steps were taken to ensure the students' voluntary participation in the study. The researcher engaged with the HODs of all three of the HEIs and not directly with the students to ensure that all the students received the information letter which emphasised that participation was voluntary and that the students were able to withdraw at any stage of the study without prejudice. The information letter also clearly highlighted that there would be no direct benefit to the participating students. Only students who had completed the consent form to participate in the study were allowed to take part in the different phases of the study.

4.11 CONCLUSION

This chapter provided an overview of the research methodology applicable to the study. The chapter also included a discussion of the methods used in the study, and of validity, reliability and trustworthiness. The chapter concluded by reviewing the ethical considerations and processes followed to obtain permission to conduct the study. In the following chapter the results and discussion of the survey questionnaire will be presented.

CHAPTER 5: THE QUESTIONNAIRE

5.1 INTRODUCTION

As mentioned in Chapters 1 and 4, one of the initial data gathering activities in this study was the administration of a survey questionnaire to both the academic staff and emergency medical care (EMC) students at the three participating higher education institutions (HEIs). This chapter deals with the results and findings from the questionnaire. The chapter begins by presenting the methodology and approach to this quantitative phase, before presenting and discussing the results that emerged following the analysis of the respondents' responses to each of the questions. The chapter concludes with a summary of the results, and an explanation for how these findings informed the agenda for the subsequent focus group interviews, which are dealt with in Chapter 6 which follows. As mentioned in Chapters 1 and 4, the intention of the questionnaire was to investigate and describe the opinions of the academic staff and emergency medical care students regarding the physical requirements and task-oriented activities linked to participation in the Bachelor of Health Science Degree in Emergency Medical Care (BHSc EMC) programme, and to explore the extent to which they feel their current physical preparedness assessment tool adequately assesses task-oriented physical preparedness.

5.2 METHOD AND APPROACH

This phase of the research was quantitative in nature and made use of a purpose-designed pre-piloted survey questionnaire (Appendices 5A and 5B). The questionnaire for both the student respondents and the academic staff was divided into four sections: 1) demographics; 2) background content; 3) physical training; and 4) assessment of physical preparedness. The structure and approach to the design of the questionnaire are described in detail and defended in the methodology chapter (Chapter 4). The population accessible for the questionnaire consisted of academic staff engaged in the teaching of the Medical Rescue and/or Physical Preparedness modules in the BHSc EMC programme, and students registered for either their third or fourth year of study in the BHSc EMC programme at the three participating HEIs. A cross-sectional design was utilised, and the sampling technique was purposive, which resulted in a final response rate of 89.3% (117/131) for student respondents and 85.7% (12/14) for academic staff.

The online platform, QuestionPro, was utilised to administer the questionnaire to both the academic staff and students. An information letter (Appendix 3) and consent form (Appendix 4) were included as part of the online survey questionnaire and the potential respondents had to read the information letter and agree to participate in the study before being allowed to proceed with the online questionnaire. The raw data from the survey questionnaire was analysed by the researcher with the assistance of a statistician making use of Statistical Package for the Social Sciences (SPSS Statistics) Version 25.0. The statistical component of the research consisted of both descriptive, as well as inferential, statistics that included descriptive statistics, analysis of variance (ANOVA), a binomial test, the one sample t-test and independent sample t-test. A p value less than 0.05 indicates significance at the 95% level. Manual coding of the free responses was utilised for the open question. The results of this statistical analysis are presented in the next sections, along with a brief discussion of the findings.

5.3 DEMOGRAPHICS (SECTION A OF THE QUESTIONNAIRE)

Figure 5.1 and Figure 5.2 show the demographic profile of the student respondents and the academic staff who completed the questionnaire. The mean age of the student respondents was 25.4 years, and the age range was between 20 and 49. The mean age of the academic staff was 35.7 years, and the age range was between 28 and 46.

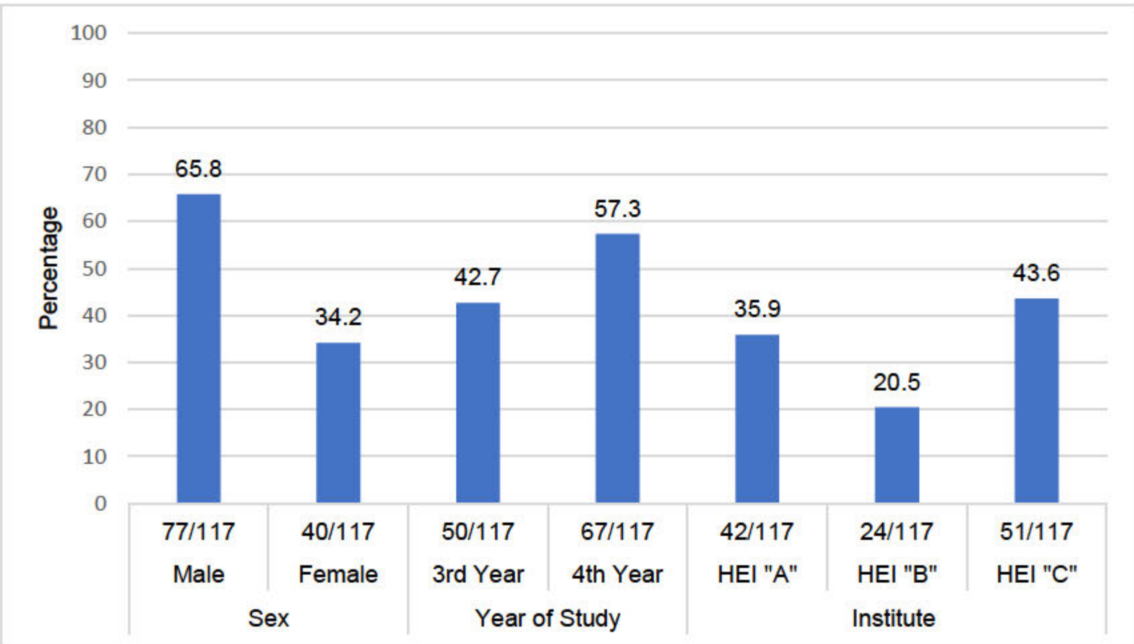


Figure 5.1: Demographic profile of the student respondents

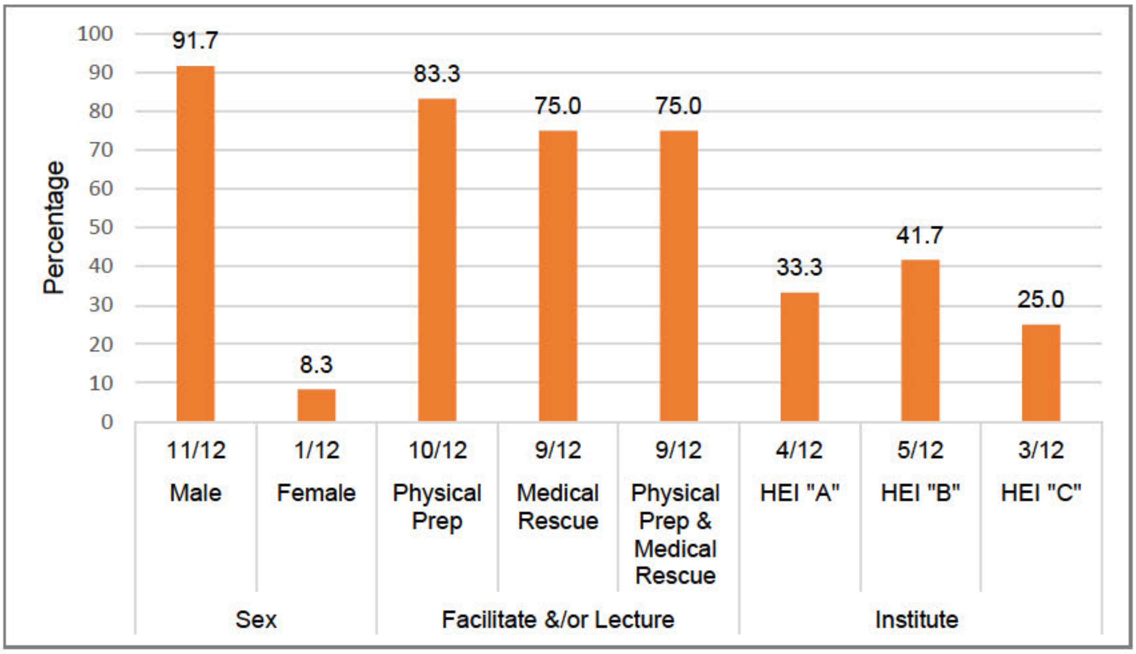


Figure 5.2: Demographic profile of the academic staff

5.3.1 Comment and discussion

Figures 5.1 and 5.2 show that there were considerably more male than female students and academic staff who participated in the research. However, this is in keeping with other similar studies which looked at fitness in emergency care providers. In a local study by Mthombeni, Coopoo and Noorbhai (2020a), 91 emergency care providers took part in a study which investigated the fitness levels of rural emergency medical and rescue service providers in the North West Province in South Africa. Of the 91 participants, 64 were male and 27 were female (Mthombeni, Coopoo and Noorbhai 2020a). Similarly, in an international study by Meadley *et al.* (2021) which looked at the aerobic capacity of helicopter rescue paramedics, out of a total of 14 participants, 12 were male and two female (Meadley *et al*. 2021); and in the study by Siddall *et al.* (2021) to develop physical employment standards for specialist paramedic roles, out of 62 participants, 53 were males and nine were female. All the above might be attributed to the fact that emergency care has historically been a male-dominated profession and ongoing work needs to be done to transform the gender profile of the profession by providing more support and opportunities for females to participate.

5.4 BACKGROUND TO PHYSICAL PREPAREDNESS IN THE PROGRAMME (SECTION B OF THE QUESTIONNAIRE)

5.4.1 Views on the positioning of physical preparedness as a stand-alone module

Respondents were asked whether Physical Preparedness is a stand-alone module that is reflected on a student's academic record with a mark. This question was important in order to determine whether the HEIs identified Physical Preparedness as a stand-alone module in the curriculum of the BHSc programme, just as they would any of the other modules that form part of the curriculum, such as Emergency Medical Care or Medical Rescue. A total of 86.3% (101/117) of the student respondents and 100.0% (12/12) of the academic staff responded 'yes' to this question.

A total of 13.7% (16/117) of the student respondents responded 'no' to this question, which was an unexpected finding. Due to the unexpected nature of this response, further statistical analysis was undertaken, and it was determined that 37.5% (6/16) were third-year students and 62.5% (10/16) were fourth-year students. Further analysis of the data also revealed that 87.5% (14/16) of the student respondents who responded 'no' to this specific question were from HEI 'C', whilst 12.5% (2/16) were from HEI 'B'.

5.4.1.1 Comment and discussion

Many of the academic staff and student respondents selected 'yes' to the question about whether Physical Preparedness was a stand-alone module on a student's academic record with a mark. This response was expected, as it corresponds with the programmes designed for the BHSc EMC programme at the three participating HEIs, which were reviewed as part of the literature review (DUT Faculty of Health Sciences 2023; UJ Faculty of Health Sciences 2023).

The 87.5% (14/16) of student respondents from HEI 'C' who selected 'no' as a response to this question can be explained by the fact that some of the students may still have been registered on an older curriculum of the BHSc EMC programme at HEI 'C' in which Physical Preparedness was not a stand-alone module. Instead, Physical Preparedness was included as a sub-module within the Medical Rescue module (DUT Faculty of Health Sciences 2020). This was later changed at HEI 'C', when the BHSc

EMC programme was recurriculated, and Physical Preparedness was then included as a stand-alone module (DUT Faculty of Health Sciences 2023). The reasons for the 12.5% (2/16) of student respondents from HEI ‘B’ responding ‘no’ to this question cannot be determined.

5.4.2 Value of physical fitness on the BHSc EMC programme

Three questions were formulated to assess the opinion of the respondents on whether there were physically demanding activities on the BHSc EMC programme and whether they viewed physical fitness as an important aspect of the BHSc EMC programme.

There was agreement amongst the student respondents, as well as those on the academic staff, regarding the physically demanding nature of the BHSc EMC programme. There was also agreement from both the student respondents and the academic staff regarding the importance of physical fitness for both the students registered on the BHSc EMC programme and the lecturers presenting the Medical Rescue and Emergency Medical Care modules. These results are presented in Table 5.1.

Table 5.1: The value of physical fitness on the BHSc EMC programme

Statement	Students					Academic Staff				
	Frequency (%)				n	Frequency (%)				n
	Strongly agree	Agree	Disagree	Strongly disagree		Strongly agree	Agree	Disagree	Strongly disagree	
There are activities in which the student participates on the BHSc EMC programme that are physically demanding.		99.1 (116/117)	0.9 (1/117)		117		100.0 (12/12)	0.0 (0/12)		12
It is important for a BHSc EMC student to be physically fit and healthy to engage safely and efficiently with the content of the BHSc programme at my university.	62.4 (73/117)	34.2 (40/117)	2.6 (3/117)	0.9 (1/117)	117	83.3 (10/12)	16.7 (2/12)	0.0 (0/12)	0.0 (0/12)	12
Lecturers presenting the Medical Rescue and Emergency Medical Care modules should also be physically fit.	59.0 (69/117)	39.3 (46/117)	1.7 (2/117)	0.0 (0/117)	117	91.7 (11/12)	8.3 (1/12)	0.0 (0/12)	0.0 (0/12)	12

5.4.2.1 Comment and discussion

In analysing the results presented in Table 5.1, it is evident that both the academic staff and the student respondents agree on the importance of physical fitness on the BHSc EMC programme. This agreement was an expected, yet still important, finding as it sets a strong foundation in support of the need for task-oriented physical preparedness in South African emergency medical care (EMC) students, and the assessment thereof. This is in keeping with some of the other national and international studies, which found that emergency care providers require a high level of physical fitness to cope with the physically demanding occupational tasks associated with emergency care. Emergency care providers who have an appropriate level of physical fitness are also able to work for longer, and more efficiently, ensuring optimal patient care with limited risk of injury (Aljaloud 2018; Meadley *et al.* 2020; Mthombeni, Coopoo and Noorbhai 2020a; Waack, Meadley and Gosling 2023). The students registered on the BHSc EMC programme are also exposed to a wide variety of physically demanding tasks during simulated and authentic emergency medical care and medical rescue scenarios, like that of an operational emergency care provider. Ružbarská and Turek (2010a) undertook a study which assessed the motor performance of 71 students registered for the Medical Rescuer bachelor's study programme at the Faculty of Health, the University of Prešov, in Slovakia. The study noted that rescue competence and safety whilst performing the operational tasks associated with rescue healthcare are largely dependent on the physical disposition of the medical rescuers (Ružbarská and Turek 2010a).

In a local study by Dlamini, Ndlovu and Olifant (2019), who were a group of undergraduate students at HEI 'C', administered a questionnaire to all students registered on the BHSc EMC programme in the 2019 academic year to explore the students' views on physical preparedness. In a question that looked at whether a student's level of physical preparedness had an impact on the student's ability to perform tasks associated with the BHSc EMC programme, 39.77% (35/88) of participants strongly agreed, and 43.18% (38/88) agreed with this question (Dlamini, Ndlovu and Olifant 2019).

The results from both the local and international studies cited above are in agreement with the students' and academic staff's responses regarding the value of physical fitness to engage successfully with the physically demanding nature of the South African BHSc EMC programmes.

5.4.3 Importance of swimming on the BHSc EMC programme

Three follow-on questions from the above focused specifically on whether the ability to swim is deemed as an important skill in the context of the BHSc EMC programme. The results of these three questions are presented in Table 5.2.

Table 5.2: The importance of swimming on the BHSc EMC programme

Statement	Students			Academic Staff		
	Frequency (%)		n	Frequency (%)		n
	Agree	Disagree		Agree	Disagree	
The ability to swim is a valuable life skill.	94.0 (110/117)	6.0 (7/117)	117	100.0 (12/12)	0.0 (0/12)	12
Persons engaging in emergency care and rescue work should be able to swim.	88.9 (104/117)	11.1 (13/117)	117	91.7 (11/12)	8.3 (1/12)	12
It is important for students registered on the BHSc EMC programme to be able to swim.	91.5 (107/117)	8.5 (10/117)	117	91.7 (11/12)	8.3 (1/12)	12

5.4.3.1 Comment and discussion

Based on the researcher's anecdotal experiences, swimming has historically been viewed as a challenge for some students in the BHSc EMC programme at the university where she worked. This had resulted in several complaints, with some even escalating to the level of the Professional Board for Emergency Care (PBEC) and Council on Higher Education (CHE). With this anecdotal experience, the researcher was quite surprised at the level of agreement, as reflected in Table 5.2, by both the academic staff and, more specifically, the student respondents, regarding the value and importance of swimming on the BHSc EMC programme. The aforementioned study by Dlamini, Ndlovu and Olifant (2019) reported similar findings, in that most respondents were also in agreement – 34.09% (30/88) strongly agreed and 38.64% (34/88) agreed – that swimming should be a basic requirement for all emergency medical care providers, while 24/88 (27.27%) disagreed. As this was an undergraduate research study that employed a questionnaire to collect data, the researchers were unable to determine the reasoning behind the results for this question.

Learning how to swim is a life skill, and swimming abilities are inextricably linked to the purpose of the BHSc EMC programme, which is 'to produce a graduate capable of providing broad-based comprehensive quality emergency care and rescue service to all sectors of the community' (Professional Board for Emergency Care 2019). Fatal drownings are a serious health concern, and Africa has been reported to have the highest drowning rates (Fortuin *et al.* 2022). Africa's high drowning rates may be attributed to a lack of drowning prevention initiatives, inadequate drowning prevention policies and regulations, insufficient water safety awareness, and a lack of basic swimming skills (Fortuin *et al.* 2022). In 2019, according to the World Health Organization's (WHO) Global Health Estimates, 236 000 people died due to drowning incidents (WHO 2023). In South Africa, the fifth most commonly reported cause of death due to accidental injury was accidental drowning and submersion, with 3.9% (1 444/36 997) (Statistics South Africa 2018). Fatal drownings are more prevalent in males than in females (Erasmus, Robertson and van Hoving 2018; Fortuin *et al.* 2022; Morris, du Toit-Prinsloo and Saayman 2016). Fatal drownings were reported to have occurred in buckets, bathtubs, swimming pools, dams, rivers, and the sea. Limited data is available documenting the activity of the victim prior to the drowning. However, Lifesaving South Africa has reported that in 27.8% of the cases the victims were swimming; in 13.5% of the cases the victims were playing near a body of water; and in 9.4% of the cases the victims were fishing (Saunders, Sewduth and Naidoo 2018).

When drafting the minimum standards for the Professional Degree in Emergency Care, the PBEC was cognisant of the requirement for swimming proficiency and included it as one of the assessment criteria under Exit Level Outcome 3, which addresses the Medical Rescue component of the programme (Professional Board for Emergency Care 2019; SAQA 2015). The importance of swimming is further emphasised through the inclusion of a compulsory stand-alone Aquatic Rescue module within South African BHSc EMC programmes. This module is typically sub-divided to address the core components of aquatic rescue, namely surface water rescue, swift water rescue, and small boat handling (DUT Faculty of Health Sciences 2023). Students registered for the BHSc EMC programme are, therefore, expected to achieve a certain level of swimming proficiency to ensure that they are successful with the physically strenuous learning outcomes associated with the aquatic rescue training and operational environments.

Although the focus of this research was on the physical preparedness requirements for engaging successfully with the physically strenuous learning outcomes of the BHSc EMC programme, graduates who register as an Emergency Care Practitioner may encounter an aquatic rescue-related incident as part of their daily operational duties as an emergency care provider in real-world scenarios.

An example is the natural disaster that occurred in KwaZulu-Natal on 11 April 2022 in which a 300mm rainfall over a 24-hour period led to widespread flooding and landslides. This incident was declared a provincial disaster, and by 13 April 2022, 395 fatalities had been recorded, with an estimated 40 700 people affected and 16 262 houses and 264 schools destroyed (International Federation of Red Cross and Red Crescent Societies 2022). Emergency care providers were actively involved in the evacuation of persons impacted by these devastating floods.

More recently, in December 2023, Ladysmith experienced a flash flood during which emergency care providers again assisted in rescuing victims affected by the incident (Haripersad 2023).

Another example of when an emergency care provider may be exposed to an aquatic rescue environment is when the National Sea Rescue Institute (NSRI) requires assistance to evacuate a patient off a ship at sea. This is a high-risk situation for the emergency care provider, who will need to step off the NSRI vessel onto a pilot ladder and climb up onto the deck of the vessel. Once the patient has been stabilised, the emergency care provider needs to make their way back down the pilot ladder and step back onto the NSRI vessel (Erasmus, Robertson and van Hoving 2018).

Some graduates may elect to form part of an aquatic rescue team at aquatic events such as the Midmar Mile Swim or Dusi Canoe Marathon; however, this would not form part of their daily operational duties.

5.4.4 Previous sporting experience from school

The next two questions in the questionnaire were only posed to the student respondents and not the academic staff. These two questions explored whether students were surprised by the level of physical preparedness required on the BHSc EMC programme and whether they had previously engaged in strenuous sporting activities at school.

A total of 56.4% (66/117) of the student respondents indicated that they had participated in strenuous sporting activities at school, whilst 43.6% (51/117) had not. Despite the student respondents' previous exposure to strenuous sporting activities at school, 65.0% (76/117) of the respondents agreed that they were surprised at the level of physical preparedness required on the BHSc EMC programme, whilst 35.0% (41/117) were not surprised at the level of physical preparedness on the BHSc EMC programme. The Pearson chi-square test was utilised to determine whether there was a significant relationship between these two questions. The result of this statistical test demonstrated that a significant number of those students who had participated in strenuous exercise at school were not surprised at the level of physical preparedness required on the BHSc EMC programme ($p = 0.007$).

5.4.4.1 Comment and discussion

Looking at the above data, and following several tests, the researcher found that students who took part in physically strenuous activities whilst they were at school were less surprised at the level of physical preparedness necessary for the BHSc EMC programme. It is possible that they had a foundation in physical activity from school which assisted in developing their 'physical literacy'. 'Physical literacy' is defined as an individual's ability and desire to participate in physical activity throughout life (Physical Literacy 2023).

However, a large number of the student respondents were surprised at the level of physical preparedness required in the BHSc EMC programme. Based on anecdotal evidence, the researcher feels that this may possibly be explained by the changes that the South African schooling system has undergone over the past few years, with specific reference to Physical Education (PE), which seems to have all but disappeared from the South African school curriculum.

Dating back to 1996, PE was a standalone subject taken by South African school pupils. However, with the implementation of outcomes-based education, PE was grouped with Life Orientation in 2002 and it is predicted that by 2023, Life Orientation will no longer be a compulsory subject in public schools. This has resulted in no clear evidence of the prioritisation of PE in the school curriculum, and in the 2018 Healthy Active Kids South Africa (HAKSA) Report, out of 12 countries, South Africa had the highest percentage of learners (32%) not participating in PE at school (Goslin 2020). With PE rapidly disappearing from the South African schooling system, it has been documented that only half of the children in South Africa are achieving the internationally recommended 60 minutes per day of moderate-to-vigorous physical activity, which is having a negative impact on their health. If children are encouraged to take part in physical activity when they are young, they will continue to remain physically active throughout life (Tee 2020). Without this exposure to PE at school, these children are growing up without having this foundation in physical activity. All of this creates a significant and ongoing challenge for university students and educators who have to grapple with the emotional and physical challenge of getting ‘unfit’ youngsters (some of whom have very low levels of physical literacy) to meet with the physical preparedness requirements associated with their chosen programmes and careers.

5.4.5 Rating of perceived exertion (RPE) levels

Linking in with the above, the researcher explored respondents’ ratings of perceived exertion (RPE). The RPE is a widely used and reliable indicator to assess and guide exercise intensity and, combined with the Borg Scale, it gives individuals the opportunity to subjectively rate their own personal level of exertion during a physical activity (Borg 1998; Waack, Meadley and Gosling 2023). The respondents (both the students and academic staff) were required to rate their level of perceived exertion from 0 to 10 for all 12 of the Medical Rescue modules that form part of the BHSc EMC programme. In the event where the student respondent had yet to complete one of the 12 Medical Rescue modules, they were provided with a ‘not applicable (N/A)’ option. Similarly, if the academic staff had not participated in, and/or lectured on, any of the listed 12 Medical Rescue modules, they were also provided with the N/A option. The coding that was utilised for the data analysis of the Borg Scale was as follows: 1 = at rest; 2 = very easy; 3 = somewhat easy; 4 = moderate; 5 = somewhat hard; 6 = hard; 8 = very hard and 11 = very, very hard. The N/A responses were also excluded from any of the inferential statistical analysis. Figure 5.3 represents the mean RPE for the student respondents and the academic staff.

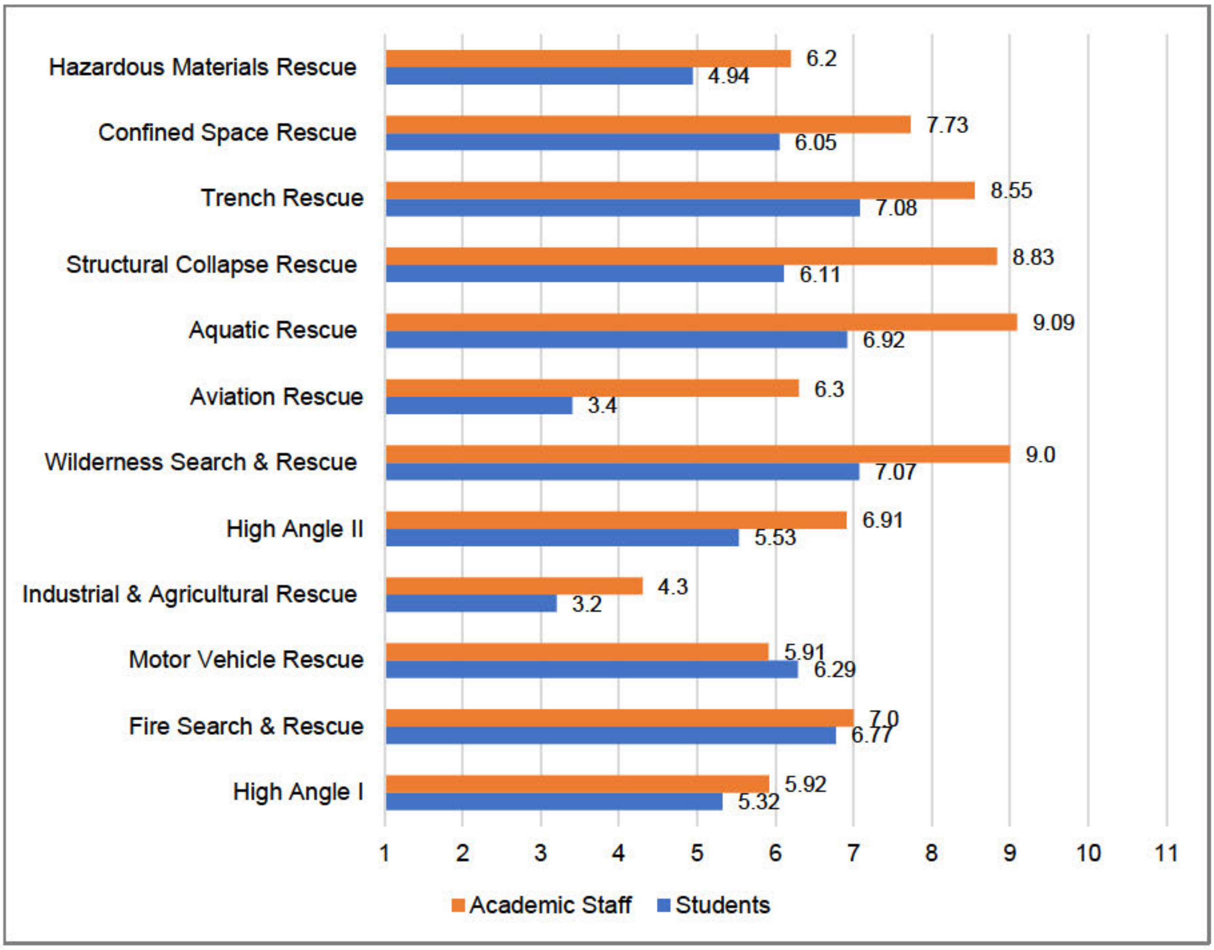


Figure 5.3: Mean RPE for the 12 Medical Rescue modules for the student respondents and academic staff

The one sample t-test was utilised to test if the mean RPE score was significantly different from the central score of '6' which represents 'hard' on the RPE scale. The one sample t-test was a valid test to determine this, even though the sample size was small, as the scores were normally distributed. The results of this statistical analysis for the student respondents demonstrated that the students found certain of the Medical Rescue modules significantly more difficult than a rating of '6'. These modules included Fire Search and Rescue; Wilderness Search and Rescue; Aquatic Rescue; and Trench Rescue. The student participants rated the following Medical Rescue modules as less difficult (an RPE score less than '6'): High Angle I; Industrial and Agricultural Rescue; High Angle II; Aviation Rescue; and Hazardous Materials Rescue. In terms of the academic staff, the following modules were deemed to be significantly more difficult than 'hard' (RPE score greater than '6'): Wilderness Search and Rescue; Aquatic Rescue; Structural Collapse Rescue; Trench Rescue; and Confined Space Rescue. This data is presented in Table 5.3.

Table 5.3: Comparison of the average RPE scores in relation to the central score of '6'

Medical Rescue Module	Students					
	N*	Mean	Std. Deviation	t	df	Sig. (2-tailed)
High Angle I	113	5.32	2.176	–3.328	112	0.001
Fire Search & Rescue	111	6.77	2.291	3.563	110	0.001
Motor Vehicle Rescue	113	6.29	2.313	1.342	112	0.182
Industrial & Agricultural Rescue	79	3.20	2.209	–11.254	78	0.000
High Angle II	101	5.53	2.105	–2.222	100	0.029
Wilderness Search & Rescue	92	7.07	2.506	4.077	91	0.000
Aviation Rescue	55	3.40	2.131	–9.049	54	0.000
Aquatic Rescue	83	6.92	2.296	3.633	82	0.000
Structural Collapse Rescue	54	6.11	2.462	0.332	53	0.741
Trench Rescue	59	7.08	2.521	3.305	58	0.002
Confined Space Rescue	61	6.05	2.636	0.146	60	0.885
Hazardous Materials Rescue	35	4.94	2.209	–2.831	34	0.008
Medical Rescue Module	**Academic Staff**					
	N**	**Mean**	**Std. Deviation**	**t**	**df**	**Sig. (2-tailed)**
High Angle I	12	5.92	1.621	–0.178	11	0.862
Fire Search & Rescue	11	7.00	2.191	1.514	10	0.161
Motor Vehicle Rescue	11	5.91	1.814	–0.166	10	0.871
Industrial & Agricultural Rescue	10	4.30	2.541	–2.116	9	0.063
High Angle II	11	6.91	1.446	2.085	10	0.064
Wilderness Search & Rescue	11	9.00	2.280	4.363	10	0.001
Aviation Rescue	10	6.30	1.767	0.537	9	0.604
Aquatic Rescue	11	9.09	1.814	5.651	10	0.000
Structural Collapse Rescue	12	8.83	1.697	5.785	11	0.000
Trench Rescue	11	8.55	2.067	4.084	10	0.002
Confined Space Rescue	11	7.73	1.794	3.193	10	0.010
Hazardous Materials Rescue	10	6.20	1.814	0.349	9	0.735

** The n value varies for the student respondents as some students elected not to respond to this question, and others selected N/A as they had yet to complete that specific Medical Rescue module.*
*** The n value varies for the academic staff as some of the academic staff elected not to respond to this question, and others selected N/A as they had never engaged in the teaching of that specific Medical Rescue module.*

Further statistical testing was done using the independent samples t-test to determine whether the average scores for each of the Medical Rescue modules differed by sex and year of study for the student respondents. Regarding sex, the male students scored the RPE significantly higher than the female students for the following modules: High Angle I; High Angle II; Structural Collapse Rescue; and Trench Rescue. There was no statistically significant finding when analysing the age of the student respondents and their scoring of the RPE. However, when applied, ANOVA identified a significant difference in the RPE for the Industrial and Agricultural Rescue module ($F (2.76) = 5.214$, $p = 0.008$). The Tukey post-hoc test demonstrated that senior students from HEI 'C' scored a higher RPE, on average, than students from HEI 'B' ($p = 0.036$).

5.4.5.1 Comment and discussion

Both the students and academic staff found the following Medical Rescue modules to be significantly more difficult than a rating of '6', which represents 'hard' on the RPE scale:

1) Wilderness Search and Rescue
2) Aquatic Rescue
3) Trench Rescue

In addition, the students found Fire Search and Rescue to be significantly more difficult than a rating of '6' and the academic staff found Structural Collapse Rescue and Confined Space Rescue to be significantly more difficult than a rating of '6'.

The Wilderness Search and Rescue module involves students hiking for several days in mountainous, wilderness areas with a weighted backpack to master navigation and different search techniques. The weighted backpack contains essential items such as food, clothing, tents and sleeping bags, as well as both medical and rescue equipment, and these packs can weigh up to 30kg. During the multi-day simulated search and rescue exercise, the students will traverse several types of terrain with varying gradients in order to find the patient (Orr *et al.* 2022). Once the patient has been located and emergency care has been initiated, the EMC students are then required to move the patient to an extraction point with the aid of a stretcher, and this load can then easily exceed 100kg (Conolly, Elder and Dawes 2015). All these aspects impact on the energy expenditure of the student and high levels of fitness are required to manage the prolonged and strenuous work associated with the evacuation of a patient from a mountainous, wilderness area. In the Wilderness Search and Rescue module, the students work independently and the load that the individual students are expected to carry is not shared. This means that every student engaged in this module is exposed to the same level of physical tasks.

As discussed earlier in this chapter, the Aquatic Rescue module consists of three sub-modules (surface water rescue, swift water rescue and small boat handling). The swift water rescue component is physically demanding as students are expected to undertake various different rescue techniques in fast flowing rivers and this requires the students to have quite a high level of swimming competency and fitness in order to successfully achieve the practical outcomes of this module.

In the Trench Rescue module, students are required to move heavy sheets of timber, and large piles of collapsed soil, and to operate heavy equipment for prolonged periods of time, as incidents involving a collapsed trench can take several hours of hard work to free a patient trapped inside a trench. This extended period of physical strenuous work would result in a significantly higher RPE score. However, in the Trench Rescue module, the students work as a team to carry the heavy equipment, and therefore not all students engaged in this module are exposed to the same level of physical exertion.

Within the Fire Search and Rescue module, the students are exposed to aspects of training that a firefighter would be exposed to, specifically the use of a self-contained breathing apparatus (SCBA) and the use of specialised equipment such as fire extinguishers and ladders. Firefighting is known to be a physically demanding job, and as this is the first time that the students are exposed to the use of the SCBA, the students find using it to be quite physically demanding (Michaelides *et al.* 2011; Nazari *et al.* 2018). The wearing of, and breathing through, the SCBA decreases VO_{2max} by 14.9% as it alters the wearer's breathing pattern. It increases the work of breathing and it reduces maximal exercise performance, while increasing submaximal cardiorespiratory responses (Lesniak 2017). The weight of the SCBA increases the load carriage of the wearer and, as it is carried on the back, the centre of mass shifts posteriorly. The SCBA is known to restrict movement, increase fatigue and reduce maximal exercising time (Kesler *et al.* 2018). The academic staff who are more familiar with the use of the SCBA in physical strenuous activities, may not have been taking into consideration these factors when rating the level of exertion associated with this module.

Similarly, as the students may not have had the necessary simulated practical experience associated with the Structural Collapse Rescue and Confined Space Rescue modules, they may not have experienced the level of exertion as determined by the academic staff for these two modules. A number of the academic staff participants have been part of medical rescue teams which have been deployed to national and international disaster zones following earthquakes and cyclones. Therefore, the academic staff may have based their rating of perceived exertion for these two modules on real-world experience.

5.4.6 Physically challenging events and/or activities on the BHSc EMC programme

Whilst the above section dealt with the RPE for the 12 Medical Rescue modules, the last part of Section B of the questionnaire required the student respondents and academic staff to comment on specific experiences, events and/or activities related to the BHSc EMC programme which they found most physically challenging for students. This was an open-ended question, and the free responses of the participants were manually coded. The academic staff and student respondent responses, according to category, are presented in Figure 5.4.

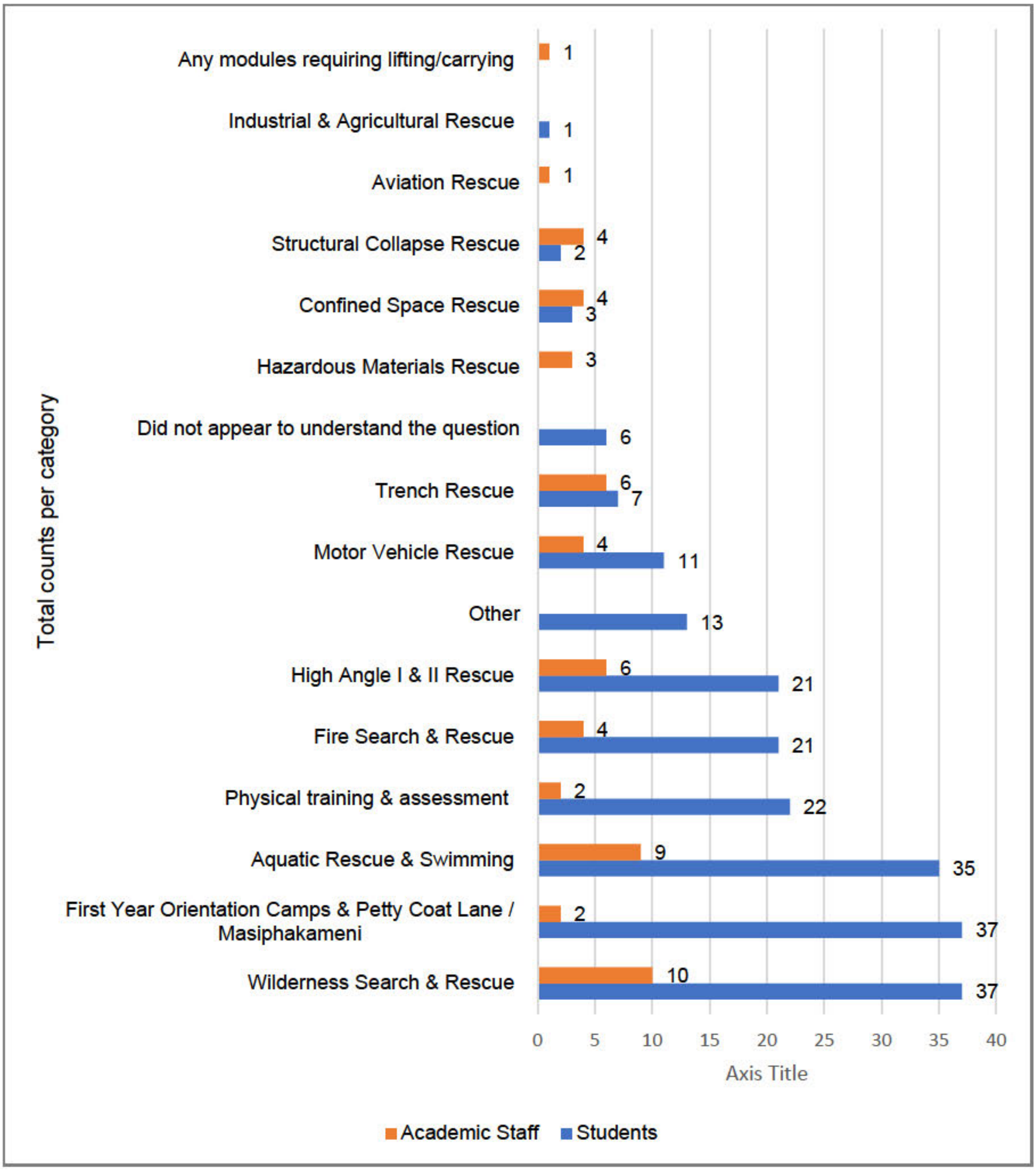


Figure 5.4: Total counts per category for the academic staff and student respondents

It is clear from Figure 5.4 that the Wilderness Search and Rescue module was highly ranked in terms of how physically challenging it was for the students, as it was identified by 37 student respondents and 10 academic staff. Below are selected quotes from the student respondents:

> *"Wilderness search and rescue hike was physically demanding".*

> *"The hike was hard..."*

"… and hiking over rough terrain during WSAR to locate patients at high altitude"

"… WSAR was also challenging, especially with all that added weight…"

"The WSAR hike was physically challenging for me with regards to endurance."

Quotes from academic staff regarding the Wilderness Search and Rescue module included:

"Carrying a patient in the mountains, hiking in the mountains with a full backpack."

"WSAR – Physical endurance as long days of carrying heavy packs and covering vast distances, need to be physically fit."

The student respondents also identified first-year orientation camps ('Hell Week', 'Vasbyt' and the 'Teamwork and Leadership Camp'), along with 'Petty Coat Lane' and 'Masiphakameni' as physically challenging, as 37 counts were noted that linked to this category. The purpose of these events is to orientate the first-year students to the BHSc EMC programme, in terms of the level of discipline required to engage with the programme content, as well as to develop teamwork and leadership skills amongst the students. During some of these events, the first-year students are divided into smaller teams, and the teams are expected to navigate through various exercises over a 48-to-72-hour time period. This type of activity is physically and mentally taxing as it includes extended periods without proper sleep. From the researcher's perspective, exposing students to high-fidelity simulated rescue activities has value. However, these exercises must be carefully designed and managed to ensure safety at all times and that the event is closely linked to clear learning outcomes. The researcher does not support the use of these first-year orientation camps as hazing events. Here are some of the quotes from the student participants relating to the above events:

"Masipakameni was physically challenging due to the amount of patient carrying that was done, but the rescue aspect wasn't necessarily challenging, but the sleep deprivation was."

"The first-year teamwork and leadership camp was the most challenging for me. The reason is that the style of the activities were very different from what I was

used to at that point, so the uncertainty combined with the physical strain was difficult to cope with."

The category that received the second-most student responses was aquatic rescue and swimming with 35 counts. The academic staff also identified this category as physically strenuous, with nine counts. Many of the students entering the BHSc EMC programme at the beginning of the programme are unable to swim. Students are provided with swimming lessons in order to ensure that they are able to swim at least 200m within six minutes by the end of their first academic year. The third year of the BHSc EMC programme has a Medical Rescue module called Aquatic Rescue, which has three components: surface water rescue, small boat handling and swift water rescue. The content of this module requires a higher level of swimming proficiency from the students as they are placed in open bodies of water such as dams and the sea, as well as in fast flowing rivers for the swift-water component. Here are some of the quotes from the student respondents relating to the aquatic rescue and swimming category:

"Sea swims…"

"… learning to swim from not being able to at all"

"Aquatic rescue was hard because of the time required to swim."

"Activities that involve swimming…"

"Swimming, especially the increase in laps (200m to 400m) as you progress in the years of study."

"Timed distance swimming assessments followed by timed water treading assessment."

"I'm still adjusting to swimming. It's hard."

"… swimming in swift-water rescue"

Some quotes from the academic staff regarding the Aquatic Rescue module and swimming category were:

"Various rescue swim techniques (with a patient)"

"Swift-water rescue practical"

"Aquatic rescue, swimming and moving in fast flowing water"

"Aquatic rescue, being in the ocean and having to swim also seems exhaustive even life jackets and buoyancy aids."

"Swift-water – endurance, due to long hours in the fast-flowing water and doing activities around it."

The physical training and assessment response category received 22 counts from the student respondents addressing physical training, the assessment of physical preparedness, and the different components of fitness which may be required to engage with the modules on the BHSc EMC programme. The students are required to engage in physical training and physical preparedness assessments as part of the BHSc EMC programme. These are some of the quotes from the student respondents relating to this specific category:

"The time allocation of physical training, as I perform better physically in the afternoon than I do in the morning, as well as the level of endurance required as I primarily train for strength."

"5km run"

"… cardio sessions in first year"

"… the first physical preparedness test of every year"

"The arm hang is a bit challenging and running is a bit challenging too."

In the 'other' response category, some of the responses from the senior students addressed points relating to clinical learning shifts, the Gariep Dam Rescue Exercise, and general time management. The students registered for the BHSc EMC programme are required to engage in clinical learning in the authentic environment in both the pre- and in-hospital environment, where they are expected to manage patients under supervision as part of their teaching and learning process. The Gariep Dam Rescue is an event attended by the third-year students and this event involves the students engaging in multiple high-fidelity medical rescue scenarios over a period of three days. Here are some of the student participant quotes relating to this category:

"Sometimes holding a patient down that's starting to become a bit combative."

"… and Gariep"

"Balancing the time between the needs of all the modules maintaining/making time for physical training in between learning and studying in order to maintain fitness."

"Standing upright on long hospital shifts. Staying in good posture when doing assignments and studying. Carrying heavy patients in awkward settings and long distances."

"None."

The academic staff also identified High Angle Rescue and Trench Rescue as physically challenging components of the BHSc EMC programme as there were six counts for each of these modules. The High Angle Rescue was also identified as physically challenging by the student respondents with 21 counts. However, there were only seven counts for the Trench Rescue module from the student respondents. The High Angle Rescue module requires the EMC student to make use of ropes and other high angle equipment to access and extricate patients from both the urban and wilderness high-angle environment. This can involve the student having to ascend a rope, hauling a two-person load over a significant distance, or functioning as a stretcher jockey. In the Trench Rescue module, the students are required to move heavy sheets of timber and large piles of soil, and operate heavy equipment for lengthy periods of time. These are some of the academic staff's quotes relating to these two modules:

"Ascending a rope hauling a two-person litter"

"High Angle 1 – rope ascent"

"Trench Rescue, carrying of heavy equipment, moving large amounts of soil, and working for long durations"

"Students seemed to suggest to me that trench rescue is extremely hard and requires a level of fitness when carrying wooden beams and equipment around, as well as physically having to climb in and out of trenches."

"Trench Rescue – very labour intensive, students have to be physically fit and strong."

5.5 PHYSICAL TRAINING (SECTION C OF THE QUESTIONNAIRE)

5.5.1 Structured physical training

The first four questions in Section C of the Questionnaire were formulated to determine whether structured physical training was included in the different academic years of the BHSc EMC programme. This data is presented in Table 5.4, and most of the student respondents and academic staff responded 'yes' to this question. However, the frequency of positive responses was less in the fourth year of study. Only the fourth-year students were required to respond to the question relating to structured physical training in the fourth year of study and therefore the n value for the senior students changed from 117 to 67.

Table 5.4: Structured physical training as part of the BHSc EMC programme

Statement	Students				Academic Staff		
	Frequency (%)			n	Frequency (%)		n
	Yes	No	Did not respond*		Yes	No	
Structured physical training is included as part of the first year of the BHSc EMC programme at my institution.	89.7 (105/117)	8.5 (10/117)	1.7 (2/117)	117	91.7 (11/12)	8.3 (1/12)	12
Structured physical training is included as part of the second year of the BHSc EMC programme at my institution.	82.9 (97/117)	14.5 (17/117)	2.6 (3/117)	117	83.3 (10/12)	16.7 (2/12)	12
Structured physical training is included as part of the third year of the BHSc EMC programme at my institution.	80.3 (94/117)	17.1 (20/117)	2.6 (3/117)	117	91.7 (11/12)	8.3 (1/12)	12

Statement	Students				Academic Staff		
	Frequency (%)			n	Frequency (%)		n
	Yes	No	Did not respond*		Yes	No	
Structured physical training is included as part of the fourth year of the BHSc EMC programme at my institution.	56.7 (38/117)	38.8 (26/117)	4.5 (3/117)	67**	66.7 (8/12)	33.3 (4/12)	12

** Some student participants elected not to respond to certain questions within this section.*
*** The n value for the question on the structured physical training in the fourth year of study on the BHSc EMC programme is 67, as only the fourth-year students were eligible to answer this question.*

5.5.1.1 Comment and discussion

Students registered for the BHSc EMC programme at the three participating HEIs all register for a stand-alone Physical Preparedness module (DUT Faculty of Health Sciences 2023; NMU Faculty of Health Sciences 2023; UJ Faculty of Health Sciences 2023). At all three participating HEIs, the module is credit bearing and appears in each of the four academic years of the programme, with allocated periods in the academic timetable (Allan 2023; Muhlbauer 2022; Van Nugteren 2023). There is some variation in the number of periods and/or days per week allocated to the Physical Preparedness module in the academic timetable between the three participating HEIs. However, in general it appears that the number of periods remains consistent, but the number of days per week is reduced in the third and fourth year of study.

5.5.2 Facilitation of the structured physical training sessions

The next four questions in Section C addressed the facilitation of the structured physical training sessions and these results are presented in Table 5.5. The results demonstrated agreement amongst both the student respondents and the academic staff that the structured physical training sessions are presented by one dedicated lecturer/facilitator. However, this lecturer changes from session-to-session or year-to-year at the different HEIs. There was also agreement from both the student respondents and the academic staff that the lecturer presenting the structured physical training sessions views these sessions just as if they were any other lecture scheduled on the academic timetable. The question that addressed whether the physical training sessions started off well at the beginning of the academic year, and lost momentum towards the end of the academic year, did not produce a clear positive or negative answer from either the student respondents or academic staff.

Further statistical analysis was performed on the question which addressed whether the physical training sessions started off well at the beginning of the academic year, and lost momentum towards the end of the academic year, in order to determine if there were any statistically significant findings in relation to the student participants' responses from the three different HEIs and the two different academic years (third and fourth year). Making use of the chi-square test, a statistically significant result ($p = 0.001$) was identified when analysing the responses of the student respondents in relation to their respective HEIs, as the majority of the 'true' responses to this statement originated from two of the HEIs, with 30 and 16 counts, respectively, out of a total of 58. When undertaking further analysis of the academic years with the chi-square test, a statistically significant result was also identified as a significant number of the third-year students responded 'true', while a significant number of fourth-year students responded 'false' ($p = 0.006$).

Table 5.5: Facilitation of the structured physical training sessions

Statement	Students				Academic Staff		
	Frequency (%)			n	Frequency (%)		n
	True	False	Did not respond *		True	False	
The physical training is presented by one dedicated lecturer/facilitator who is solely responsible for all of the physical training across all four years on the BHSc EMC programme at my institution.	10.3 (12/117)	85.5 (100/117)	4.3 (5/117)	117	8.3 (1/12)	91.7 (11/12)	12

Statement	Students				Academic Staff		
	Frequency (%)			n	Frequency (%)		n
	True	False	Did not respond *		True	False	
The physical training is presented by one dedicated lecturer/facilitator; however, this lecturer differs either from session to session or year to year at my institution, e.g. the third-year coordinator is responsible for the physical training of the third-year students.	88.0 (103/117)	7.7 (9/117)	4.3 (5/117)	117	100.0 (12/12)	0.0 (0/12)	12
The physical training sessions start well at the beginning of the academic year at my institution, however, towards the end of the academic year, sessions are often cancelled and the structure is lost.	49.6 (58/117)	46.2 (54/117)	4.3 (5/117)	117	41.7 (5/12)	58.3 (7/12)	12
The lecturer assigned to facilitate the physical training sessions sees these as part of the BHSc EMC programme, and they approach these sessions just as if they were any other lecture scheduled on the academic timetable at my institution.	76.9 (90/117)	17.9 (21/117)	5.1 (6/117)	117	91.7 (11/12)	8.3 (1/12)	12

** Some student participants elected not to respond to certain questions within this section.*

5.5.2.1 Comment and discussion

The Physical Preparedness module has dedicated periods on the academic timetable and, based on this, an academic staff member is allocated to present the module just as is done with any of the other academic modules in the BHSc EMC programme (Allan 2023; Muhlbauer 2022; Van Nugteren 2023). The responses from the student and academic staff respondents demonstrated agreement that there is a dedicated academic staff member responsible for the physical training. However, there can be a different academic staff member from session-to-session or year-to-year. The consistency and structure of the physical training appears to dwindle towards the end of the academic year, although this only appears to be significant at two of the HEIs, specifically at HEI 'C', where there were 30 counts out of a total of 58; and specifically with the third-year students at this HEI.

5.5.3 Academic structure of the physical training sessions

Two questions were formulated around the academic structure of the physical training sessions at the different HEIs in order to determine whether there were clear aims and objectives provided for the structured physical training sessions, just as would be expected in any of the other modules which form part of the BHSc EMC programme. There was agreement from the student respondents that there were set aims for each of the structured physical training sessions at their respective HEIs. These results are presented in Table 5.6.

Table 5.6: Academic structure of the physical training sessions

Statement	Students				Academic Staff		
	Frequency (%)			n	Frequency (%)		n
	Yes	No	Did not respond *		Yes	No	
There are set aims for each of the structured physical training sessions at my institution.	65.8 (77/117)	29.1 (34/117)	5.1 (6/117)	117	75.0 (9/12)	25.0 (3/12)	12
There are clear objectives which are outlined for each of the structured physical training sessions at my institution.	55.6 (65/117)	39.3 (46/117)	5.1 (6/117)	117	50.0 (6/12)	50.0 (6/12)	12

** Some student participants elected not to respond to certain questions within this section.*

5.5.3.1 Comment and discussion

The results reflected agreement by both the students and academic staff respondents that there are clear aims and objectives for the physical training sessions. This finding is supported in that the Physical Preparedness module is a stand-alone module within the BHSc EMC curriculum at the three participating HEIs and there is a formal learning guide which clearly highlights the purpose of the module, along with the stated learning outcomes to be achieved (Allan 2023; Muhlbauer 2022; Van Nugteren 2023).

5.5.4 Emotional and physical impact of the structured physical training sessions

The next series of questions in Section C explored the opinions from both the student respondents and the academic staff on the perceived emotional and physical impact of the structured physical training sessions on the students. Seven questions were formulated around this area of interest, and the questions along with the results are presented in Table 5.7. There was agreement from both the student respondents as well as the academic staff that the structured physical training sessions had provided the students with greater mental endurance and the sessions had benefited the students physically. This section also attempted to identify the impact that an unfit student has on the class dynamics, and both the student respondents and the academic staff agreed that this negatively impacts the class dynamics. The last question in this section was formulated to determine whether the student respondents and academic staff felt that structured physical training was important in order to ensure that an EMC student is adequately prepared to engage successfully with the physically strenuous learning activities of the BHSc EMC programme, and there was agreement from both the student respondents and the academic staff for this specific question.

Table 5.7: Emotional and physical impact of the structured physical training sessions

Statement	Students						Academic Staff				
	Frequency (%)					n	Frequency (%)				n
	Strongly agree	Agree	Disagree	Strongly disagree	Did not respond*		Strongly agree	Agree	Disagree	Strongly disagree	
The structured physical training appears to be emotionally draining for the students.	10.3 (12/117)	29.1 (34/117)	38.5 (45/117)	17.1 (20/117)	5.1 (6/117)	117	0.0 (0/12)	16.7 (2/12)	50.0 (6/12)	33.3 (4/12)	12
The structured physical training appears to have provided the students with greater mental endurance.	32.5 (38/117)	44.4 (52/117)	12.0 (14/117)	6.0 (7/117)	5.1 (6/117)	117	66.7 (8/12)	33.3 (4/12)	0.0 (0/12)	0.0 (0/12)	12
The structured physical training appears to have benefitted the students physically.	46.2 (54/117)	35.0 (41/117)	9.4 (11/117)	4.3 (5/117)	5.1 (6/117)	117	83.3 (10/12)	16.7 (2/12)	0.0 (0/12)	0.0 (0/12)	12
When someone in the class is unfit, the whole class gets slowed down to that student's pace.	18.8 (22/117)	37.6 (44/117)	29.1 (34/117)	9.4 (11/117)	5.1 (6/117)	117	8.3 (1/12)	41.7 (5/12)	41.7 (5/12)	8.3 (1/12)	12
I find it frustrating if there is an unfit student in the class that slows down the pace of the physical training session.	15.4 (18/117)	32.5 (38/117)	32.5 (38/117)	14.5 (17/117)	5.1 (6/117)	117	16.7 (2/12)	58.3 (7/12)	16.7 (2/12)	8.3 (1/12)	12
When the pace of the physical training session is slowed down due to an unfit student, this has a negative impact on the class dynamics.	19.7 (23/117)	37.6 (44/117)	32.5 (38/117)	5.1 (6/117)	5.1 (6/117)	117	16.7 (2/12)	66.7 (8/12)	16.7 (2/12)	0.0 (0/12)	12
Structured physical training sessions are important to ensure that an EMC student is adequately prepared to engage safely and efficiently with the learning activities of the BHSc EMC programme.	45.3 (53/117)	40.2 (47/117)	6.0 (7/117)	3.4 (4/117)	5.1 (6/117)	117	83.3 (10/12)	16.7 (2/12)	0.0 (0/12)	0.0 (0/12)	12

** Some student participants elected not to respond to certain questions within this section.*

5.5.4.1 Comment and discussion

The student respondents and academic staff agreed that the physical training had benefited the students both mentally and physically. The Biopsychosocial Model presented in Chapter 2 demonstrated the relationship that exists between physical fitness and the components of wellness, such as psychological and physiological health (Paoli and Bianco 2015). Physical fitness is achieved through physical exercise which consists of planned, structured physical training, proper nutrition and rest (American College of Sports Medicine 2018; Corbin and Pangrazi 2012). Based on these definitions of physical fitness and physical training, it was an expected finding, that both the students and academic staff agreed that students registered on the BHSc EMC programme had benefitted both mentally and physically from the physical training. Similar findings were also noted in the undergraduate study where 45.45% (40/88) of the student respondents agreed and 28.41% (25/88) strongly agreed that they had benefitted mentally and physically from the physical training sessions (Dlamini, Ndlovu and Olifant 2019).

Regular participation in physical activity is crucial for increasing the likelihood of living a healthy life. The American College of Sports Medicine (ACSM) released reports dating back 20 years clarifying the amount and intensity of physical activity required to improve health, lower morbidity, and reduce premature mortality. The ACSM recommends that healthy adults aged 18–65 years of age should partake in moderate intensity aerobic physical activity for a minimum of 30 minutes five days a week, or vigorous intensity aerobic activity for a minimum of 20 minutes three days a week. In addition, every adult should perform activities that maintain or increase muscular strength and endurance at least twice a week (American College of Sports Medicine 2018). The structured physical training sessions on the academic timetable ensure that the EMC students complete at least two to three of these sessions as a group, under the supervision of an academic staff member. This arrangement helps ensure that the students exercise at the required intensity and frequency to engage successfully with the physically strenuous learning activities of the BHSc EMC programme.

The rostered physical training sessions, which were the focus of the survey questionnaire, appear on the academic timetable as set periods. These are conducted with a group of students, usually organised according to the relevant academic year. These sessions are typically presented by the academic staff member responsible for the Physical Preparedness module for that academic year, and comprise different physical activities, such as a run, swim or functional fitness session.

Engaging in physical activity as a group fosters cohesion amongst group members, who tend to bond and unite in their pursuit of common outcomes. This group training also provides a supportive environment in which to exercise (Davis, Maccarron and Cohen 2021). In some instances, a student may struggle with some of the physical activities, which may cause that student to feel isolated from the rest of the class. This would negatively impact the teamwork dynamics within that specific class. The researcher was not able to explore the psychological impact – whether positive or negative – of the group physical training sessions, as this was a closed question within an online survey questionnaire. Although it was an important finding warranting further research, it was not the focus area of this research.

5.5.5 Accountability for the structured physical training sessions

The last three questions in this section were formulated to determine who should be accountable for the offering of the physical training sessions and whether these physical training sessions should be structured, or whether they should be elective. The results of these three questions are presented in Table 5.8. There was agreement amongst both the student respondents and the academic staff that there should be structured physical training sessions. In support of this finding, there was also disagreement from both the student respondents and the academic staff that the development and maintenance of physical preparedness should be left to the individual student and not be facilitated by the university.

Table 5.8: Accountability for the structured physical training sessions

Statement	Students						Academic Staff				
	Frequency (%)					n	Frequency (%)				n
	Strongly agree	Agree	Disagree	Strongly disagree	Did not respond *		Strongly agree	Agree	Disagree	Strongly disagree	
There should be structured physical training sessions.	53.8 (63/117)	31.6 (37/117)	9.4 (11/117)	0.0 (0/117)	5.1 (6/117)	117	83.3 (10/12)	16.7 (2/12)	0.0 (0/12)	0.0 (0/12)	12
The attendance of physical training should be elective.	21.4 (25/117)	31.6 (37/117)	23.9 (28/117)	16.2 (19/117)	6.8 (8/117)	117	8.3 (1/12)	16.7 (2/12)	25.0 (3/12)	50.0 (6/12)	12
The development and maintenance of physical preparedness should be left to the individual student and not be facilitated by the University.	13.7 (16/117)	20.5 (24/117)	35.9 (42/117)	23.1 (27/117)	6.8 (8/117)	117	0.0 (0/12)	16.7 (2/12)	25.0 (3/12)	58.3 (7/12)	12

** Some student participants elected not to respond to certain questions within this section.*

5.5.5.1 Comment and discussion

There was support for structured physical training sessions by both the students and academic staff respondents. This support may be rooted in a finding described above that there was general agreement that the students do benefit (both mentally and physically) from the physical training sessions, and that the structured physical training assisted in preparing the students to engage successfully with the physically strenuous demands of the BHSc EMC programme. The results also reflected that the students and academic staff did not agree that physical training should be an elective activity and/or left to the individual student to develop and maintain. Anecdotally, in the researcher's experience, if the physical training sessions are not compulsory, the students who are most in need of the physical training tend not to attend unless they are 'forced' to do so. In another local study, the compulsory nature of physical training sessions was also supported by student respondents, with 39.77% (35/88) agreeing and 30.68% (27/88) strongly agreeing that attendance at physical training sessions should be compulsory (Dlamini, Ndlovu and Olifant 2019).

5.6 ASSESSMENT OF PHYSICAL PREPAREDNESS (SECTION D OF THE QUESTIONNAIRE)

5.6.1 Current practice relating to the assessment of physical preparedness

One of the opening questions of Section D attempted to establish the opinion of both the student respondents and academic staff on whether the level of physical preparedness of the students should be assessed. The results for this question demonstrated agreement amongst the student respondents regarding this question, as 47.9% (56/117) strongly agreed and 40.2% (47/117) agreed that the level of physical preparedness of the students should be assessed. There was also agreement amongst the academic staff as 91.7% (11/12) strongly agreed and 8.3% (1/12) agreed.

The next important aspect to establish, when considering the assessment of physical preparedness, was whether the various emergency medical care (EMC) departments at the three participating HEIs currently utilise a formal physical preparedness assessment to assess the level of physical preparedness of the students registered for the BHSc EMC programme. In response to this question, 92.3% (108/117) of the student respondents and 100.0% (12/12) of the academic staff responded 'true' to this question.

The following six questions were formulated to obtain the opinions of the student respondents and academic staff about the structure of the physical preparedness assessment at their respective HEIs. The responses to these six questions are presented in Table 5.9. The last question in Table 5.9 set out to determine the opinion of the student participants and academic staff about whether the physical preparedness assessment should be the same for all students, irrespective of their age, sex, height or weight. The results for this question demonstrated agreement from both the student respondents and the academic staff.

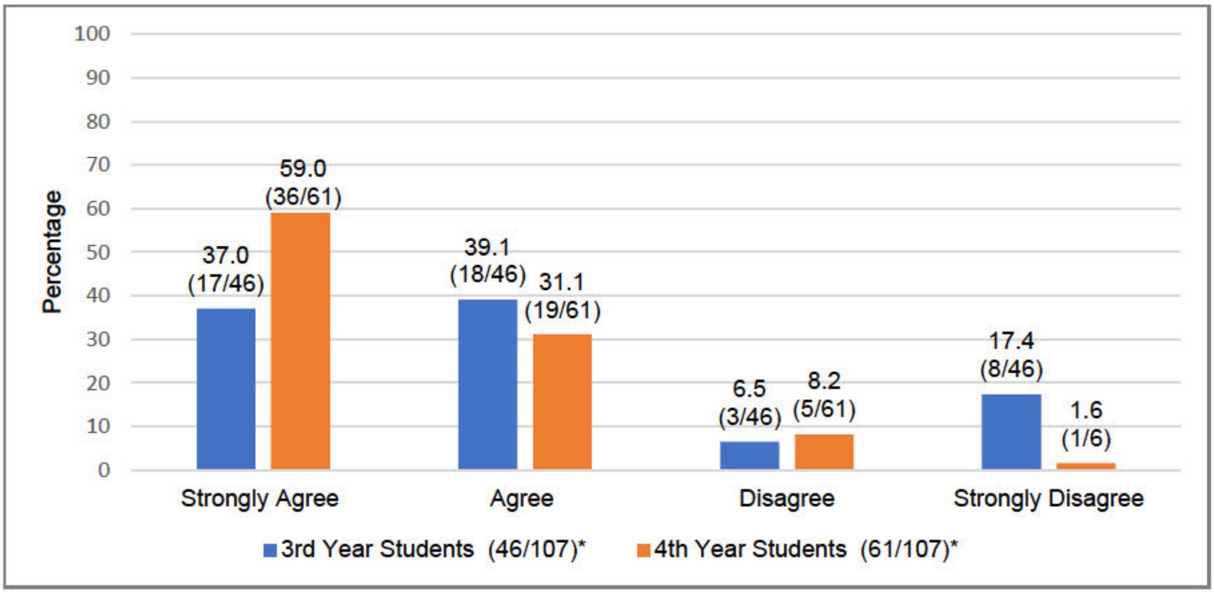
Table 5.9: Current practice relating to the assessment of physical preparedness

Statement	Students						Academic Staff				
	Frequency (%)					n	Frequency (%)				n
	Strongly agree	Agree	Disagree	Strongly disagree	Did not respond *		Strongly agree	Agree	Disagree	Strongly disagree	
All universities offering the BHSc EMC programme should make use of a similar physical fitness standard and assessment.	50.4 (59/117)	37.6 (44/117)	2.6 (3/117)	2.6 (3/117)	6.8 (8/117)	117	66.7 (8/12)	25.0 (3/12)	8.3 (1/12)	0.0 (0/12)	12
The physical preparedness assessment results should be weighted throughout the academic year towards a final module mark.	35.9 (42/117)	38.5 (45/117)	12.8 (15/117)	6.0 (7/117)	6.8 (8/117)	117	50.0 (6/12)	50.0 (6/12)	0.0 (0/12)	0.0 (0/12)	12
The physical preparedness assessment utilised by my department is a good indicator of a student's level of physical preparedness and ability to engage safely and efficiently in the learning activities of the BHSc EMC programme.	19.7 (23/117)	36.8 (43/117)	29.9 (35/117)	5.1 (6/117)	8.5 (10/117)	117	33.3 (4/12)	41.7 (5/12)	25.0 (3/12)	0.0 (0/12)	12
The current physical preparedness assessment is very difficult and it is a challenge to pass the assessment.	2.6 (3/117)	15.4 (18/117)	51.3 (60/117)	22.2 (26/117)	8.5 (10/117)	117	0.0 (0/12)	8.3 (1/12)	50.0 (6/12)	41.7 (5/12)	12
Students that are unfit and unable to engage safely and efficiently in the learning activities of the BHSc EMC programme do not pass my department's physical preparedness assessment.	18.8 (22/117)	51.3 (60/117)	16.2 (19/117)	5.1 (6/117)	8.5 (10/117)	117	41.7 (5/12)	33.3 (4/12)	16.7 (2/12)	8.3 (1/12)	12
The physical preparedness assessment should be the same for all students irrespective of their age, sex, height or weight.	45.3 (53/117)	31.6 (37/117)	6.8 (8/117)	7.7 (9/117)	8.5 (10/117)	117	75.0 (9/12)	8.3 (1/12)	16.7 (2/12)	0.0 (0/12)	12

** Some student participants elected not to respond to certain questions within this section.*

The results to the last question in Table 5.9 were further explored to determine if there were any statistically significant correlations between the demographic profile of the respondents in relation to their response to this specific question. Although 72.7% (8/11) of the male academic staff respondents strongly agreed, and 9.1% (1/11) of males agreed; 18.2% (2/11) of males disagreed; and 100.0% (1/1) of females strongly agreed, indicating that there was no statistically significant relationship or correlation between the sex of the academic staff and responses to this specific question ($p = < 0.05$: CI 95%). A similar result was seen with the student respondents, where there was no statistically significant relationship or correlation between the sex of the student respondents and their responses to this question: 55.7% (39/70) of males strongly agreed; 27.1% (19/70) of males agreed; 7.1% (5/70) of males disagreed and 10.0% (7/70) of males strongly disagreed; while 37.8% (14/37) of females strongly agreed; 48.6% (18/37) of females agreed; 8.1% (3/37) of females disagreed and 5.4% (2/37) of females strongly disagreed. A total of 8.5% (10/117) of the student respondents elected not to respond to this question. There were also no statistically significant correlations or relationships identified when analysing the age of the respondents in relation to this specific question.

The only significant relationship identified was between the year of study of the student and their response to the last question in Table 5.9 ($p = 0.011$, Fisher's exact test). A significant proportion of the third-year students strongly disagreed, while a significant proportion of the fourth-year students strongly agreed, that the physical preparedness assessment should be the same for all students irrespective of age, sex, height or weight. The results of this are presented in Figure 5.5.



** Some student participants elected not to respond to this question as reflected in Table 5.9*

Figure 5.5: Fisher's exact test: testing for correlations between the year of study of the student respondents on the structure of the physical preparedness assessment in the context of age, sex, height or weight

The following question was only posed to the academic staff and not the student respondents. The aim of this specific question was to determine how frequently, within an academic year, the academic staff felt the students should be assessed on their level of physical preparedness. There was agreement amongst the academic staff that the physical preparedness assessment should be conducted quarterly. The results for this question are presented in Figure 5.6.

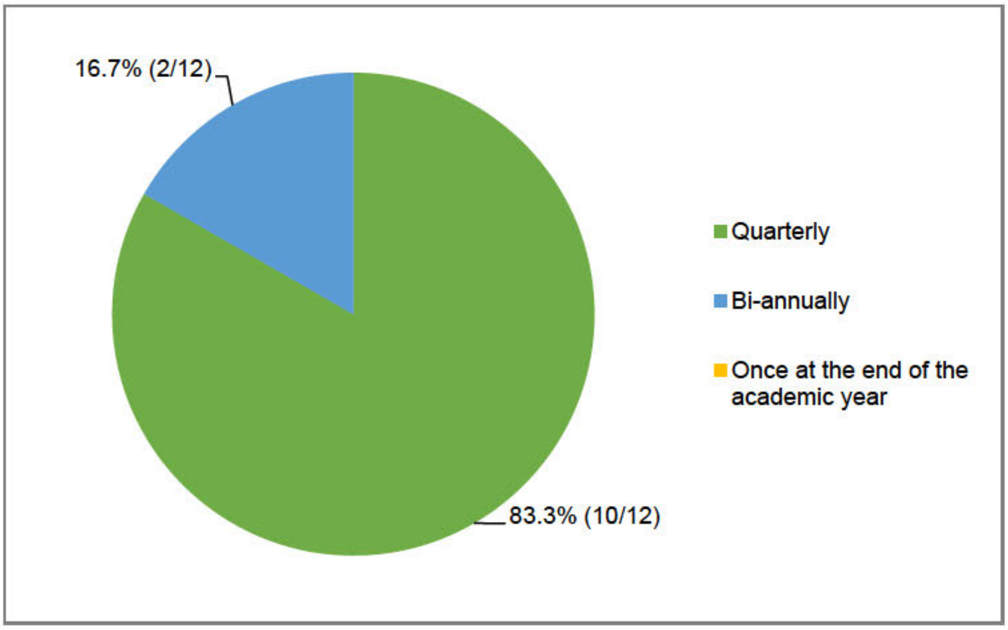


Figure 5.6: Frequency of physical preparedness assessments within an academic year, according to academic staff

5.6.1.1 Comment and discussion

The student respondents and academic staff felt there should be standardisation in the assessment of physical preparedness at the different HEIs accredited to offer the BHSc EMC programme. This finding ties in with the Minimum Standards for the Professional Degree in Emergency Care which were set by the PBEC. The purpose of the minimum standards was to provide the HEIs planning to offer the BHSc EMC programme standards which the graduates would need to achieve to be eligible to register as an Emergency Care Practitioner (ECP) with the Health Professions Council of South Africa (HPCSA) and to provide a guide to curriculum design and development. The document clearly highlights the expected exit level outcomes, as well as the associated assessment criteria for the programme (Professional Board for Emergency Care 2019). Although HEIs are seen to be autonomous in their day-to-day operations and curriculum development, programmes that lead to registration with a regulatory body, such as the HPCSA, would need to ensure compliance with the regulator’s minimum graduation requirements. Taking this into consideration, it would be beneficial if all the HEIs exposed their students to a standardised physical preparedness assessment, as reflected in the results of this study, as this would ensure that all students and graduates of the BHSc EMC programme are exposed to physical training and assessment of the same important components of fitness which are required to engage successfully with the physically strenuous programme content.

In terms of the frequency of the physical preparedness assessments, the academic staff felt that the students on the BHSc EMC programme should have their level of physical preparedness assessed quarterly (once a term). Physical Preparedness is a stand-alone annual module within the programme design of the BHSc EMC programme, with formal learning guides detailing the assessment plan for the academic year (Allan 2023; Muhlbauer 2022; Van Nugteren 2023). With Physical Preparedness as an annual module, the agreement by the academic staff that the assessment of physical preparedness should be quarterly and weighted towards a final mark throughout the academic year is an expected finding. This approach to the assessment plan for this module allows the academic staff to track the student’s physical preparedness throughout the academic year, and as the student attends compulsory structured physical training sessions throughout the academic year, their level of fitness would improve to support an increase in the weightings as the academic year progresses. As an example, at HEI ‘B’, in the 2023 academic year, the four assessments are weighted at 20%, 30% 20% and 30%, respectively; and at HEI ‘A’, the four assessments are weighted at 10%, 20%, 30% and 40% (Allan 2023; Van Nugteren 2023).

With regard to the structure of the current physical preparedness assessment and the expected pass criteria, the academic staff and student respondents believed that the assessment is not very difficult or challenging to pass. Despite this finding, there was agreement from the student respondents that unfit students do not pass the physical preparedness assessment. Most notably, there was agreement amongst the student and academic staff respondents that the current physical preparedness assessment tool is a good indicator of a student’s level of physical preparedness and ability to engage successfully in the demands of the physically strenuous learning outcomes associated with the BHSc EMC programme.

The last aspect which was explored in this section of the questionnaire centred around whether the physical preparedness assessment should be altered, based on age- and gender-based fitness norms, or whether there should be an absolute standard for all BHSc EMC students. The literature presented in Chapter 3 supports the use of absolute standards in this context, as the physical preparedness assessment is utilised to assess the minimum level of fitness required by the students to engage successfully with the physically strenuous content of the BHSc EMC programme (Armstrong *et al.* 2019b; Farrell 2017). There was agreement amongst the student and academic staff respondents that the physical preparedness assessment should be the same for all students, irrespective of their age, sex, height or weight.

5.6.2 Components of physical fitness

The last question in Section D of the questionnaire required both the student respondents and the academic staff to provide their opinion on which components of physical fitness are important to participate successfully in the physically strenuous learning outcomes associated with the BHSc EMC programme. The responses to this question are represented in Figure 5.7 and Figure 5.8.

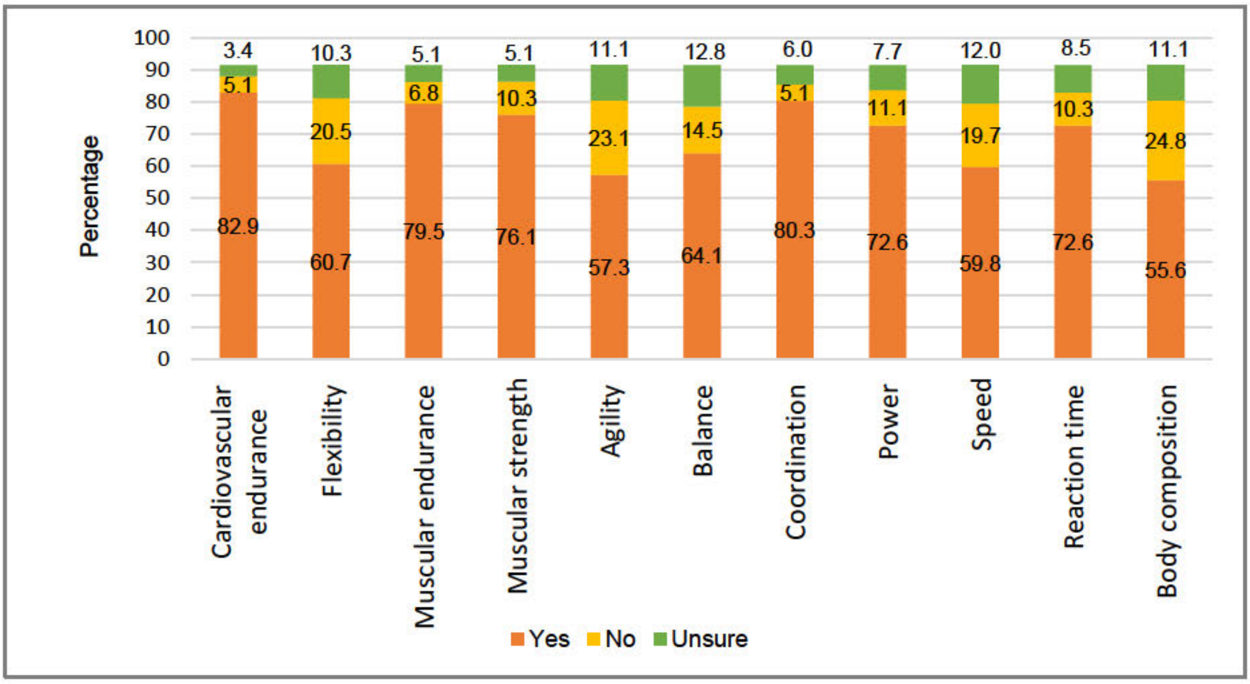


Figure 5.7: Components of physical fitness that student respondents deemed important for the BHSc EMC programme

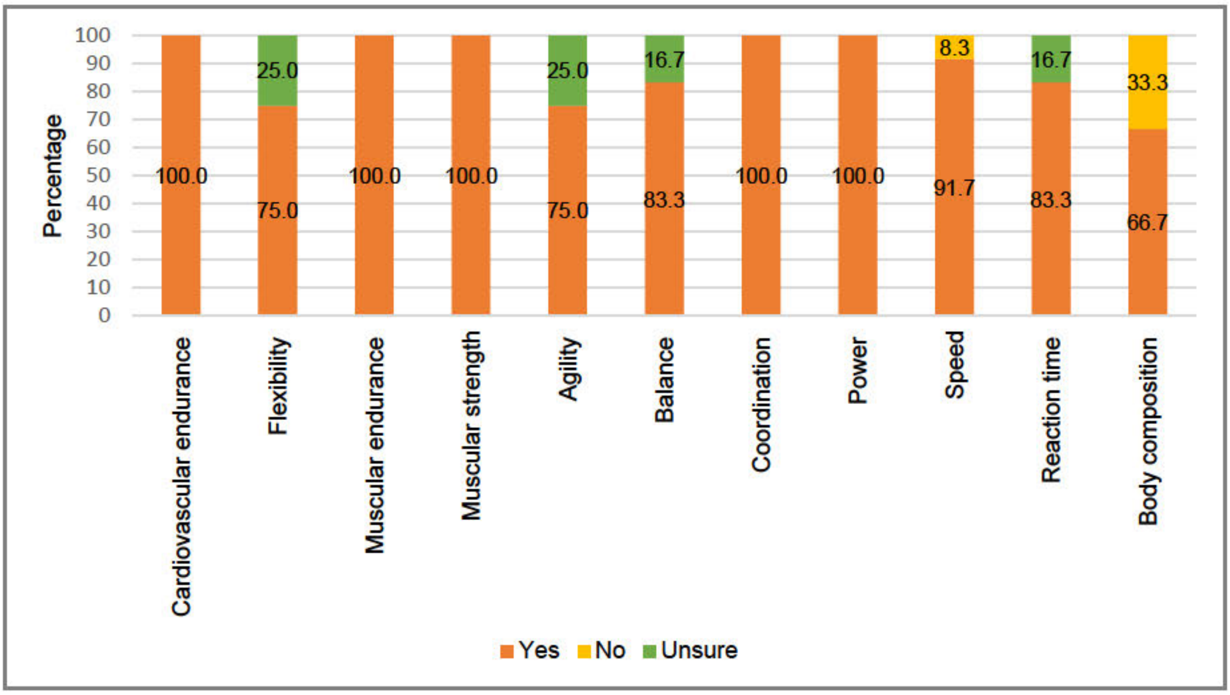


Figure 5.8: Components of physical fitness that academic staff deemed important for the BHSc EMC programme

5.6.2.1 Comment and discussion

The student respondents and academic staff were provided with a list of the eleven recognised components of health-related and skill-related physical fitness with a brief description of each component (American College of Sports Medicine 2018; Corbin and Pangrazi 2012). Based on this brief description, the respondents were then required to indicate whether they felt that the component was important or not, in order for a student to engage successfully with the physically strenuous content of the BHSc EMC programme. Despite providing a brief description of the different components of fitness, neither of the two groups (students and academic staff) were able to clearly identify key components of fitness required for the BHSc EMC programme. However, the three components of fitness which are well recognised as being important for emergency care providers did feature with higher response rates. These include: 1) cardiovascular endurance, 2) muscular strength and 3) muscular endurance (Conolly, Elder and Dawes 2015; Mthombeni, Coopoo and Noorbhai 2020a; Rue *et al.* 2019).

5.7 CONCLUSION

Although the results from the questionnaire provided clarity on several key aspects concerning the assessment of task-oriented physical preparedness of the BHSc EMC students, the questionnaire contained (in the main) closed questions with preset response options. The limitation of this methodological approach was that it does not allow for the researcher to further explore, describe and understand deeply the meaning of some of the responses provided by the student and academic staff respondents. Having carefully reflected on the results presented and discussed above, key focus areas were identified to inform the agenda for the subsequent focus group interviews. These interviews would allow for a deeper probing of the understanding and feedback from both the emergency medical care students and academic staff involved in the Medical Rescue and/or Physical Preparedness modules of the BHSc EMC programme. These key focus areas identified for further enquiry and clarification included:

1. The current physical preparedness assessment being utilised, and which aspects are appropriate and/or not appropriate.
2. The use of task-simulated tests, versus physical performance tests, to assess the physical preparedness of the BHSc EMC students.
3. The physically strenuous aspects of the BHSc EMC programme, and how these relate to the eleven components of fitness.

In this chapter the researcher described the use of a purpose-designed questionnaire as a tool for gathering data for the study. Also included is a description of the approach to the dissemination of the questionnaire and the approach to the analysis of the responses. The chapter included the presentation of the results, followed by a brief discussion of the interesting findings. The chapter concluded with the identification of three key focus areas that were identified from the results and used to inform the agenda for the focus group interviews. The interviews and findings that emerged are presented and discussed in the chapter that follows.

CHAPTER 6: THE FOCUS GROUP INTERVIEWS

6.1 INTRODUCTION

As described in Chapters 1 and 3, the next phase of data collection for this study was qualitative in nature. Focus group interviews were conducted with the academic staff and fourth-year emergency medical care students from the three participating higher education institutions (HEIs). This chapter presents both the methodology and the results of this qualitative phase of data collection. The chapter will end with a discussion of the results and a summary to indicate how the findings from the focus group interviews informed the content of the final phase of the study, that being the assessment of physical preparedness. The aim of the focus group interviews was to further investigate and describe the views and opinions of the academic staff and emergency medical care students regarding the physical requirements/task-oriented activities linked to participation in the Bachelor of Health Science Degree in Emergency Medical Care (BHSc EMC) programme, and the extent to which they feel their current physical preparedness assessment tool adequately assesses task-oriented physical preparedness.

6.2 METHOD AND APPROACH

In this qualitative phase of the research study, the researcher made use of a purposefully and carefully constructed agenda that was used for two focus group interviews. The agenda and questions were informed by the results of the quantitative questionnaire phase that preceded the focus group interviews. For this phase of the study the researcher adopted a qualitative, exploratory, descriptive, phenomenological design. The same academic and emergency medical care students who completed the questionnaire were all eligible to take part in the focus group interviews, and a purposive sampling strategy was utilised to identify participants. For the interview with the student grouping, the researcher included nine participants (three from each of the HEIs), all nine being senior students in their final year of study. For the academic staff focus group interview, two staff members were invited from each of the HEIs, making a total of six participants.

As mentioned above, the agendas for the two focus group interviews (Appendices 9A and 9B) were purposefully and carefully constructed by the researcher, taking into account the findings of the questionnaire. The participants in both focus group interviews were provided with an information letter (Appendix 6), consent form (Appendix 7) and consent request for audio recording (Appendix 8). The focus group interviews were conducted by the researcher via the online Microsoft Teams® platform and the interviews were recorded via the Microsoft Teams® platform, and an additional recording was made with the use of a Philips DVT1100 digital recording device. The audio recordings of the focus group interviews were transcribed by a professional transcription service and a hybrid content analysis approach was utilised to analyse the transcribed data from the two focus group interviews (Creswell *et al.* 2016). The results from this content analysis are presented below.

6.3 RESULTS

The transcribed data from the two focus group interviews was initially deductively coded to determine themes, as this allowed the researcher to approach the analysis with a very focused lens. Once these initial themes had been established, inductive coding was utilised to identify categories based on the content of the transcripts. Analysis of the data yielded five main themes, each of which were further developed to expand on the topics covered in the focus group interviews. The themes and categories that were constructed are summarised in Table 6.1.

Table 6.1: Themes and categories emerging from the focus group interviews

Theme 1	Need to adjust aspects/components of the current physical preparedness assessment tool	**Category 1**	The level of swimming requirements is inadequate to prepare the student for the BHSc EMC programme's specific requirements
		Category 2	Value of the flexed-arm hang test
		Category 3	The need for a scientifically validated physical preparedness assessment specific for the BHSc EMC programme
		Category 4	The current physical preparedness assessment tool is a poor reflection of a student's fitness level

Theme 2	Standardisation of the physical preparedness assessment tool at all HEIs	**Category 1**	Standardised outcomes for students and graduates from the BHSc EMC
		Category 2	Programme-specific physical preparedness assessments
Theme 3	Task-simulated or physical performance test to assess physical preparedness of BHSc EMC students	**Category 1**	Task-simulated assessment is functionally related to the operational tasks in the BHSc EMC programme
		Category 2	Task-simulated assessment is impractical
		Category 3	Physical performance test is consistent and practical to administer
		Category 4	Hybrid approach
Theme 4	Physically strenuous aspects of the BHSc EMC programme	**Category 1**	Physical preparedness assessment
		Category 2	Physically strenuous Medical Rescue modules
		Category 3	First-year orientation camps
		Category 4	Treating patients in the authentic clinical environment
Theme 5	Fitness components required for the BHSc EMC programme	**Category 1**	Top seven fitness components required for the BHSc EMC programme
		Category 2	Ideal body composition to cope with the physically strenuous aspects of the BHSc EMC programme

The themes and categories summarised in Table 6.1 are presented below with supporting quotations extracted verbatim from the transcripts of the interviews with the fourth-year students and academic staff participants.

6.3.1 Theme 1: Need to adjust aspects/components of the current physical preparedness assessment tool

In this section of the discussion, the participants spoke about their views on which aspects and/or components of their institution's current physical preparedness assessment tool required adjustments and/or improvements. There were some similar views expressed by both the academic staff and the students on certain aspects which required adjusting. However, in other instances unique findings emerged that were specific to the academic staff and the student groups These are presented below.

6.3.1.1 Category 1: The level of swimming requirements is inadequate to prepare the students for the BHSc EMC programme's specific requirements

The academic staff placed considerable emphasis on the swimming component of the physical preparedness assessment, which entails a 200m swim to be completed within a maximum time of six minutes. The academic staff felt that the current swimming assessment in terms of the distance (200m) and the maximum time of six minutes did not adequately ensure that a student had an appropriate level of swimming fitness to engage with the practical swimming skill requirements of the BHSc EMC's Aquatic Rescue module. This module includes practical outcomes, such as executing a patient tow for surface water rescue and swimming across rapids in a river to an eddy – a safe zone for swift water rescue operations. This view was shared by the fourth-year students. The academic staff did, however, believe that the 200m swim assessment requirement within the six-minute time limit was more than adequate, and perhaps exceeded the requirements needed to demonstrate swimming competency and fitness. Swimming competency is seen as the sum of aquatic movements that help prevent drowning, as well as the associated water safety knowledge, attitudes, and behaviours that facilitate safety near and/or in water (Stallman *et al.* 2017).

> *"… I don't feel that the swimming component is sufficient enough for a student to be assessed, in terms of are they going to be functional in doing a rescue in the water?" (Academic 3)*

> *"… I am unsure in my own mind what exactly the swimming component is, because the time and the distance that the students need to swim may sometimes be interpreted as a bit more extensive than just simply demonstrating that they are able to swim…" (Academic 6)*

> *"… I think the swimming part, for me, the fact is, I think we are asking for the bare minimum, like six minutes for 200m is asking for the bare minimum, and as the other colleagues have suggested, I don't think that prepares them well enough to be able to do swift…" (Academic 2)*

"Being able to swim 200m in a pool for time, does not adequately prepare you for being able to swim in, like, a rapid…" (Student 1)

"… the 200m not being adequate for our rescue module." (Student 4)

6.3.1.2 Category 2: Value of the flexed-arm hang test

Both the academic staff and fourth-year students shared concerns about the flexed-arm hang test as an assessment of strength. Some of the participants raised concerns about the relevancy of the flexed-arm hang test; whereas others felt that further strength assessments were required in addition to the flexed-arm hang test.

"… I believe that hang, just the movement itself and what you are doing with it, I don't see its place in really what we are doing… I lose the perspective of what that part of the assessment is trying to achieve." (Academic 1)

"… I just sometimes personally feel that we have got smaller people who can easily do the underarm hang, but they can't pick the stuff that they need to pick up, they can't pick that up." (Academic 6)

"… flexed-arm hang test… only assesses one action…" (Academic 5)

"… I like the hang, to be honest, because I think it does speak to sort of being able to pick your body up and hold it in that position, but I definitely don't think it is enough." (Academic 3)

"… we have students in our class, they are very light… but they could hang easily because they weigh absolutely nothing, but they are not capable of picking up spreaders or cutters and adequately functioning in motor vehicle rescue…." (Student 2)

6.3.1.3 Category 3: The need for a scientifically validated physical preparedness assessment specific for the BHSc EMC programme

During the interview process with both the academic staff and fourth-year students, many of the discussion points centred around their views on the need for a physical preparedness assessment tool that is scientifically validated. The two fourth-year students representing HEI 'A' indicated that the components in their physical preparedness assessment had changed every year over the past four years, which has resulted in them losing trust in the 'validity' of their assessment tool. Comments were also made on the relatability of the components of fitness being assessed, and of the normative standards within the current assessment tools to the physically demanding aspects of the BHSc EMC programme.

"… run your 5ks in 25 minutes. That's awesome, but how will that relate to your rescue?" (Student 2)

"… we do a shoulder press… but in our motor vehicle rescue module we were never required to lift the spreaders and the cutters above our heads… Ja, so I don't really know how that applies." (Student 4)

"… when I was in first and second year, we had quite a thorough, like, assessment… and it would upgrade over the years. Whereas it's changed… the swimming isn't that important now. Let's make that easier, or the running needs to change, so then that, like decreased…" (Student 4)

"… for instance, you're running a 5k run, and you are able to complete a 5k run, but only in 33 minutes… how does that make you lesser than other ones who can do it within 29 minutes?" (Student 8)

"… if you are then saying, yes, you must do a 30 second hang, is that 30 seconds, has that been researched, has that been tested and validated?" (Academic 4)

"… Why are we swimming 200m in 6 minutes? Why aren't we swimming 400m in 8? Why aren't we swimming 200m in 10?" (Academic 6)

"… The assessment should be a good indicator of the type of activity that would be expected of the student and… then the assessment of competence in that assessment… that needs to again also be validated…" (Academic 6)

6.3.1.4 Category 4: The current physical preparedness assessment tool is a poor reflection of a student's fitness level

Interestingly, this point of discussion only emerged in the focus group interview with the fourth-year students. The view of some of the participants was that the current physical preparedness assessment is not a good indication of a student's physical fitness level, as the assessment is easy to prepare for and, because of this, the students do not all maintain their level of physical fitness throughout the academic year, but rather just focus on preparing for an upcoming physical preparedness assessment.

> *"So I feel like people only prepare when they know that the physical is next week, which doesn't really reflect your level of physical fitness, because you can just train… like, you train for a week and then, after that you stop running, which doesn't really reflect your level of physical fitness." (Student 5)*

> *"… the assessment itself shouldn't actually be the be-all and end-all, it should be more about the attendance throughout the year…" (Student 7)*

6.3.2 Theme 2: Standardisation of the physical preparedness assessment tool at all HEIs

The participants expressed their views and opinions on whether the physical preparedness assessment should be the same at all the HEIs accredited to offer the BHSc EMC programme.

6.3.2.1 Category 1: Standardised outcomes for students and graduates from the BHSc EMC

A common view shared by the academic staff and fourth-year students was that the physical preparedness assessment should be standardised across all the HEIs accredited to present the BHSc EMC programme. This view by the participants was supported by their understanding of the role of the regulator, which is the Professional Board for Emergency Care (PBEC), in the context of the minimum standards for the BHSc EMC programme that leads to both graduation from the HEI and registration with the Health Professions Council of South Africa (HPCSA) as an Emergency Care Practitioner (ECP).

> *"… I think it should be the same across all the universities." (Academic 3)*

> *"… I also fully support that the assessment criteria should be the same…" (Academic 4)*

> *"If the assessments would differ, we have the risk that we have some students from some university that would be – or graduates that would be – more than*

sufficiently prepared, but we might have another university, where those graduates are not sufficiently prepared." (Academic 6)

"… if we all at least have a standard, then we all – ja, we all know we're all capable of the same sort of things." (Student 3)

"… the more we can standardise and be on the same level, the better we can, like, represent and, you know, be more of like a unified group internationally." (Student 4)

"… all universities should be testing the students in the same way… and I don't think that there should be major differences between the universities from a quality point of view." (Student 7)

6.3.2.2 Category 2: Programme-specific physical preparedness assessments

A discussion point that was only raised by the academic staff centred around whether the physical preparedness assessment tool should differ between the different higher education programmes such as the Higher Certificate, Diploma and BHSc EMC programme. There were divergent views amongst the academic staff, as some felt that it should differ, as the curricula of the three programmes were vastly different; whereas others felt that it should remain the same, as the focus of the Physical Preparedness module and associated assessment tool is on general physical fitness and not task-specific physical fitness for specific modules and/or tasks.

"… there could be an argument to say that the physical requirements on the Bachelor's degree could be different than the physical requirements on the Diploma qualification." (Academic 4)

"… maybe also the same across all the other qualifications." (Academic 3)

6.3.3 Theme 3: Task-simulated or physical performance test to assess physical preparedness of BHSc EMC students

The participants reflected on the two different approaches available to assess physical preparedness – a task-simulated and/or a physical performance test. The discussion around which type of physical preparedness assessment approach would be best suited for the BHSc EMC programme was influenced by the participants not having a clear idea of the actual purpose of the physical preparedness assessment tool and what the physical preparedness assessment was intended to assess.

"… We must determine exactly what the purpose is of the physical assessment, versus the assessment based on the module... For me it goes back again to what are we determining. We are trying to determine a baseline fitness before they enter the modules…" (Academic 5)

"… The key here is to determine whether the physical preparedness module to determine whether the student is physically capable of performing physical training for the next module, and then if they pass the physical assessment, then when we do start doing the training for the next module, then they don't die or struggle that much, because they are physically capable of embarking on the training." (Academic 6)

6.3.3.1 Category 1: Task-simulated assessment is functionally related to the operational tasks on the BHSc EMC programme

The academic staff and fourth-year students felt that the task-simulated assessment would allow the students to develop a clear functional relationship between the fitness component being assessed in the physical preparedness assessment and the physically strenuous task in the BHSc EMC programme to which it relates.

"… Our assessments are not task-oriented or functional… The assessment tool that we are currently using has got no functional assessment attached to it. It is purely just there to assess some norm, and to measure whether the students are kind of meeting the norm or not… very difficult to defend when any student challenges the criteria." (Academic 4)

"… task-oriented would be much better, as it would give students a clearer idea of how things are in reality." (Student 2)

"... The task-oriented one, for me, looks more like what actually happens in reality,… and I think it is more in line with what happens, with what happens when you're qualified and when you're actually dealing with patients out there." (Student 8)

6.3.3.2 Category 2: Task-simulated test is impractical

The participants shared various opinions on the task simulated approach to assessing physical preparedness, and although the principle of a task-simulated or functional approach was supported by both the academic staff and fourth-year students, the academic staff raised concerns around the practicality of the task-simulated approach to assess the physical preparedness for the BHSc EMC programme, due to the diverse nature of the curriculum. This concern might only have been identified as an area of concern by the academic staff as they would be responsible for the logistical arrangements and administration of the physical preparedness assessment.

> *"… It would almost probably be impossible to try and mimic every single task that a student may potentially do." (Academic 5)*

> *"… If we are going to say, for example, the assessment criteria is to lift a spreader for one minute… Can the student do that? Yes or no, just as an example. Then the one institution will maybe have a type of spreader, and the other university will maybe have a different type of spreader, and it could maybe hamper the consistency among the universities…" (Academic 4)*

6.3.3.3 Category 3: Physical performance test is consistent and practical to administer

The participants expressed support for the physical performance test approach to the structuring of the physical preparedness assessment tool, especially once they had a better understanding of what a physical performance test was and how the selected tests are impacted by the different components of fitness.

> *"… If the aim of the physical preparedness module is to determine physical preparedness to embark on any type of rescue training, then I think the battery of assessments should speak to general… the components of fitness…" (Academic 6)*

> *"… It would almost probably be impossible to try and mimic every single task that a student may potentially do. So, it would be easier then to group them into a battery of tests…" (Academic 5)*

"… the consistency factor can maybe just be easier." (Academic 4)

"… Having a battery assessment approach helps standardise and just makes the whole assessment capable for the department." (Student 3)

6.3.3.4 Category 4: Hybrid approach

A point of discussion that was only raised by the fourth-year students and not the academic staff was the use of a hybrid approach, in which both the task-oriented and physical performance test approach are utilised to assess physical preparedness on the BHSc EMC programme.

"… I sort of believe that it should be a combination of both… In your first years of this degree, it's kind of important to establish a baseline of where guys need to get to; but towards, like, your final years… then a task-simulated physical fitness… is a bit more appropriate." (Student 1)

"… having, like, a combination of both…" (Student 5)

6.3.4 Theme 4: Physically strenuous aspects of the BHSc EMC programme

The participants shared various personal views on the physically strenuous aspects of the programme. During this discussion, the participants identified general aspects within the programme that they felt were very physically strenuous; and in addition to these general aspects, the participants also highlighted specific modules which they felt were physically strenuous.

6.3.4.1 Category 1: Physical preparedness assessment

The academic staff identified the physical preparedness assessment as an aspect of the BHSc EMC programme which the students appear to struggle with. This sentiment was not shared by the fourth-year students.

"The one thing that the guys really struggle with is the actual physical fitness assessment itself. There is a lot of anxiety around it… I don't think they prepare adequately…" (Academic 5)

"… I think the actual physical assessment itself, they really battle with that, because there is a lot of anxiety around that. And my feeling is the reason why it

does cause them a lot of stress, is because they haven't trained enough for it." (Academic 3)

6.3.4.2 Category 2: Physically strenuous Medical Rescue modules

The participants shared views on which modules and specific tasks within those modules on the BHSc EMC programme were physically strenuous for the students. The Medical Rescue modules which were most highlighted by the participants were aquatic rescue; high angle rescue; motor vehicle rescue; fire search and rescue; wilderness search and rescue; trench rescue, and confined space rescue.

> *"… In high angle, being able to perform properly as the stretcher jockey, they seem to struggle to move up and down and over the stretcher and manipulate that stretcher, you know, away from edges." (Academic 5)*
>
> *"… In the swift water component… you're being pummelled by a whole river's load of water…" (Student 7)*
>
> *"So I think any sort of physical activity or rescue that requires them to have endurance, so like wilderness, if they are carrying a heavy backpack over a long distance, I think that also… that becomes strenuous to them." (Academic 3)*
>
> *"… having to hike with, like, a 10 kilo bag or even more on your back, having to climb up a mountain and stuff..." (Student 5)*
>
> *"… for motor vehicle rescue and trench rescue, it's just how heavy the equipment is…" (Student 2)*
>
> *"… was fire and confined space, and trench rescue… it's moving weights around, … it was just that sustained physical exertion…" (Student 3)*
>
> *"In fire search and rescue, it is the challenge of working with an SCBA, so being in that environment, being often exposed to a hot environment, and then having to perform strenuous activities…" (Academic 4)*

6.3.4.3 Category 3: First-year orientation camps

The first-year orientation camps were only identified as a focus area by the fourth-year students, and not the academic staff. These activities usually require the students to navigate through various exercises over a 48–72-hour period. These events are both mentally and physically taxing for the students, largely due to sleep deprivation and the ‘unknown factor’ as the students are not aware of what to expect over the duration of the camp.

> *“We had a camp in second year, called Masiphakameni and that’s like a 48-hour rescue challenge… it was horrible… was quite, like, physically challenging…” (Student 4)*

> *“… I think it was the Petty Coat Lane Challenge… it was very strenuous for me, and I think more mentally than physically…” (Student 5)*

> *“… We also had our Vasbyt… were very ill-prepared for that. It was very difficult for some of them…” (Student 4)*

6.3.4.4 Category 4: Treating patients in the authentic clinical environment

The major focus throughout most of the interviews with the participants centred around the Medical Rescue modules on the programme. However, towards the end of the discussion around the physically strenuous aspects of the BHSc EMC programme, the treating of patients in the authentic clinical environment was raised as a point of discussion.

> *“… The medical side of our job is also very physically demanding…” (Academic 3)*

> *“… be able to pick up a heavy patient or be able to manage, at least manage, the patient.” (Student 4)*

> *“… We can’t do CPR [cardiopulmonary resuscitation] for 20 minutes on our own…” (Student 4)*

6.3.5 Theme 5: Fitness components required for the BHSc EMC programme

A subject expert provided an overview of the eleven components of fitness to the participants in a brief presentation to ensure that all the participants had a very clear understanding of each of the different fitness components. The one component which required further exploration was ‘body composition’, as there were divergent views on the impact that this fitness component has on a student’s ability to engage successfully with the physically strenuous content of the BHSc EMC programme.

6.3.5.1 *Category 1: Top seven fitness components required for the BHSc EMC programme*

On completion of the presentation, the participants were asked to rank their top seven fitness components which they felt were important for both the Emergency Medical Care (EMC) and Medical Rescue modules in the BHSc EMC programme. The results of this ranking are presented in Figures 6.1 and 6.2.

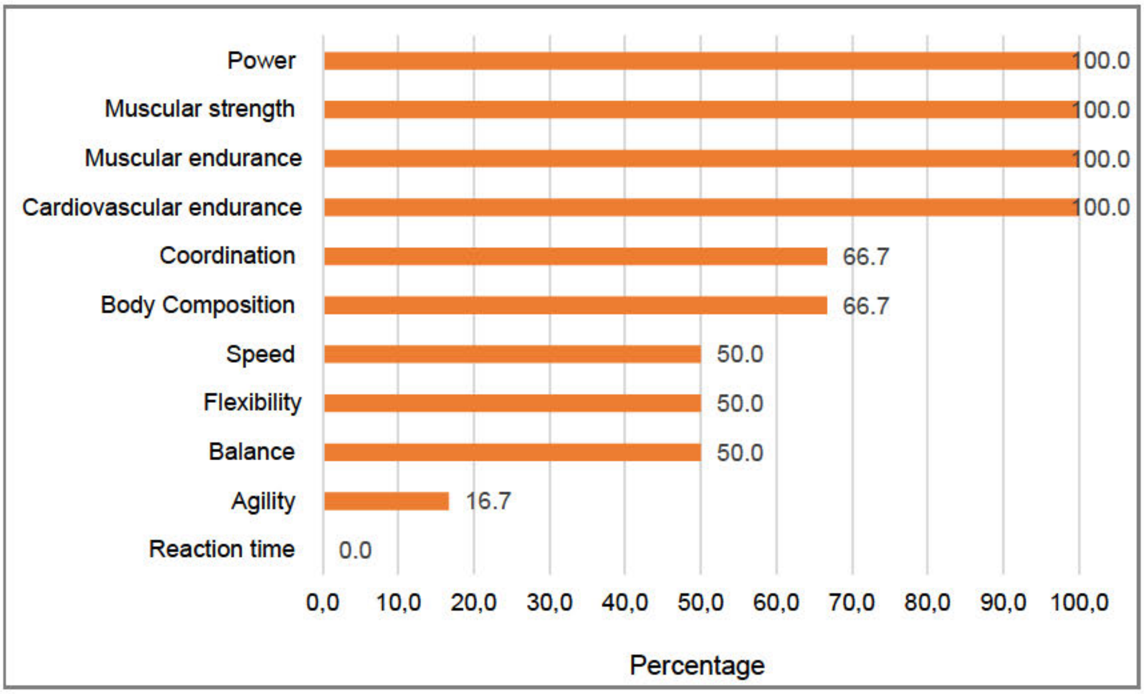


Figure 6.1: Fitness components required for the BHSc EMC programme, according to the academic staff

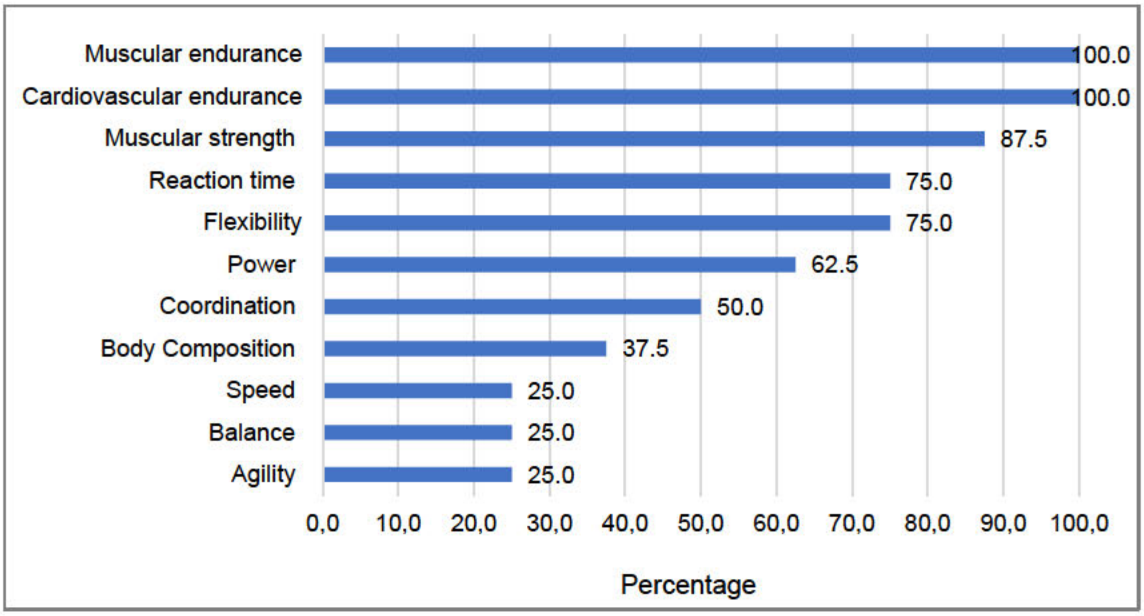


Figure 6.2: Fitness components required for the BHSc EMC programme, according to the students

"… and then flexibility for confined space…" (Academic 5)

"… loading them with a lot of stuff, and they are carrying it over distance, the muscular endurance and strength are both components that they battle with." (Academic 3)

"… balance, especially when they are carrying a load in wilderness…" (Academic 5)

"… Fire rescue was probably the one rescue component that the cardiovascular component was definitely tested." (Student 6)

"… Flexibility sort of plays a role in all your physical aspects of what you do throughout the degree; rescue activities, physical fitness." (Student 1)

"… Pretty much all our rescue modules require some form of muscular endurance." (Student 5)

6.3.5.2 Category 2: Ideal body composition to cope with the physically strenuous aspects of the BHSc EMC programme

The participants expressed their personal reasons for why they felt that body composition was important for an emergency medical care student to engage successfully in the physically strenuous learning activities in the BHSc EMC programme. This fitness component appeared to be quite a sensitive topic and some students became defensive. Although some of the participants felt that there is an ideal body composition to cope with the physically strenuous aspects of the BHSc EMC programme, others felt differently. These participants believed that, if the physical preparedness assessment is scientifically validated and developed specifically to assess the fitness components required to engage successfully with the physically strenuous content of the BHSc EMC programme, and students are able to pass that assessment, then their body composition is irrelevant.

"… I want and try and say this as politely as I can, but I just noticed in the years of my experience teaching on the diploma, and then the BEMC [Bachelor's Degree in Emergency Medical Care], and specifically pretty much only in Rescue, it is just the students that are overweight or obese just don't manage…" (Academic 3)

"… let's remain focussed on what is the actual assessment criteria, and then, how can I say, the body composition is subjected, you know, it is almost as though if the student – or let me put it this way, I don't care what they are built like, if they can pass the assessment, then they are good." (Academic 4)

"… some of the students that we get that are borderline anorexic, they can pass the run, they can pass the swim, but physically with strength-wise they cannot do it." (Academic 2)

"… if you have got an appropriate body composition, you are setting yourself up for success…" (Academic 6)

"… there are some people that it's just not practical for them to partake in rescue, because of their body composition." (Student 7)

"It becomes more for the person who's doing the activity to perform at his or her best because he's now bearing unnecessary weight." (Student 8)

"We need to be in a physical condition that enables us to not be a burden to the rest of our team." (Student 3)

6.4 DISCUSSION

In this section, the key findings from the focus group interviews with the academic staff and fourth-year emergency medical care students will be discussed and contextualised with the available relevant literature.

6.4.1 Standardisation of the physical preparedness assessment tool

During the analysis of the quantitative data from the questionnaire, which was presented in Chapter 5, the majority of the academic staff and student respondents had agreed that all HEIs offering the BHSc EMC programme should make use of a similar physical fitness standard and assessment. A limitation to this finding in the questionnaire was that the researcher was unable to explore the reasons for this. During the focus group interviews with the academic staff and fourth-year students, this question was posed again to the participants, which allowed the researcher the opportunity to explore the reasons for this view. Once again, as in the survey questionnaire, both the academic staff and fourth-year students felt that the physical preparedness assessment tool should be standardised at all the HEIs accredited to offer the BHSc EMC programme within South Africa.

The reasons provided for the standardisation of the physical preparedness assessment tool centred around the point that the BHSc EMC programme produces a graduate who is required to register with a regulatory body (the HPCSA) upon graduation, and the graduates are expected to work and perform tasks in similar environments, irrespective of which province they graduate and/or work in. The participants were of the opinion that there should be a standard level of competency across all the HEIs regarding the expected exit level outcomes of the BHSc EMC programme, as all graduates are eligible to register with the HPCSA as an ECP and work within a prescribed list of capabilities.

The PBEC developed the minimum standards for the professional degree in emergency medical care, and the purpose of this document was two-fold. Firstly, the intention of the document was to provide the HEIs planning to offer the BHSc EMC programme standards which the graduates would need to meet to be eligible to register as an ECP with the HPCSA; and secondly, to provide a guide to curriculum design and development to ensure some form of consistency within the curriculum content at the different HEIs, despite the autonomy of these institutions (Professional Board for Emergency Care 2019).

In Greek, the word 'autonomous' means having its own laws and in the context of higher education the term is used to define a university's ability self-rule and/or self-regulate (Wermke and Salokangas 2015). Autonomy in the context of higher education refers to the freedom of the HEI to run its own affairs without direction from any other level of government and the ability of the HEI to select the tools and approaches to achieve the goals (Iwinska and Matei 2014). Academic freedom is the other crucial concept in higher education, and it is essential to teaching and research at this level of academia as it allows the academic staff the freedom, within the law, to teach, conduct research and suggest new ideas that may be controversial and/or unpopular without being punished by the university for exercising that freedom (Ren and Li 2013). Taking these important concepts relating to higher education into consideration, the purpose of the minimum standards for the professional degree in emergency medical care needs to be taken in context by the HEIs when developing the curriculum for the

BHSc EMC programme to ensure that, despite the institution’s autonomy and academic freedom, the graduates have at least covered the minimum programme standards in order to be eligible to register as an ECP with the HPCSA. Standardisation of the physical preparedness assessment tool by the various HEIs accredited to offer the BHSc EMC programme would be one way of ensuring that the core components of fitness, deemed essential for an EMC student to engage successfully with the physically strenuous programme content, are assessed.

The administration of standardised fitness tests is common practice when assessing the physical preparedness of emergency responders such as firefighters, police officers, lifesavers, and paramedics (Abel, Sell and Dennison 2011; International Life Saving Federation 2007; Regents of the University of California 2023). A standardised fitness test, in the context of these professions, would be developed to assess the minimum acceptable level of physical fitness required to engage successfully in the essential job tasks associated with that profession (Siddall *et al.* 2021). A standardised fitness test will have set rules for the test to be administered in the same manner every time, to allow for consistency in the administration of the test, irrespective of where the test is administered. The physical fitness recommendations for firefighters are based on occupational performance criteria such as the Candidate Physical Ability Test (CPAT). The CPAT is a recognised standard which is used to measure an individual’s ability to handle the physical demands associated with being a firefighter. The CPAT consists of eight tasks that simulate a physical skill or function that a firefighter would be exposed to on the job: stair climb; hose drag; equipment carry; ladder raise and extension; forcible entry; search; manikin rescue drag; and ceiling breach and pull tasks. During the CPAT, the firefighters are expected to wear a helmet, gloves and a 50-pound weight vest to simulate the weight of the personal protective equipment worn by a firefighter. Candidates carry an additional 25-pound weight during the stair climb to simulate the carrying of a hose pack into a structural high-rise building fire. The minimum standardised pass time that has been determined for this assessment is 10 minutes and 20 seconds (Abel, Sell and Dennison 2011).

Similarly, lifeguards have a minimum standardised swimming fitness test which was developed by the International Life Saving Federation. The fitness test must be conducted with no equipment in a suitable body of water and the minimum swimming requirements for beach and open water lifeguards is a 400-metre swim in eight minutes; and for pool lifeguards is a 400-metre continuous, untimed swim, and a timed 50-metre swim in 50 seconds. Organisations are required to assess specific operational requirements for the lifeguards and additional specific fitness tests such as a timed run and/or utilisation of specialised equipment may be added as needed. However, the swim test is an accepted international standard (International Life Saving Federation 2007). In Los Angeles, United States of America, all police officers are required to take the standardised Physical Abilities Test (PAT), which entails a sequence of job-related tasks which are performed in a continuous manner with no resting between the stages. The five timed events are designed to assess physical condition, strength and endurance of police officers and consist of 1) a 99-yard obstacle course which consists of several sharp turns, curb-height obstacles and a 34-inch obstacle that must be vaulted; 2) lift and drag a 165 pound rescue manikin for a distance of 32 feet; 3) run five yards to a six-foot chain link fence, climb over the fence and continue running for a further 25-yards; 4) run five yards to a six-foot solid fence, climb over the fence and continue running for a further 25-yards; and 5) run 1.5 miles in less than 15 minutes. In order to pass, candidates must score 384 points or more (Regents of the University of California 2023).

The Hazardous Area Response Team (HART) and Special Operations Response Team (SORT) in the United Kingdom also make use of a standardised physical fitness assessment. These assessments provide minimum standards reflecting the type of incidents HART and SORT attend to, and then replicate the physical activity required to complete the task. The National Ambulance Resilience Unit Physical Competency Assessment Standards for HART and SORT are objective, role related, age- and gender-free physical fitness standards. Members of HART are expected to complete the following tests: movement in ground task simulation, unload secondary response vehicle, marauding terrorist attack, subterranean rescue and overground rescue. Tests required of members of SORT are: unload decontamination vehicle, clinical decontamination recovery, and marauding terrorist attack (National Ambulance Resilience Unit 2022).

Standardised physical fitness assessments are routinely utilised to assess the physical preparedness of emergency responders, nationally and internationally; and based on the nature of the BHSc EMC programme and the purpose of the qualification, if a standardised physical preparedness assessment tool was utilised to assess the core fitness components required for an EMC student to engage successfully with the physically strenuous programme content, the graduates exiting the BHSc EMC programmes from the different HEIs would have met the minimum physical fitness standards required for registration with the HPCSA, and hence employment in the South African pre-hospital emergency care environment as an ECP.

6.4.2 Preferred type of physical fitness test to assess physical preparedness of EMC students

6.4.2.1 Defining task-simulated and physical performance fitness tests

The physical fitness of emergency responders can either be assessed by task-simulated or physical performance fitness tests. In a task-simulated fitness test, profession-specific simulated tasks are selected to assess operational-specific physical fitness. In firefighters for example, the candidates would be expected to perform physically strenuous tasks which are representative of fire suppression tasks performed by operational firefighters during a structural fire (Davis, Dotson and Santa Maria 1982; Michaelides *et al.* 2011). The selected operational tasks in a task-simulated fitness test for a paramedic would be different, as their operational tasks would differ from those of a firefighter.

A South African study by Mthombeni Coopoo and Noorbhai (2021) examined the relationship between validated fitness parameters and an emergency rescue simulation performed by emergency care providers. The rescue simulation consisted of five physical ability tests selected to represent tasks commonly performed by emergency care providers during an operational shift, and they were performed in a sequential manner. The five stations consisted of 1) ascend and descend four flights of stairs carrying a 16.5kg medical/rescue bag, electrocardiogram and a suction unit; 2) simulate a vehicle extrication using a 19.6kg ‘jaws of life’ hydraulic extrication spreader by holding the spreader at three different heights (0.9m, 1.2m and 1.5m) for at least 15 seconds at each height; 3) reverse drag a 120kg manikin for a distance of 30m; 4) complete five minutes of continual chest compressions; and 5) simulate the carrying of a patient on a spine board by carrying a pair of 48kg (24kg each) kettlebells for a distance of 20m (Mthombeni, Coopoo and Noorbhai 2021). In a paramedic job-related test developed at the University of Manitoba, participants are required to carry a trauma bag, oxygen tank and defibrillator up and down one flight of stairs without stopping; perform three consecutive minutes of cardiopulmonary compressions on a manikin; ascend and descend four stairs both forwards and backwards carrying a 50kg barbell; and transfer an 80-pound sand bag from a cradle position from a table height down to a height of approximately one foot from the ground, and then return the sand bag to the table (University of Manitoba 2023).

Mountain rescue callouts can continue for extended periods of time and usually occur in remote locations with difficult terrain. Prolonged searches may take place and once the patient has been located, egress may require the manual carry of a stretcher with a patient to rendezvous with a helicopter or ambulance. A task-simulated fitness test for mountain rescue personnel in the United Kingdom consists of a simulated callout that has been modelled on a situation with no helicopter support. The task-simulated fitness test requires participants to hike to and evacuate a simulated 70kg patient on a stretcher to the closest access point for a vehicle. The patient is positioned 2.96km from the access point and the vertical height gain is 472m. The participants are required to wear standard team clothing for the test, which includes their personal equipment (Callender, Ellerton and Macdonald 2011).

A physical performance fitness test, on the other hand, utilises validated fitness tests to test fitness components such as muscular strength, muscular endurance, flexibility and cardiovascular endurance, which are required to perform the physically strenuous tasks of the selected profession (Nazari *et al.* 2018). If one had to consider firefighters: instead of performing the simulated fire suppression tasks mentioned above, the candidate would be required to complete a selection of fitness tests which assess the relevant components of fitness for a firefighter required to perform those tasks. Muscular strength, muscular endurance and cardiovascular endurance are frequently highlighted as the important fitness components for a firefighter, and therefore validated fitness tests that assess these components would be selected. An example of a physical performance fitness test for firefighters is presented in the study by Claessens *et al.* (2003), in which a sample of 95 professional firemen from a fire-brigade in Belgium completed the EUROFIT test battery which consisted of nine validated fitness tests: flamingo balance test; plate tapping; sit-and-reach test;

standing broad jump; handgrip test; sit-ups in 30 seconds; bent-arm hang; 10x5m shuttle runs; and 20m endurance shuttle run (bleep test) (Claessens *et al.* 2003; Wood 2008a). The EUROFIT test battery was also utilised to assess the physical performance of medical rescue candidates and active rescuers (Ružbarská and Turek 2010b). In a study which focused on the physical capacity of New South Wales ambulance paramedics, a physical performance fitness test was developed to assess muscular strength and flexibility. Upper body strength was assessed by a maximal push-up test performed on the toes for men and modified for women. Lower body strength was assessed by a single-leg static squat test (wall-squat) and core strength was assessed by a plank-hold test. Upper body (shoulder) flexibility was assessed on the left and right sides with the back scratch test, and hamstring flexibility was assessed by the sit-and-reach test (Hunter, MacQuarrie and Sheridan 2019). A physical performance fitness test is also more commonly known as a battery of fitness tests (Blacker *et al.* 2016).

6.4.2.2 Pros and cons of the two types of physical fitness tests: task-simulated and physical performance

When developing a physical preparedness assessment tool some points to take into consideration include: ease of administration; limited equipment requirements; field settings; and time required to administer the tests (Roy *et al.* 2010). Although the academic staff and fourth-year student participants both felt that the task-simulated fitness test was more relatable to the physically strenuous requirements of the BHSc EMC programme, due to the diverse nature of the programme curriculum, the participants felt that it would be an impractical approach to assess the physical preparedness of EMC students, and hence preferred the physical performance fitness test.

In many jobs it is impractical to implement a specific task-simulated fitness test for every physically strenuous task that the individual may be exposed to. This is especially true in the context of the BHSc EMC programme, where the purpose of the programme is to produce a graduate who is competent in the knowledge and skills required for the emergency medical care and rescue professions within South Africa (SAQA 2015). Task-simulated fitness tests can be quite time consuming to administer. They can be resource-heavy, as specialised equipment is required, and specialised locations may also be required, depending on the tasks to be performed. The participants undertaking the task-simulated fitness test are also required to be technically proficient in the different tasks to be performed (Siddall *et al.* 2021). Based on these factors, a task-simulated fitness test is not always a viable option and standardisation would be a challenge.

When developing a physical preparedness assessment, it is more advantageous to develop one that is broadly applicable to predict physical preparedness across a wide range of physically strenuous tasks. Based on this description, the physical performance fitness test is better suited for the BHSc EMC programme, as the key fitness components required for the student to engage successfully with the physically strenuous content of the BHSc EMC programme can be identified, and specific, validated fitness tests can be selected to predict performance across a range of essential tasks (Carstairs *et al.* 2018; Roberts *et al.* 2016). A physical performance fitness test is essentially a battery of validated fitness tests which are more affordable; the equipment is more portable; the test is easier to construct, and it is easier to standardise in order for comparisons to be made between scores at different times and locations (Siddall *et al.* 2021; Wood 2015). One potential risk with a physical performance fitness test is that the tasks become simplified for implementation, and they lose job-relatedness and face validity. Therefore, it is crucial to have a very clear understanding of the core fitness components required by a student registered on the BHSc EMC programme in order to select valid, appropriate tests.

6.4.2.3 Preferred test for the BHSc EMC programme

The ideal physical preparedness assessment tool represents the minimum level of fitness required to perform the associated job tasks and should focus on the essential fitness components required for the student to engage successfully with the physically strenuous content of the BHSc EMC programme, while not focusing on task-specific fitness tests (Farrell 2017). The physical preparedness assessment tool which was the focus of this research (Table 3.6 in Chapter 3), and which is currently being utilised by the three participating HEIs, makes use of the physical performance fitness test approach (Allan 2023; Muhlbauer 2022; Van Nugteren 2023; Vincent-Lambert, Coopoo and Van Nugteren 2022). After much deliberation over the pros and cons of the two different approaches, the shared opinion of the academic staff and fourth-year students was that the physical performance fitness test is the preferred approach to assess general physical fitness as part of the Physical Preparedness module in the BHSc EMC programme. The view was that task-simulated fitness could be utilised as the assessment approach within the specific Medical Rescue modules, if needed, as this would then ensure that the students are technically proficient in the required skillset to complete the selected tasks (Siddall *et al.* 2021).

6.4.3 Fitness components required for the BHSc EMC programme

In order to ensure that the physical preparedness assessment has sufficient criterion and face validity, it is essential that the core fitness components needed to engage successfully with the physically strenuous content of the BHSc EMC programme are identified (Siddall *et al.* 2021). The academic staff and fourth-year students identified several aspects of the programme which they felt were physically strenuous, and these aspects assisted the participants in selecting the core fitness components required by the EMC students.

6.4.3.1 Core components of fitness

The participants identified several Medical Rescue modules which they felt were physically strenuous, in addition to the Clinical Learning module. The three core fitness components identified by both the academic staff and fourth-year students for the EMC students to engage successfully with the physically strenuous content of these modules were cardiovascular endurance, muscular endurance, and muscular strength. These findings were comparable to other national and international studies that assessed the physical preparedness of emergency responders such as firefighters, police officers, and paramedics. Taking into consideration the diverse nature of the BHSc EMC programme curriculum, it was important to compare the fitness components required for the BHSc EMC programme with those of other emergency responders.

Firefighters require cardiovascular endurance, muscular strength, muscular endurance, power and flexibility (Michaelides *et al.* 2011; Parker, Bayne and Clifford 2014). The components of fitness commonly identified for police officers are cardiovascular endurance, muscular strength and muscular endurance (Campbell *et al.* 2023; Lockie *et al.* 2018). Ground evacuations from mountainous areas are strenuous and carry on for extended periods of time. Therefore, muscular and cardiovascular endurance are critical for members of a mountain search and rescue team (Callender, Ellerton and Macdonald 2011; Conolly, Elder and Dawes 2015). In the study by Mthombeni, Coopoo and Noorbhai (2020a), adequate levels of aerobic capacity, local muscular strength and endurance were identified for workplace competence in emergency care providers. Other studies which looked at the fitness components for emergency care providers also identified flexibility and co-ordination as important components, in addition to cardiovascular endurance, muscular endurance and muscular strength (Barnekow-Bergkvist *et al.* 2004; Davies, Naidoo and Parr 2008; Hunter, MacQuarrie and Sheridan 2019; Rue *et al.* 2019; Siddall *et al.* 2021; Thornton and Sayers 2014).

As can be seen from the above, the three core fitness components identified by the participants of the focus group interviews were cardiovascular endurance, muscular endurance, and muscular strength. In 2015, in an attempt to design a more scientific and defendable physical preparedness assessment, academic staff from HEI 'B', offering both EMC and Sport and Movement Studies, analysed the physical preparedness requirements of the BHSc EMC programme. Through collaboration between the EMC and Sport Sciences departments, a physical preparedness assessment tool was developed specifically for EMC students. This physical preparedness assessment tool was presented in Chapter 3 in Tables 3.4, 3.5 and 3.6, and consists of a 5km run as an assessment of cardiovascular endurance and a 30-second flexed-arm hang test as a test of muscular strength and endurance. The student is also required to swim 200m as a test of swimming competency. This assessment tool has found favour and anecdotal support from staff and EMC students. However, the assessment has not yet been scientifically validated.

6.4.3.2 Anxiety associated with the physical preparedness assessment

An interesting collateral finding, when exploring the strenuous aspects of the BHSc EMC programme, was the identification of the actual physical preparedness assessment as an 'emotional' and 'mentally' challenging aspect of the BHSc EMC programmes by the academic staff, presumably caused by high levels of performance anxiety that the physical preparedness assessment creates. Test or performance anxiety is recognised as a situation-specific trait accounting for the degree to which individuals find assessments threatening. Assessments are stressful for students because of their educational and/or employment consequences. They are markers of self-esteem and they create anxiety as one is being assessed and/or judged by others (Putwain 2008). Test anxiety is a related to possible negative consequences, such as failure, and it is usually due to poor preparation by the students for the assessment, which results in them not feeling confident in their ability to perform well in the assessment (Trifoni and Shahini 2011). This definition of test anxiety ties in well with the comments provided by the academic staff on this aspect, as they had verbalised that they felt that the anxiety experienced by the students was most likely linked to poor preparation for the assessment, and that the EMC students had probably not trained enough. This was a noteworthy finding and is an important psychological aspect to identify and manage regarding the physical preparedness assessment, in order to avoid any unnecessary negative associations with the assessment.

6.4.4 The importance of utilising a scientifically validated assessment tool

One of the most important themes emerging from the focus group interviews was the need for a scientifically validated physical preparedness assessment tool which was specifically developed for the EMC student registered for the BHSc EMC programme. Most, if not all, the areas of concern that were raised by the academic staff and fourth-year student participants could be addressed if the tool being utilised by the HEIs to assess the physical preparedness of the EMC students had been scientifically validated.

A physical preparedness assessment tool which is developed to assess task-oriented physical preparedness must reflect the minimum requirements which are critical to successfully perform the physically strenuous tasks associated with the BHSc EMC programme (Roberts *et al.* 2016; Siddall *et al.* 2021). When designing a physical preparedness assessment tool, one of the first steps in the process is to identify the components of fitness required by the EMC student needed to engage with the programme content of the BHSc EMC programme. It is crucial that the physical preparedness assessment tool measures what it is supposed to measure (validity) and that the results of the assessment are consistent and reproducible over time (reliability) (Wood 2015).

The physical preparedness assessment developed by higher education institution (HEI) 'B' consisted of three fitness tests. However, two of the three fitness tests are not currently validated as scientific tests for the physical fitness of EMC students. Furthermore, normative standards for each component of the current assessment have yet to be developed. When interviewing the academic staff and the fourth-year students, there was anecdotal support for the current physical preparedness assessment tool. However, there was some uncertainty why certain of the components had been selected; and also how the minimum pass criteria had been determined. As an example, questions were raised pertaining to the distance of 200m for the swim competency assessment, and whether the six-minute time limit was appropriate to ensure that the EMC students had the appropriate level of swimming competency required to engage with the swimming aspects of the BHSc EMC curriculum.

One of the academic staff participants correctly highlighted the need for the physical preparedness assessment they use to be scientifically defensible, so that an EMC student who passes the physical preparedness assessment should comfortably cope with all the physically strenuous aspects of the BHSc EMC programme.

6.5 CONCLUSION

This chapter presented the results from the two focus group interviews with the academic staff and fourth-year students. The interviews presented the researcher with the opportunity to explore three focus areas that were identified from the questionnaire in more detail. A brief overview of the methodology for this phase of data collection was provided and the themes that arose from the content analysis of the transcripts was presented. The discussion of the findings focused on the key areas which would be utilised to develop the physical performance test for the assessment of physical preparedness phase of the study. The results from the assessment of physical preparedness will be presented and discussed in Chapter 7.

CHAPTER 7: ASSESSMENT OF PHYSICAL PREPAREDNESS

7.1 INTRODUCTION

This chapter presents the results of the final phase of data collection, which comprised several physical performance tests conducted on a sample of emergency medical care (EMC) students from the three participating universities. The components selected for the physical performance test were informed by a critical analysis of the literature and the findings that derived from both the questionnaire (Chapter 5) and the focus group interview (Chapter 6).

As mentioned in the methodology chapter (Chapter 4), the aim of the physical performance testing was twofold. First, it sought to investigate whether the current physical preparedness assessment tool used by the universities is able to produce valid results. Second, it aimed to determine to what extent it can be defended as an appropriate and accurate gauge of an emergency medical care student's ability to engage successfully with the physically strenuous learning outcomes associated with the Bachelor of Health Science Degree in Emergency Medical Care (BHSc EMC) programme. A critical consideration of the results from the physical performance tests, together with those flowing from analysis of the questionnaires and focus group interviews, would allow the researcher to determine if there was a need to adjust and/or refine the historically-used physical preparedness assessment tool.

The results presented in this chapter include the demographic profile of the participants, their anthropometric measurements and the outcomes of the different physical performance tests that were conducted, with a focus on describing any correlations that were found to exist between:

1) the participant's performances in the three physical fitness tests making up the current physical preparedness assessment tool; and
2) the participant's performances in the additional physical fitness tests that were included in the physical performance test specifically designed for this phase of the study; and finally
3) the participant's anthropometric measurements and their performance in the different components of the physical performance tests conducted in the study.

7.2 METHOD AND APPROACH

The last phase of data collection was conducted in the format of a physical performance test (Appendix 13). The structure and approach to the development of the test is described and defended in detail in the methodology chapter (Chapter 4). A cross-sectional descriptive study design was utilised by the researcher. The total population for the assessment of physical preparedness consisted of students registered for either their third or fourth year of study in the BHSc EMC programme at the three participating HEIs (n = 112).

Participants were required to sign a hard copy of the consent form (Appendix 11) after reading the detailed information letter (Appendix 10). Once the participants had provided informed consent, they were required to complete a Physical Activity Readiness Questionnaire (PAR-I) which assessed whether they were healthy and free from any absolute contraindications for exercise testing (Appendix 12). Testing was conducted over six days – two days at each of the three participating universities – with the assistance of the academic staff and student assistants from the Sports Science Department. The sporting facilities (athletics tracks, swimming pools and gym areas) that the departments utilised to administer their current physical preparedness assessments were utilised for data collection. This ensured that participants were familiar with the environments in which they would be tested. All the participants were required to wear fitness attire that was appropriate for the different tests. Participants were also requested to have a light breakfast on the morning of the testing to ensure that they were adequately fuelled for the testing, and to try to avoid any strenuous exercise for 48 hours prior to the testing. The participants were afforded, at least, a fifteen-minute rest between the different testing stations, which allowed sufficient time for the phosphagen energy system to restore.

The demographic information, anthropometric measurements and results of the physical fitness tests were recorded manually on a specifically designed data collection template (Appendix 13) and then later transferred onto an Excel® spreadsheet for data analysis. The raw data from the assessment of physical preparedness was analysed by the researcher with the assistance of a statistician making use of Statistical Package for the Social Sciences (SPSS Statistics) Version 25.0. The data from the testing was analysed by utilising a number of statistical methods. These included descriptive statistics; regression analysis; Pearson's correlation; the independent samples t-test and the Mann-Whitney test. A p value < 0.05 was used to indicate significance at the 95% level.

7.3 RESULTS

The total number of participants who completed the anthropometric measurements and physical fitness tests was 47.

7.3.1 Demographics

The demographic profile of the participants who took part in the testing is presented in Figure 7.1. The participants were made up of 27/47 (57.4%) males and 20/47 (42.6%) females; with 27/47 (57.4%) third-year and 20/47 (42.6%) fourth-year emergency medical care students. Thirty of the 47 (63.8%) participants were from HEI 'A', 12/47 (25.5%) from HEI 'B' and 5/47 (10.6%) from HEI 'C'. The mean age of the participants was 26.4 ± 6.7 years, ranging from 19–44 years, which was consistent with the inclusion criteria. The mean age of the male participants was 27.6 ± 7.4 years, and 24.7 ± 5.4 years for the female participants.

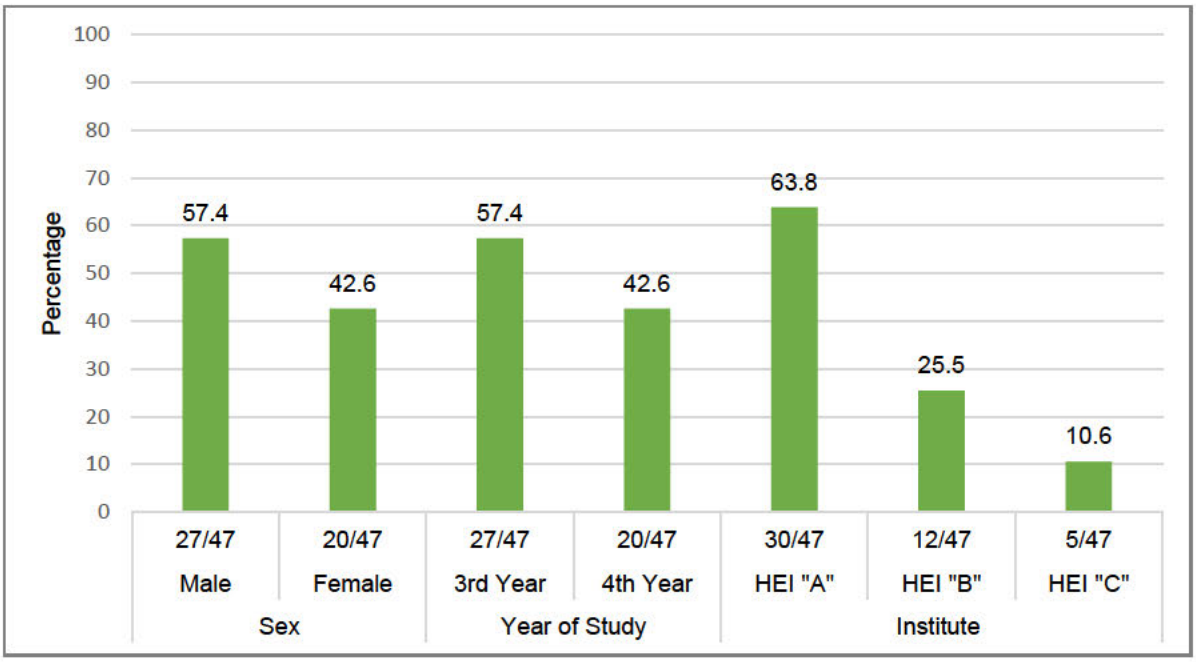


Figure 7.1: Demographic profile of the participants

The participants were required to indicate their frequency of training per week and the average duration of training per day. The frequency of training per week is presented in Figure 7.2. Most of the students trained two, three or four days a week, with very few training five or six days a week. Two of the 47 (4.3%) fourth-year students from HEI 'B' indicated that they do not train at all during the week. The mean training duration per day was 63.5 ± 24.4 minutes, ranging from 0–120 minutes.

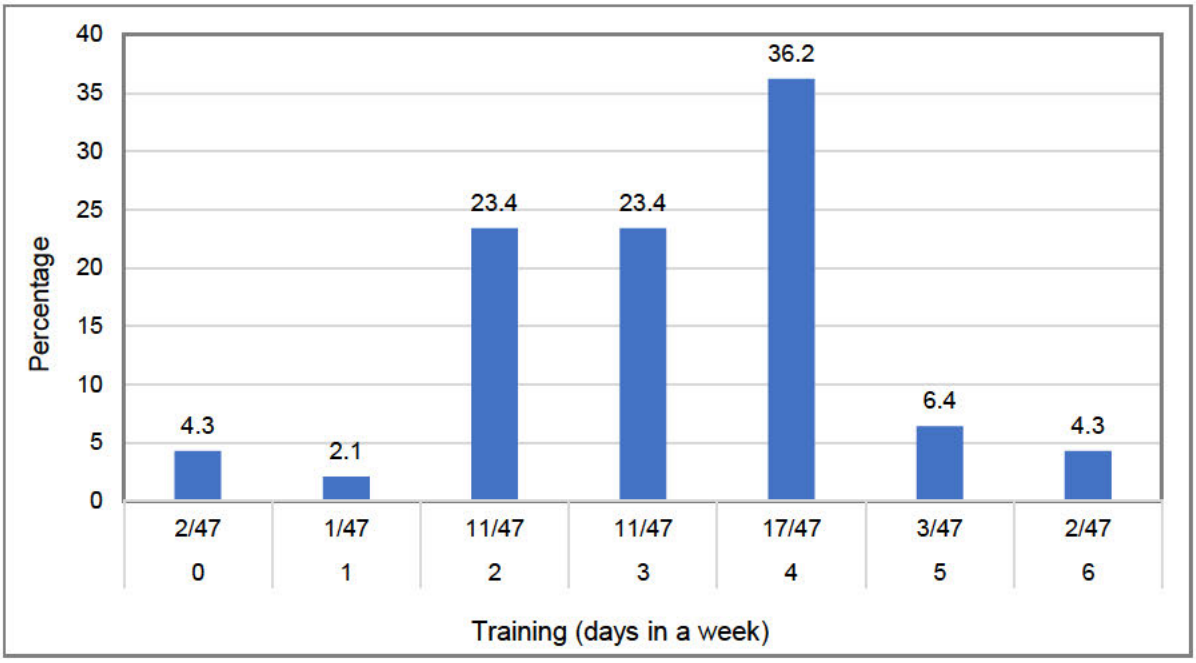


Figure 7.2: Frequency of training per week

7.3.2 Anthropometric measurements

The anthropometric measurements of the participants are provided in Table 7.1. The mean height was 169.5 ± 8.3cm. ranging from 153–188.2cm; with a mean weight of 74.1 ± 13.4kg, ranging from 51.7–114.6kg. The mean body mass index (BMI) was 25.8 ± 4.2kg/m^2, which is greater than the recommended normal adult BMI range of 18.5–24.9kg/m^2. Mean body fat was 23.7 ± 7.5% ranging from 8.9–37.6%. The male participants are significantly taller ($p = 0.001$) and heavier ($p = 0.005$), on average, than the female participants, whilst the average female participant's body fat percentage was significantly higher than that of the males ($p < 0.001$).

Table 7.1: Anthropometric measurements of the participants

Variable	Combined (n=47)		Males (n=27)		Females (n=20)		*t*	df	Significance
	Mean ± SD	Range (min-max)	Mean ± SD	Range (min-max)	Mean ± SD	Range (min-max)			
Height (cm)	169.5 ± 8.3	153.0–188.2	172.8 ± 7.3	157.0–188.2	165.1 ± 7.8	153.0–180.0	3.5	45	p = 0.001*
Weight (kg)	74.1 ± 13.4	51.7–114.6	78.7 ± 14.7	53.5–114.6	67.9 ± 8.4	51.7–87.8	2.9	45	p = 0.005*
BMI (kg/m^2)	25.8 ± 4.2	19.4–39.1	26.3 ± 4.6	19.4–39.1	25.0 ± 3.7	20.2–34.7	1.0	45	p = 0.304
Body fat percentage (%)	23.7 ± 7.5	8.9–37.6	20.2 ± 7.3	8.9–36.2	28.6 ± 4.5	21.0–37.6	-4.9	43.9	p < 0.001*

n = number of participants
SD = Standard Deviation
BMI = Body Mass Index
kg = kilogram
cm = centimetres
t = *t* value
df = degrees of freedom
* indicates significance at the 95% level between sexes

Of the male participants, 13/27 (48.1%) were rated in the normal BMI category; 10/27 (37%) were in the overweight category; 2/27 (7.4%) were in the obese class I category; and 2/27 (7.4%) were in the obese class 2 category. Of the 20 female participants, 11/20 (55.0%) were rated in the normal category; 7/20 (35%) were in the overweight category; and 2/20 (10.0%) were in the obese class I category. The World Health Organization (WHO) reported that the male population was proportionally heavier in comparison to the female population (WHO 2022). In the total population (n = 47), there were more participants with an elevated body fat percentage than in the normal range (4.3% lean; 23.4% leaner than average; and 10.6% average, compared to 25.5% slightly high; 25.5% high; and 10.6% obese) (National Strength and Conditioning Association 2012).

7.3.3 Physical fitness test results

Table 7.2 shows the means, standard deviations, and ranges for all the physical fitness tests administered in the assessment of physical preparedness. Comparisons between the male and female participants were computed with the use of the independent samples t-test for all the physical fitness tests. In most of the physical fitness tests, namely the Cooper 12-minute run test; maximal oxygen consumption (VO_{2max}); the 5 km run test; the flexed-arm hang test; the maximum push-up test; and the grip strength test, the male participants performed significantly better than the females (p value was < 0.05). The male and female participants performed similarly in the 400m swim test; the 200m swim test; the seven-stage abdominal strength test; and the modified sit-and-reach test, with no significant differences being found.

Table 7.2: Physical fitness test results

Variables	Combined (n=47)		Males (n=27)		Females (n=20)		*t*	df	p value
	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range			
400m Swim Test (minutes/seconds)	10m33.3s ± 1m52.7s	6m30–13m14s	10m46s ± 1m46s	7m44s–12m50s	10m16s ± 2m13s	6m30s–13m14s	0.923	45	0.361
200m Swim Test (minutes/seconds)	4m40.2s ± 49.5s	3m00s–6m05s	4m44s ± 45s	3m20s–5m56s	4m35s ± 55s	3m00s–6m05s	0.587	45	0.560
Cooper 12-Minute Run Test (m)	2114.1 ± 367.0	1448–2857	2261.5 ± 340.8	1561–2857	1915.2 ± 307.7	1448–2517	3.588	45	0.001*
VO_{2max} (ml/kg^{-1}/min^{-1})	36.0 ± 8.2	21.1–52.6	39.3 ± 7.6	23.6–52.6	31.5 ± 6.9	21.1–45.0	3.588	45	0.001*
5km Run Test (minutes/seconds)	28m59.6s ± 4m59.3s	20m30s–42m24s	26m37s ± 3m41s	20m30s–34m17s	32m13s ±4m46s	24m09s–42m24s	-4.550	45	<0.001*
Flexed Arm Hang Test (seconds)	45.8 ± 19.1	7–93	51.5 ± 18.4	10–93	38.2 ± 17.6	7–70	2.510	45	0.016*
Maximum Push Up Test (repetitions)	20.0 ± 14.8	1–61	26.7 ± 14.7	3–61	11.0 ± 9.3	1–33	4.483	44.091	<0.001*
7-Stage Abdominal Strength Test (level)	4.7 ± 2.3	0–7	4.2 ± 2.5	0–7	5.4 ± 1.7	0–7	–2.010	44.750	0.050
Grip Strength Test (kg)	38.5 ± 9.7	21.9–57.7	45.7 ± 4.9	37.0–57.7	28.8 ± 4.7	21.9–38.1	11.847	45	<0.001*
Modified Sit & Reach Test (cm)	30.3 ± 9.7	5.3–52.0	28.6 ± 9.3	5.3–44.7	32.7 ± 9.9	19.7–52.0	–1.420	45	0.162

n = number of participants
SD = Standard Deviation

t = *t* value

df = degrees of freedom

* indicates significance at the 95% level

7.3.4 Correlations between the different physical fitness tests

Pearson's correlation was utilised to determine whether there were any correlations between the results of the physical fitness tests. There was a high positive correlation (r = 0.910) between the time taken to complete the 200m and 400m swim tests. A high negative correlation (r = –0.751) was found between the distance run in the 12-minute Cooper run test and the time taken to complete the 5 km run test. There was a weak correlation between the flexed-arm hang test and the grip strength test, and a weak negative correlation between the flexed-arm hang test and the seven-stage abdominal strength test. A moderate- to-low correlation (r = 0.452) was noted between the flexed-arm hang test and the maximum push-up test. A low correlation was identified between the modified sit-and-reach test and the 5km run test; and very low correlations were identified between the modified sit-and-reach test and the 400m swim test as well as between the modified sit-and-reach test and the 200m swim test.

Table 7.3: Correlation between the physical fitness tests

Variable A	Variable B	Pearson's Correlation (r)	p-value
200m Swim Test	400m Swim Test	0.910	<0.001*
5km Run Test	Cooper 12-Minute Run Test	–0.751	<0.001*
Flexed Arm Hang Test	Grip Strength Test	0.258	0.080
	7-Stage Abdominal Strength Test	–0.077	0.608
	Maximum Push Up Test	0.452	0.001*
Modified Sit & Reach Test	400m Swim Test	0.099	0.508
	200m Swim Test	–0.010	0.945
	Cooper 12-Minute Run Test	–0.183	0.219
	5km Run Test	0.207	0.162
	Flexed Arm Hang Test	–0.068	0.651
	Grip Strength Test	–0.040	0.791
	7-Stage Abdominal Strength Test	0.143	0.338
	Maximum Push Up Test	0.081	0.590

* indicates significance at the 95% level

7.3.5 Effect of the anthropometric measurements on the physical fitness tests

Linear regression was used to determine what effect the set of independent variables (anthropometric measurements) had on the dependent variable (physical fitness test). Table 7.4 presents the results of the linear regression analysis. Statistically significant findings were noted for the effect of weight, height, BMI and body fat percentage on the following physical fitness tests: the 12-minute Cooper run test; the maximum push-up test; the grip strength test; the 5km run test and the flexed-arm hang test.

Body fat percentage had a significant effect on the distance completed in the 12-minute Cooper run test, with an increase in body fat percentage being associated with a decrease in the distance completed in the 12-minute time limit, $\beta = -27.416$. $p = 0.001$. Height had a significant effect on the time taken to complete the 5km run test, as the taller participants completed the 5km distance in faster times, $\beta = -11.208$, $p = 0.027$. An increase in weight ($\beta = 0.527$, $p = 0.002$), a decrease in height ($\beta = -0.590$, $p = 0.030$) and a decrease in body fat percentage ($\beta = -1.555$, $p < 0.001$) are significant predictors of an increase in the number of push-ups completed. An increase in weight ($\beta = 0.604$, $p < 0.001$), an increase in BMI ($\beta = 1.763$, $p < 0.001$) and an increase in body fat percentage (-0.879, $p < 0.001$ and $\beta = -1.045$, $p < 0.001$) were significant predictors of a higher grip strength in kilograms. Lastly, weight, body fat percentage and BMI had a significant effect on the time, in seconds, that the participants could hang for in the flexed-arm hang test. Participants with an increased body weight and high BMI, irrespective of whether that BMI was due to skeletal muscle mass or fat, had shorter hang times for the flexed-arm hang test, $\beta = -0.488$, $p = 0.021$ (weight), $\beta = -1.174$, $p = 0.002$ and $\beta = -1.173$, $p = 0.001$ (body fat percentage) and $\beta = -1.453$, $p = 0.016$ (BMI).

Table 7.4: Anthropometric measurement correlations with the physical fitness tests

Dependent Variable	Independent Variable	R^2	F	df1; df2	p-value	B (regression coefficient)	t	p-value
Modified Sit & Reach Test	Weight	0.067	1.022	3; 43	0.392	–0.008	–0.060	0.952
	Height					–0.300	–1.365	0.179
	Body fat %					–0.164	–0.704	0.485
400m Swim Test	Weight	0.048	0.600	3; 36	0.619	–1.282	–0.911	0.368
	Height					–0.427	–0.181	0.857
	Body fat %					–0.064	–0.026	0.979
200m Swim Test	Weight	0.057	0.849	3; 42	0.475	0.244	0.354	0.725
	Height					–1.634	–1.472	0.149
	Body fat %					–0.691	–0.567	0.574
Cooper 12-Minute Run Test	Weight	0.363	8.183	3; 43	<0.001*	0.119	0.028	0.978
	Height					4.992	0.725	0.473
	Body fat %					–27.416	–3.761	0.001*
5km Run Test	Weight	0.373	6.143	3; 31	0.002*	6.476	1.997	0.055
	Height					–11.208	–2.329	0.027*
	Body fat %					6.291	1.276	0.211
5km Run Test	Body fat %	0.318	7.472	2; 32	0.002*	9.197	1.951	0.060*
	BMI					15.766	1.671	0.105
Maximum Push Up Test	Weight	0.429	10.784	3; 43	<0.001*	0.527	3.218	0.002*
	Height					–0.590	–2.242	0.030*
	Body fat %					–1.555	–5.587	<0.001*
Maximum Push Up Test	Body fat %	0.419	15.893	2; 44	<0.001*	–1.501	–5.633	<0.001*
	BMI					1.482	3.144	0.003*
7-Stage Abdominal Strength Test	Weight	0.018	0.265	3; 43	0.850	–0.003	–0.098	0.922
	Height					–0.009	–0.172	0.864
	Body fat %					–0.040	–0.712	0.480
Grip Strength Test	Weight	0.748	42.526	3; 43	<0.001*	0.604	8.463	<0.001*
	Height					–0.065	–0.565	0.575
	Body fat %					–0.879	–7.251	<0.001*
Grip Strength Test	Body fat %	0.593	31.991	2; 44	<0.001*	–1.045	–7.141	<0.001*
	BMI					1.763	6.808	<0.001*
Flexed Arm Hang Test	Weight	0.467	12.580	3; 43	<0.001*	–0.488	–2.394	0.021*
	Height					0.468	1.431	0.160
	Body fat %					–1.174	–3.391	0.002*
Flexed Arm Hang Test	Body fat %	0.472	19.662	2; 44	<0.001*	–1.173	–3.584	0.001*
	BMI					–1.453	–2.508	0.016*

7.4 DISCUSSION

7.4.1 Introduction

In 2015, in an attempt to design a more scientific and defendable physical preparedness assessment, academic staff from HEI 'B', offering both EMC and Sport and Movement Studies, analysed the physical preparedness requirements of the BHSc EMC programme. Through collaboration between the EMC and Sport Sciences departments, a physical preparedness assessment tool was developed specifically for EMC students. This physical preparedness assessment tool was presented in Table 3.6 in Chapter 3 and consists of a 5km run as an assessment of cardiovascular endurance, and a 30-second flexed-arm hang test as a test of muscular strength and muscular endurance. The students are also required to swim 200m as a test for swimming competency. This assessment tool has found favour and anecdotal support from staff and EMC students; however, prior to this study, no attempts had been made to scientifically validate the assessment. The purpose of this phase of the study was, therefore, two-fold: 1) to determine to what extent the current physical preparedness assessment tool presented in Table 3.6 in Chapter 3 is capable of producing valid results which accurately assess the emergency medical care student's ability to effectively engage in activities associated with the real-life emergency care and rescue working environments; and 2) to determine if there is evidence of a need to adjust and/or refine the current physical preparedness assessment tool.

The participants in the testing phase of the study participated in a physical performance test, specifically designed by the researcher, that assessed a number of different components of physical fitness, including the three tests featured in the current physical preparedness assessment (Table 3.6 in Chapter 3). A brief overview of the physical fitness tests administered during the assessment of physical preparedness is provided in Table 7.5.

Table 7.5: Brief overview of the physical fitness tests in the assessment of physical preparedness

Day 1	Day 2
Swimming Assessment: 400m swim test	**Swimming Assessment:** 200m swim test
Cardiovascular Endurance: Cooper 12-minute run test	**Cardiovascular Endurance:** 5km run test
Muscular Strength & Muscular Endurance: Maximum push-up test 7-Stage abdominal strength test Grip strength test	**Muscular Strength & Muscular Endurance:** Flexed-arm hang test

The discussion that follows will explore the demographic profiles of the participants, as well as their anthropometric measurements. The different physical fitness tests will also be discussed in relation to the fitness components assessed, and whether the sex and/or anthropometric measurements of the emergency medical care student participants had any effect on the different physical fitness tests.

7.4.2 Demographic profile of the participants

7.4.2.1 Sex

In line with the demographic profile of the respondents in the questionnaire phase of this study, a higher proportion of male participants was noted compared to female participants. This corresponds with the demographic profile typically observed in the programmes offered at the three participating universities. This is similar to other national and international studies which looked at the physical preparedness of emergency responders. In the study by Hunter, MacQuarrie and Sheridan (2019), which researched the physical capacity of New South Wales ambulance paramedics, of the 140 enrolled participants, 78 were male and 62 were female; and in another international study by Barnekow-Bergkvist *et al.* (2004), out of a total possible population of 68 male and 19 female ambulance personnel, 48 male and 17 female participants took part in the study. In a local study which researched the physical performance characteristics of South African male and female emergency care students, there were 20 male and 18 female participants (Davies, Naidoo and Parr 2008). Similarly, in the local study by Mthombeni, Coopoo and Noorbhai (2020b), which reviewed the physical health status of emergency care providers in South Africa, out of 91 participants, there were 64 males and 27 females. These results are again reflective of the fact that emergency care remains a male-dominated profession.

7.4.2.2 Age

The mean age of the participants was 26.4 ± 6.7 years ranging from 19–44 years, and the mean age of the male participants was 27.6 ± 7.4 years, and 24.7 ± 5.4 years for the female participants. In a study describing and comparing the indicators of motor performance of 35 full-time and 36 extramural students at the Faculty of Health at the University of Prešov in Slovakia, the mean age of the male full-time students was 21.6 years, and 28.1 years for the male, extramural students. The mean age of the female full-time students was 20.3 years, and 31.6 years for the female, extramural students (Ružbarská and Turek 2010b). The full-time students from this study were registered for the Medical Rescuer bachelor's study programme at the University of Prešov in Slovakia and, therefore, were representative of a student population. In a local study by Davies, Naidoo and Parr (2008), which looked at the physical performance characteristics of 38 South African emergency care students, the mean age of the male participants was 22.8 ± 3.6 years, with 21.1 ± 1.8 years for the females. The mean age of the student participants that took part in the assessment of physical preparedness phase of this study is similar to other national and international studies which also utilised students as the population for the study.

7.4.2.3 Physical training frequency

Most participants indicated that they trained between two and four days a week, as 11/47 (23.4%) trained two days; 11/47 (23.4%) trained three days; and 17/47 (36.2%) trained four days per week. The mean training duration per day was 63.5 ± 24.4 minutes. Although this daily training time falls well within the American College of Sports Medicine's (ACSM) guidelines, which recommend at least 30–60 minutes of moderate-intensity exercise per session, the frequency of training reported by this study's participants is less than the recommended five days per week (Mthombeni, Coopoo and Noorbhai 2020b; Roy *et al.* 2010).

7.4.3 Participants' anthropometric measurements

Body composition was identified as an important component of fitness by both the academic staff and emergency medical care students and it addresses the relative amounts of muscle, fat, bone and other vital parts of the body (American College of Sports Medicine 2018). To evaluate the body composition of the participants, anthropometric measurements were assessed, such as weight, height, BMI and body fat percentage. These anthropometric measurements were utilised to comment on the body composition of the participants and to determine whether any of these measurements influenced the participants' performance in the different physical performance tests.

7.4.3.1 Weight

Two weight measurements were taken and the lowest of the two readings was captured in kilograms (kg) to the nearest 0.1kg. The mean weight of the total population was 74.1 ± 13.4kg; 78.7 ± 14.7kg for the males and 67.9 ± 8.4kg for the females. A statistically significant difference in weight was noted between the male and female participants ($p = 0.005$). This finding was supported by other similar studies in which statistically significant differences between the weight of the male and female participants were also identified. In the study by Barnekow-Bergkvist *et al.* (2004), the mean weight for the female ambulance personnel was 69.2 ± 7.3kg, and 84.4 ± 12.3kg for the males ($p < 0.001$); and in the study by Thornton and Sayers (2014), the weight of the female paramedics was 68.3 ± 14.7kg, with 79.5 ± 15.8kg for the males ($p < 0.001$) (Barnekow-Bergkvist *et al.* 2004; Thornton and Sayers 2014).

7.4.3.2 Height

The mean height of the total population was 169.5 ± 8.3cm; 172.8 ± 7.3cm for the males and 165.1 ± 7.8cm for the females. A statistically significant difference in height was noted between the male and female participants ($p = 0.001$). In the study by Thornton and Sayers (2014), which evaluated the pre-employment fitness screening test results of 251 paramedics, the mean height of the male participants was 179.1 ± 7.5cm, with 169.2 ± 6.4cm for the females ($p < 0.001$); and in the study by Davies, Naidoo and Parr (2008), the male emergency care students were 180 ± 8cm and the females 163 ± 10cm ($p = 0.01$) (Davies, Naidoo and Parr 2008; Thornton and Sayers 2014).

7.4.3.3 Body mass index (BMI)

Body mass index (BMI) is a measure of body composition calculated from height and weight measurements. However, a limitation with BMI is that it cannot distinguish excess fat from muscle or bone mass (Hoffman 2006; National Strength and Conditioning Association 2016). Due to this, BMI can often result in the misclassification of individuals, especially in physically active populations such as emergency medical care students who may possess an above-average skeletal muscle mass (Lessons, Bhakta and McCarthy 2022). The calculated BMI score (BMI = body mass (kg) / height (m^2)) was utilised to classify the participants as either underweight, normal weight, overweight or obese (WHO 2022). The mean BMI of the total population was 25.8 ± 4.2kg/m^2; 26.3 ± 4.6kg/m^2 for the males and 25.0 ± 3.7kg/m^2 for the females; and the BMI of many of the participants classified them as overweight or obese. In a study of 160 Australian emergency care providers and 270 firefighter candidates, 43.8% of the participants were overweight and 33% were obese (Tsismenakis *et al.* 2009). Overweight or obese individuals are at an increased risk of developing hypertension and coronary heart disease, which may have a negative impact on their physical health and the minimum level of physical preparedness required to engage successfully with the physically strenuous learning outcomes of the BHSc EMC programme (National Strength and Conditioning Association 2016). The BMIs of this study's participants were found to be similar to those reported in other studies which investigated the physical fitness of emergency responders. The mean BMI of the male paramedics in the study by Thornton and Sayers (2014) was 24.4 ± 4.8kg/m^2, with 23.8 ± 4.6kg/m^2 for the females. In the study by Mthombeni, Coopoo and Noorbhai (2020a), which investigated the fitness levels of 91 emergency care providers in the North West Province in South Africa, the mean BMI for the males was 27.8 ± 4.7kg/m^2, and 29.0 ± 5.4kg/m^2 for the females (Mthombeni, Coopoo and Noorbhai 2020a; Thornton and Sayers 2014).

7.4.3.4 Body fat percentage

Skinfold thickness measurements are utilised to estimate body fat percentage by determining the thickness of several skinfolds across the body (American College of Sports Medicine 2018). In this assessment of physical preparedness, four upper body sites (biceps, triceps, subscapularis and suprailiac) were measured and the Durnin and Womersley (1974) equation was then utilised to calculate the sum of all of the skinfolds in order to determine the total body fat percentage for each of the participants (National Strength and Conditioning Association 2012). The mean body fat percentage of the total population was 23.7 ± 7.5%; 20.2 ± 7.3% for the males and 28.6 ± 4.5% for the females. A statistically significant difference in body fat percentage was noted between the male and female participants ($p < 0.001$). However, this is to be expected, as on average adult females have more body fat, less muscle mass and a lower bone density in comparison to adult males (National Strength and Conditioning Association 2016).

In a study investigating the physical performance characteristics of 38 emergency care students registered at a South African university, the mean body fat percentage of the male participants was 13.19 ± 7.9, and 25.68 ± 6.1 for the females, with a statistically significant difference between the two sexes ($p = 0.01$) (Davies, Naidoo and Parr 2008). Body fat percentage is classified as very lean; lean; leaner than average; average; slightly high; high; and obese (National Strength and Conditioning Association 2012). Looking at the total population ($n = 47$) in this assessment of physical preparedness, many of the participants had an elevated body fat percentage (4.3% lean; 23.4% leaner than average; and 10.6% average, vs. 25.5% slightly high; 25.5% high; and 10.6% obese). This is a concerning finding, as an elevated body fat percentage can negatively influence cardiovascular endurance; muscular strength; muscular endurance; balance; co-ordination; and flexibility (American College of Sports Medicine 2018; Lessons, Bhakta and McCarthy 2022).

7.4.4 Physical fitness tests

When designing the physical performance test which was administered on the first day of the assessment of physical preparedness, universally recognised valid and reliable fitness tests for the various components of fitness were selected. In the assessment of physical preparedness, these tests were compared to the fitness tests which made up the current physical preparedness assessment tool (Table 3.6 in Chapter 3). The components of fitness tested in the assessment of physical preparedness were: 1) cardiovascular endurance (aerobic capacity); 2) muscular endurance; 3) muscular strength; and 4) flexibility. In addition, swimming aerobic capacity was assessed.

7.4.4.1 Swimming tests

Emergency medical care students registered for the BHSc EMC programme are required to complete a Medical Rescue module which focuses specifically on aquatic rescue. During this module, the students are exposed to different aquatic rescue scenarios in open bodies of water, such as dams and the sea, as well as fast flowing rivers for the swift water component. Therefore, the EMC student is required to have a high level of swimming proficiency (SAQA 2015). The current physical preparedness assessment, as described in Table 3.6 in Chapter 3, utilises a 200m swim to assess the swimming aerobic capacity of the EMC students. However, the 200m swim test is not a universally recognised test of swimming aerobic capacity. The universally recognised swimming aerobic capacity test which was selected to form part of the physical performance test in the assessment of physical preparedness was the 400m swim test, which is a recognised test of swimming aerobic capacity by the International Life Saving Federation (American Aquatics and Safety Training 2022; International Life Saving Federation 2007).

The mean time taken to complete the 400m swim test for the total population was 10m 33.3s ± 1m 52.7s; and for the 200m swim test, the mean time was 4m 40.2s ± 49.5s. The internationally recognised time in which the 400m swim test should be completed is eight minutes, and the maximum time in which the EMC students are allowed to complete the 200m swim test is six minutes (International Life Saving Federation 2007; Van Nugteren 2023). Although the participants who took part in the assessment of physical preparedness did not complete the 400m swim test within the internationally required time of eight minutes, there was a high positive correlation ($r = 0.910$) between the time taken by the participants to complete the 200m and 400m swim tests. There were no significant differences between the time taken by the male and female participants, and none of the anthropometric measurements had a significant effect on either the 200m or 400m swim tests.

Due to the high positive correlation between the 200m and 400m swim tests, either of these tests could be selected to form part of the battery of fitness tests to assess swimming competency in students registered on the BHSc EMC programme.

7.4.4.2 Cardiovascular endurance

Cardiovascular endurance relates to the ability of the cardiovascular and respiratory system to provide oxygen during sustained physical activity (American College of Sports Medicine 2018). Aerobic capacity, on the other hand, reflects an individual's ability to perform sustained, high-intensity exercise and usually involves activities lasting longer than three minutes (Hoffman 2006; National Strength and Conditioning Association 2012). In the context of emergency responders, aerobic capacity is deemed to be the important aspect to assess in cardiovascular endurance (Conolly, Elder and Dawes 2015; Mthombeni, Coopoo and Noorbhai 2020a; Siddall *et al.* 2021).

The current physical preparedness assessment (Table 3.6 in Chapter 3) utilises a 5km run to assess the aerobic capacity of the students, and the EMC students are required to complete this distance within a maximum time of 32 minutes and 30 seconds. The 5km run test is not a universally recognised physical fitness test for aerobic capacity. The validated physical fitness test which was selected to form part of the physical performance test in the assessment of physical preparedness was the Cooper 12-minute run test.

The Cooper 12-minute run test is a field test which assesses aerobic capacity, and it also allows for the indirect measurement of VO_{2max}, as a mathematical model is utilised to estimate the participant's aerobic capacity, based on the distance covered in the Cooper 12-minute run test (Buttar, Saboo and Kacker 2019). The VO_{2max} reflects the point at which oxygen uptake plateaus with an increase in workload (Hoffman 2006). The mean distance completed in the Cooper 12-minute run test for the total population was 2114.1 ± 367.0m, and the mean time to complete the 5km run test, in minutes and seconds for the total population, was 28m 59.6s ± 4m 59.3s. The mean distance covered by the participants in the Cooper 12-minute run test was greater than the distance completed by the 20 male emergency care provider participants in Mthombeni *et al.'s* study (2114.1 ± 367.0m vs. 1866.5 ± 416m), even though the study population was smaller (Mthombeni, Coopoo and Noorbhai 2021).

There were statistically significant differences in the distance completed by the male and female participants in the Cooper 12-minute run test ($p = 0.001$) and the time taken to complete the 5km run test ($p < 0.001$). In the study by Mthombeni, Coopoo and Noorbhai (2020a), which assessed the fitness levels of emergency care providers in the North West Province in South Africa, a statistically significant difference was also noted between the distance completed by the male and female participants (1960.3 ± 395.5m vs. 1538.1 ± 293.7m; $p < 0.001$).

The Cooper 12-minute run test is an indirect measurement of aerobic capacity, as a mathematical calculation is utilised to calculate the VO_{2max} of the participants, based on the distance completed within the 12-minute time limit (Buttar, Saboo and Kacker 2019). The mean VO_{2max} for the total population was 36.0 ± 8.2ml/kg^{-1}/min^{-1}; 39.3 ± 7.6ml/kg^{-1}/min^{-1} for the male participants and 31.5 ± 6.9ml/kg^{-1}/min^{-1} for the females. These results were similar to the findings in the study by Barnekow-Bergkvist *et al.,* (2004), in which the VO_{2max} was assessed in 17 female (38.0 ± 5.3ml/kg^{-1}/min^{-1}) and 48 male (43.3 ± 7.3ml/kg^{-1}/min^{-1}) ambulance personnel (Barnekow-Bergkvist *et al.* 2004). A statistically significant difference was noted between the VO_{2max} of the male and female participants in this assessment of physical preparedness ($p = 0.001$), as well as in Barnekow-Bergkvist *et al.'s* (2004) study ($p < 0.001$) (Barnekow-Bergkvist *et al.* 2004). The mean age of the male participants in this assessment of physical preparedness was 27.6 ± 7.4 years, and 24.7 ± 5.4 years for the female participants. According to the ACSM, the mean VO_{2max} for both the male and female participants in the assessment of physical preparedness would be categorised as poor (American College of Sports Medicine 2019).The poor VO_{2max} is a concerning finding, as it reflects a poor aerobic capacity in the study population. A greater aerobic capacity would allow the EMC students to perform the physically strenuous tasks associated with the BHSc EMC programme at a lower heart rate, which would reduce the level of exertion during these strenuous activities (Armstrong *et al.* 2019b).

Body fat percentage had a statistically significant effect ($p = 0.001$) on the distance completed by the participants in the Cooper 12-minute run test, as the higher the body fat percentage, the shorter the distance completed. A study by Mendez-Cornejo *et al.* (2021), which investigated the relationship between body fat and aerobic capacity of 110 physical education students (75 males and 35 females) from a Chilean university, had a similar finding – students with a higher aerobic capacity presented with less body fat. These physical education students participated in moderate physical activity twice a week for 90 minutes per day as part of the physical education sport's subjects. The results of the study revealed moderate negative correlations between the university students' body adiposity indicators and their aerobic capacity (Mendez-Cornejo *et al.* 2021). In the 5km run test, height had a statistically significant effect on the time taken to complete the 5km distance, as the taller participants had longer strides, which resulted in faster times ($p = 0.027$). In terms of running, speed is equal to stride length multiplied by stride frequency (Magness 2024). This equation supports the finding in the current study, as taller students had a longer stride length, resulting in a faster time to complete the 5km run test due to their increased speed.

With the high negative correlation ($r = -0.751$) between the time taken to complete the 5km run test and the distance completed in the Cooper 12-minute run test, either of these aerobic capacity tests could be selected to form part of the battery of fitness tests to assess aerobic capacity (cardiovascular endurance) in students registered for the BHSc EMC programme.

7.4.4.3 Muscular strength and muscular endurance

Muscular strength refers to the force that a muscle or group of muscles can exert with a single effort, whereas muscular endurance is the ability of a muscle or group of muscles to repeatedly move against a submaximal resistance without undue fatigue (Hoffman 2006). These components of fitness usually require the participant to perform several repetitions within a specific time frame, or the test can record the time for which a muscular contraction is sustained (Clemons *et al.* 2004; Hoffman 2006; National Strength and Conditioning Association 2012). Both of these are essential fitness components required by emergency responders and have been identified as such for emergency care providers, police officers and firefighters (Campbell *et al.* 2023; Michaelides *et al.* 2011; Mthombeni, Coopoo and Noorbhai 2020a; Rue *et al.* 2019).

Flexed-arm hang test:

The current physical preparedness assessment (Table 3.6 in Chapter 3) made use of the flexed-arm hang test to assess both muscular strength and muscular endurance. This test is a posture-specific isometric test and is used to test arm and shoulder girdle strength, upper body muscular endurance and weight-relative muscular endurance, as the participant is required to keep their chin above the bar until the muscles are no longer able to hold the required position (Clemons *et al.* 2004). The underhand grip was selected over that of the overhand grip, as this grip has been demonstrated to have a stronger relationship with relative strength. This is a validated test of muscular strength and endurance and one that has been widely used in fitness test batteries for emergency responders as well as civilians. Although there was support for the flexed-arm hang test by the academic staff and fourth-year students during the focus group interviews, concerns were raised whether this isolated test was sufficient to assess the muscular strength and muscular endurance of the EMC students. Based on this finding from the focus group interviews, additional validated fitness tests for both muscular strength and muscular endurance were included in the physical performance test. The additional fitness tests included the maximum push-up test, the grip strength test, and the 7-stage abdominal strength test.

The mean time for the flexed-arm hang test for the total population was 45.8 ± 19.1 seconds; 51.5 ± 18.4 seconds for the males and 38.2 ± 17.6 seconds for the females. Similar times (51.5 ± 18.4 vs. 50.9 ± 16.8 for the full-time male students and 38.2 ± 17.6 vs. 39.1 ± 12.6 for the females) were noted in the study by Ružbarská and Turek (2010b). The times for the emergency care providers from the North West Province, South Africa, were a lot shorter (51.5 ± 18.4 vs. 34.5 ± 16.0 for the males and 38.2 ± 17.6 vs. 9.4 ± 11.3 for the females) (Mthombeni, Coopoo and Noorbhai 2020a). There was a significant difference in the times for the male and female participants in the flexed-arm hang test ($p = 0.016$) and this significant difference was also a finding in the two previously mentioned studies (Mthombeni, Coopoo and Noorbhai 2020a; Ružbarská and Turek 2010b).

Weight, BMI and body fat percentage all had an effect on the flexed-arm hang test. The heavier students recorded shorter times for the flexed-arm hang test, irrespective of whether that additional weight was due to skeletal muscle mass or fat. This was an expected finding, as the flexed-arm hang test is designed to assess weight-related muscular endurance (Clemons *et al.* 2004). This was also one of the shortfalls of this test identified by the academic staff and fourth-year students in the focus group interviews, as they highlighted the fact that lighter students can easily pass the flexed-arm hang test, yet they are unable to lift some of the heavy rescue equipment as they lack skeletal muscle mass.

Maximum push-up test:

The maximum push-up test assesses muscular endurance of the upper body musculature (pectoralis major, anterior deltoids and triceps) by having the participant perform as many push-up repetitions as possible against a submaximal load, utilising both eccentric and concentric contractions until failure (Hoffman 2006; National Strength and Conditioning Association 2012). This differs to the flexed-arm hang test, which requires the participant to maintain the hang position until failure. Although there are key differences between these two tests of muscular endurance, the key focus of both is the ability of the active musculature to resist fatigue (National Strength and Conditioning Association 2012).

The mean score in repetitions for the maximum push-up test for the total population was 20.0 ± 14.8; 26.7 ± 14.7 for the males and 11.0 ± 9.3 for the females. Similar results, with minor differences, were noted in a study by Paakkonen, Ring and Kettunen (2018) which assessed the physical fitness of 57 student paramedics (26.7 ± 14.7 vs. 29.3 ± 10.3 for the males, and 11.0 ± 9.3 vs. 11.6 ± 6.8 for the females), and in the local study by Mthombeni, Coopoo and Noorbhai (2020a) (26.7 ± 14.7 vs. 26 ± 12 for the males and 11.0 ± 9.3 vs. 8 ± 9 for the females). A statistically significant difference was determined between the number of repetitions completed by the male and female participants ($p < 0.001$). This significant difference between the sexes in the maximum push-up test was also a finding in other studies which administered the maximum push-up test to male and female participants (Mthombeni, Coopoo and Noorbhai 2020a; Paakkonen, Ring and Kettunen 2018). All participants in the assessment of physical preparedness, whether male or female, performed the push-ups using the same technique – the modified push-up was not permitted. Weight, body fat percentage and BMI all influenced the number of repetitions completed in the maximum push-up test. Participants who were heavier, and with a higher BMI, but with a low body fat percentage, were able to complete a higher number of repetitions. This demonstrates that the weight was due to skeletal muscle mass, which led to increased strength, instead of fat.

7-Stage abdominal strength test:

The 7-stage abdominal strength test assesses abdominal muscular endurance, which is important for core stability and back support. Poor abdominal strength and endurance may contribute towards lower back pain, and a strong core is therefore crucial in a profession which requires lifting heavy equipment and patients regularly (American College of Sports Medicine 2018). This test has replaced the one-minute sit-up test, as in a curl-up when the participant’s feet are held, there is an increased involvement of the hip flexor muscles, which impacts the validity of the test to assess abdominal muscular endurance.

The mean score for the 7-stage abdominal strength test for the total population was 4.7 ± 2.3: 4.2 ± 2.5 for the males and 5.4 ± 1.7 for the females. Studies of physical fitness testing of emergency responders utilised the one-minute sit up test. However, the study by Thornton and Sayers (2014), which evaluated the paramedic pre-employment fitness screening test results of 251 Bachelor Paramedic Science students in Australia, made use of the 7-stage abdominal strength test. The results for the male participants were quite similar to the results of the males in the assessment of physical preparedness (4.2 ± 2.5 vs. 4.3 ± 2.0); but the female participants in the assessment of physical preparedness performed better than those in this study (5.4 ± 1.7 vs. 3.7 ± 1.7) (Thornton and Sayers 2014). No statistically significant difference between the sexes was noted with the 7-stage abdominal strength test in the assessment of physical preparedness and in the study by Thornton and Sayers (2014).

Grip strength test:

This test is utilised to measure the maximum isometric muscular strength of both the hand and forearm muscles (Hoffman 2006). The emergency care provider undertakes a number of demanding tasks which require an adequate grip strength, such as lifting; lowering; loading; unloading; pushing; pulling and carrying of patients and heavy rescue equipment (Armstrong *et al.* 2019b). Stretcher loads in wilderness search and rescue can exceed 100kg, and the rescuers are expected to carry this load over unstable and uneven terrain (Conolly, Elder and Dawes 2015). Grip strength is one of the best predictors of an individual's capacity to carry a 90kg patient and individuals who have a greater grip strength have also been shown to maintain high quality chest compressions during cardiopulmonary resuscitation (CPR) (Armstrong *et al.* 2019b). Poor grip strength can result in an emergency care provider or rescuer dropping a patient or not being able to carry some of the essential equipment.

The mean score in kilograms for the grip strength test for the total population was 38.5 ± 9.7; 45.7 ± 4.9 for the males and 28.8 ± 4.7 for the females. These results are quite similar to the results for the male and female emergency care providers in the study by Mthombeni *et al.* (2020) (45.7 ± 4.9 vs. 43.6 ± 7.5 for the males and 28.8 ± 4.7 vs. 31.2 ± 5.5 for the females) (Mthombeni, Coopoo and Noorbhai 2020a). In the study by Thornton and Sayers (2014), the results for the male and female paramedic students were slightly higher than the males and females in this assessment of physical preparedness (45.7 ± 4.9 vs. 51.1 for the males and 28.8 ± 4.7 vs. 34.7 ± 7.3 for the females). There was a statistically significant difference between the grip strength of the male and female participants in this assessment of physical preparedness. Weight, BMI and body fat percentage had a statistically significant effect on the results of the grip strength test, as the heavier participants with a high BMI, but low body fat percentage, had a better grip strength. This is similar to the finding in the maximum push-up test, where participants with more muscle mass performed better.

Applying Pearson's correlation for the flexed-arm hang test with the three additional tests of muscular endurance and muscular strength, there was a weak positive correlation (r = 0.258) with the grip strength test; a weak negative correlation (r = –0.077) with the 7-stage abdominal strength test; and a moderate-to-low correlation (r = 0.452) with the maximum push-up test. As each of these tests measures a different aspect of muscular endurance and muscular strength, and as there were no strong correlations, there is sufficient evidence to suggest that all four of these tests should appear in the battery of fitness tests for the BHSc EMC student.

7.4.4.4 Flexibility

Flexibility assesses an individual's ability to move a muscle or group of muscles through a full range of motion (Hoffman 2006). Maintaining flexibility of joints facilitates movement and may reduce the risk of injury and lower back pain (American College of Sports Medicine 2018). The modified sit-and-reach test was utilised to assess lower back and hamstring flexibility, with an emphasis on hamstring flexibility (National Strength and Conditioning Association 2012). Flexibility was not previously assessed as part of the current physical preparedness assessment tool (Table 3.6 in Chapter 3). However, it was determined an important component of fitness by the academic staff and emergency medical care students during the focus group interviews.

The mean result for the modified sit-and-reach test in centimetres for the total population was 30.3 ± 9.7: 28.6 ± 9.3 for the males and 32.7 ± 9.9 for the females. These results are quite similar to the results for the paramedic students in the Thornton and Sayers (2014) study (28.6 ± 9.3 vs. 29.2 ± 8.5 for the males and 32.7 ± 9.9 vs. 30.7 ± 8.1 for the females). The results were slightly higher for the male and female emergency care providers in the North West Province study (28.6 ± 9.3 vs. 34.3 ± 8.1 for the males and 32.7 ± 9.9 vs. 37.9 ± 7.2 for the females) (Mthombeni, Coopoo and

Noorbhai 2020a). There were no significant differences between the flexibility measurements of the male and female participants, and none of the anthropometric measurements had a significant effect on the results of the modified sit-and-reach test.

The modified sit-and-reach test showed a very low correlation (r = 0.099 & r = –0.010) with the 200m and 400m swim tests. There was also a low correlation (r = 0.207) with the 5km run test. As flexibility is seen as an important component of fitness, and there were low correlations with all the other physical fitness tests, the modified sit-and-reach test, as a test of flexibility, should form part of the battery of fitness tests for the BHSc EMC students.

7.4.5 Differences between males and females in the physical fitness tests

Differences in the physical characteristics of the sexes that relate to job performance in physically strenuous tasks include body composition, muscular endurance, and cardiovascular endurance. Males are generally taller, with a higher body weight and less body fat than females. It is also well documented that females have approximately 70–75% of lower body, and 40–60% of upper body, strength compared to males. Based on this, and due to the smaller stature of females, they tend to utilise a greater percentage of their muscular strength capacity to move the same object, than a male would. Therefore, females tend to fatigue faster. Females also have VO_{2max} levels that are 15–30% lower than a moderately fit male (Roberts *et al.* 2016).

In this assessment of physical preparedness, statistically significant differences were found between the sexes (males vs. females) for several of the physical fitness tests, with males showing superior ability in muscular strength, muscular endurance and aerobic capacity (cardiovascular endurance). This was also a finding in the study by Thornton and Sayers (2014), where the male participants scored higher in the cardiovascular fitness and muscular strength tests. Based on these differences, age and gender-based fitness norms were commonly utilised when setting standards for physical preparedness assessments as there was no data to suggest the use of an absolute standard.

However, an important point to remember is that, despite these physical differences and performances in the different physical fitness tests, the male and female BHSc EMC students are assessed against the same minimum standards as determined by the Professional Board for Emergency Care (PBEC), irrespective of these differences (Professional Board for Emergency Care 2019). Male and female emergency responders have the same job function and they are required to perform the same essential, critical job-related tasks (Thornton and Sayers 2014).

A physical preparedness assessment tool in the context of the BHSc EMC programme represents the minimum level of fitness required to perform the associated job tasks and should focus on the essential components of fitness required for the student to engage successfully with the physically strenuous learning outcomes of the BHSc EMC programme (Armstrong *et al.* 2019b; Farrell 2017; Roberts *et al.* 2016). Discrimination in the context of a physical employment standard (PES) for emergency responders is permitted, provided job-relatedness has been established, as a certain standard needs to be met in order to ensure that the emergency responder is able to perform the job-related tasks safely and efficiently (Cooper 2014; Siddall *et al.* 2021; Tofari, Treloar and Silk 2013).

Despite these differences in performance between the sexes in the different physical fitness tests, appropriate physical training can be utilised to improve performance during physically demanding job tasks in both males and females. Intervention strategies that focus on exercise, conditioning and resistance should be considered and implemented in order to ensure that individuals entering into any of the life-saving professions as an emergency responder are able to achieve the minimum physiological, fitness and strength profiles required of them in order to safely and efficiently execute the tasks associated with their chosen profession (Davies, Naidoo and Parr 2008; Roberts *et al.* 2016). Individualised physical training programmes may serve as an intervention strategy for BHSc EMC students over and above their scheduled group physical training sessions. This will ensure that they are able to meet the required minimum levels of physical preparedness to engage successfully with the physically strenuous learning outcomes of the BHSc EMC programme.

This is an important point that will need to be considered when setting the standard scores or norms for the different physical fitness tests that will make up the design of the physical preparedness assessment for the BHSc EMC students. As an example: Although the mean time for the flexed-arm hang test was 51.5 ± 18.4 seconds for the males and 38.2 ± 17.6 seconds for the females, the standard score or norm that would result in a pass of 50% for the flexed-arm hang test should be determined as the minimum time in seconds required by an EMC student to ensure that they are able to engage successfully with the physically strenuous content of the BHSc EMC programme where this component of fitness applies.

7.5 CONCLUSION

The results from the testing that made up the final phase of this study were presented in this chapter. The testing enabled the researcher to determine to what extent the current physical preparedness assessment tool was capable of producing valid results which accurately assessed the emergency medical care student's ability to engage successfully in the physically strenuous learning outcomes associated with the Bachelor of Health Science Degree in Emergency Medical Care (BHSc EMC) programme and whether there was a need to adjust and/or refine the current physical preparedness assessment tool, based on the results from this assessment of physical preparedness. The proposed physical preparedness assessment tool for South African EMC students will be presented in Chapter 8.

CHAPTER 8: A PHYSICAL PREPAREDNESS ASSESSMENT TOOL FOR EMC STUDENTS

8.1 INTRODUCTION

This chapter will present the physical preparedness assessment tool which has been developed and validated to assess the task-oriented physical preparedness of emergency medical care (EMC) students registered for the Bachelor of Health Science Degree in Emergency Medical Care (BHSc EMC). An exploratory sequential mixed methods design was utilised to develop this scientifically validated physical preparedness assessment tool and the results of these different phases of data collection were presented in detail in previous chapters: literature review (Chapter 3); survey questionnaire (Chapter 5); focus group interviews (Chapter 6); and task-oriented physical preparedness test (Chapter 7). In this chapter, a brief reminder of the purpose of the physical preparedness assessment tool will be provided and the structure of the scientifically validated physical preparedness assessment tool will be presented. An overview of the assessment will be provided, along with a guideline detailing the implementation of the physical preparedness assessment tool.

As the purpose of this chapter is to present the tool which was developed as a result of this research study, the central aims and objectives of this study are reiterated.

8.2 AIM

As mentioned in Chapter 1, the central aim of this study was to develop and validate a tool that could be used to assess the task-oriented physical preparedness of South African emergency medical care students.

8.3 OBJECTIVES

In order to address the aim as described above, the following research objectives were derived:

1. Develop new knowledge and insights that describe the context of physical preparedness in the field of emergency medical care and medical rescue and how this relates to the BHSc EMC programme.

2. Investigate and describe the views and opinions of academics and senior emergency medical care students regarding (a) the physical requirements/task-oriented activities linked to participation in the BHSc EMC programme and (b) the extent to which they feel their current physical preparedness assessment tool adequately assesses task-oriented physical preparedness.

3. Investigate and describe the correlation between the levels of physical fitness required to perform task-oriented activities related to the Medical Rescue and Emergency Medical Care modules, and the level of fitness required to pass the current physical fitness assessment. Lastly, through triangulation and critical reflection on the new knowledge and outcomes flowing from completion of the above three research objectives, the researcher developed and validated a tool for the assessment of task-oriented physical preparedness for South African emergency medical care students.

8.4 PURPOSE OF THE PHYSICAL PREPAREDNESS ASSESSMENT TOOL FOR EMC STUDENTS

The BHSc EMC programme focuses on both emergency medical care as well as medical rescue, unlike many of the internationally offered degree programmes, which are more generic in nature, with the focus on emergency medical care and community primary care. As part of the four-year BHSc EMC programme, students are exposed to theoretical knowledge of emergency medical care, as well as real-world care of ill and injured patients in the emergency medical care and medical rescue context, in line with the list of capabilities of an Emergency Care Practitioner (ECP) (Professional Board for Emergency Care 2019). Emergency medical care and medical rescue work are physically strenuous and they place demands on the emergency care provider, both in terms of strength and endurance (Hogya and Ellis 1990; Mthombeni, Coopoo and Noorbhai 2020a). An appropriate level of physical preparedness is required for emergency responders to engage successfully in physically strenuous tasks (Siddall *et al.* 2021).

Task-oriented physical preparedness deals with the degree to which an individual is able to cope with the physical demands of their chosen profession without excessive fatigue (Vinciguerra *et al.* 2013). Due to the dual nature of the BHSc EMC programme, the EMC students are exposed to several different disciplines. This diversity is unique, as other emergency responder professions such as lifeguards, firefighters and police officers have very focused job tasks with very specific physical demands.

The ideal physical preparedness assessment tool represents the minimum level of physical preparedness required by an EMC student to engage successfully with the physically strenuous learning outcomes of the BHSc EMC programme. It should prioritise the essential components of fitness required for success, rather than emphasising task-specific fitness tests. This point was fundamental in the development of the scientifically validated physical preparedness assessment tool for EMC students, due to the diverse nature of the curriculum. The physical preparedness assessment, in the context of the BHSc EMC programme, is linked to the Physical Preparedness module which appears as a stand-alone module in the curriculum at the three participating higher education institutions (HEIs) in order to ensure that the EMC student has an adequate level of task-oriented physical preparedness to engage with the diverse practical demands of the Emergency Medical Care and Medical Rescue modules.

8.5 STRUCTURE OF THE PHYSICAL PREPAREDNESS ASSESSMENT TOOL FOR EMC STUDENTS

The validated physical preparedness assessment tool for South African EMC students is presented in Figure 8.1. The assessment includes the modified sit-and-reach test as a test of flexibility. This test is performed first, prior to any of the other physical fitness tests. Once this test of flexibility is complete, the student will move on to the four tests which were selected to assess muscular strength and muscular endurance. These four tests are presented in rotational stations, and there is no need for the student to rest between these four different tests, as each test assesses a different muscle group (Figure 8.2). Once the student has completed all four of these physical fitness tests of muscular strength and muscular endurance, the student must have a rest period of at least 15 minutes. The reason for the 15-minute break will be explained in Section 8.7.3. The student will then complete the 5km run test as the test for aerobic capacity, which is again followed by a 15-minute rest. Lastly, the student will complete the 200m swim test as a test of swimming aerobic capacity. The assessment type, physical fitness tests and the implementation of the physical preparedness assessment tool will be defended later in Chapter 8.

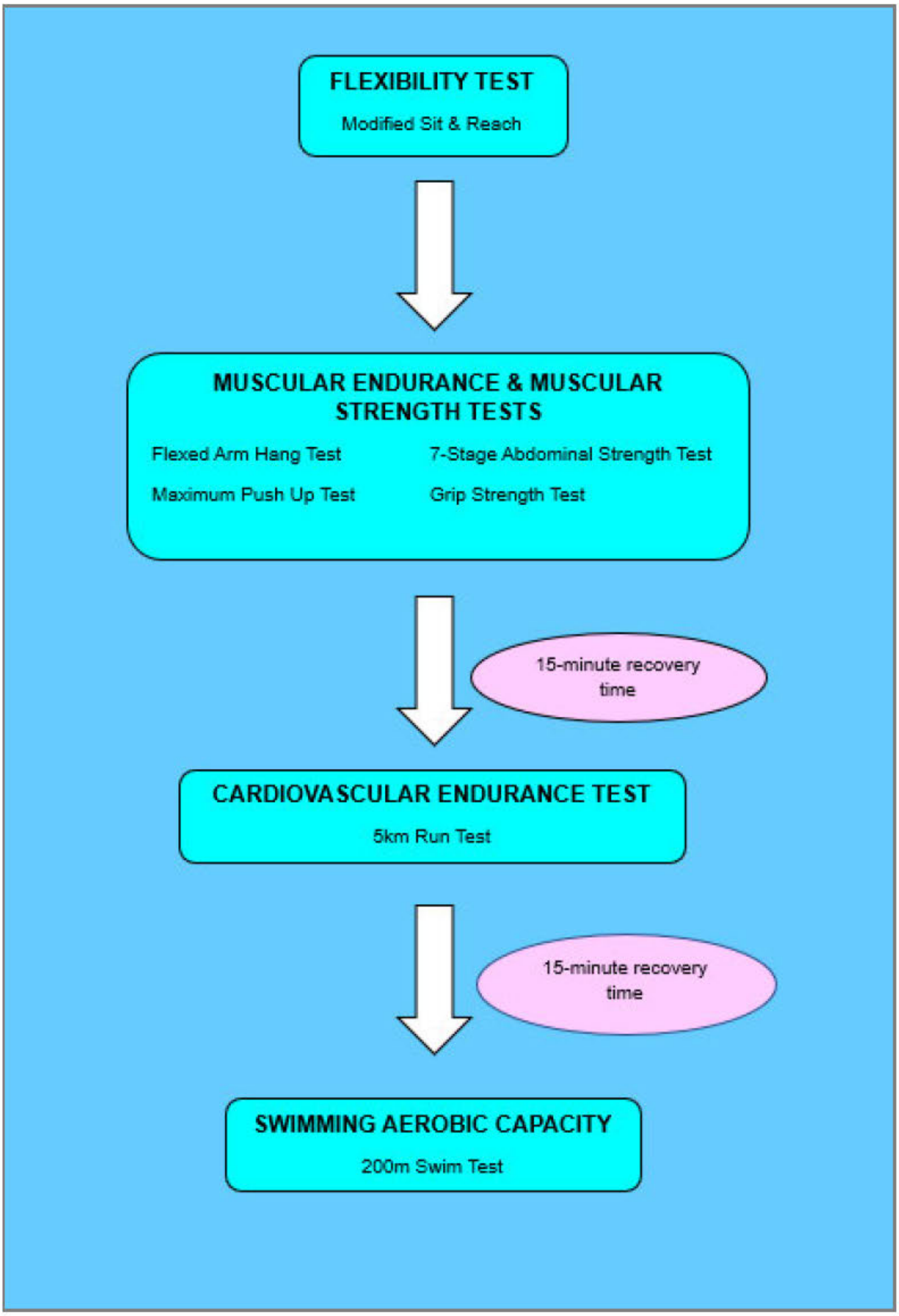


Figure 8.1: Physical preparedness assessment tool for EMC students

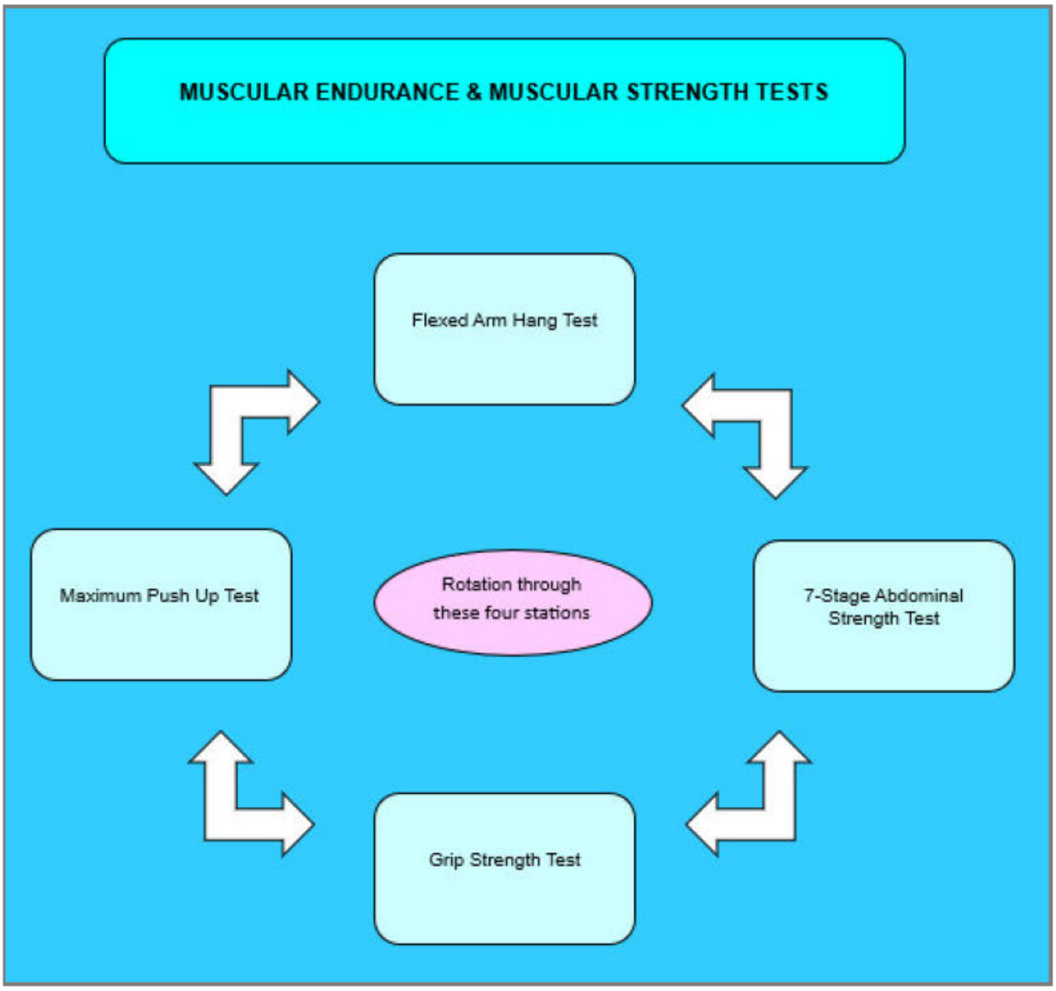


Figure 8.2: Rotational testing stations of muscular strength and muscular endurance

8.6 OVERVIEW OF THE PHYSICAL PREPAREDNESS ASSESSMENT TOOL FOR EMC STUDENTS

8.6.1 Physical performance test format

The purpose of administering a physical preparedness assessment to emergency responders is to ensure that they have the physical capacity required to perform the operational tasks associated with their chosen profession. The physical preparedness assessment can either take on the structure of a task-simulated assessment or that of a physical performance test. A task-simulated assessment consists of realistic scenarios or task reconstructions which are designed to replicate the physical demands of the chosen profession in terms of the physical effort, work layout and dynamic movements (Armstrong *et al.* 2019a; Siddall *et al.* 2021). A task-simulated assessment is typically of prolonged duration, and they are resource-intensive as they require bespoke training locations as well as specialised equipment and support. The task reconstructions also require the participant to be technically proficient and are, therefore, not always suitable to assess the physical preparedness of pre-trained participants and/or students who are still in the early stages of an academic programme, such as the first- or second-year students on the BHSc EMC programme (Siddall *et al.* 2021). The task-simulated assessment is not always a viable option as it can be impractical to implement, especially in diverse jobs (Carstairs *et al.* 2018). During the focus group interviews, this point was highlighted by one of the academic staff participants: *"… It would almost probably be impossible to try and mimic every single task that a student may potentially do." (Academic 5).* When administering a physical preparedness assessment to a large group of people, the assessment tool needs to be easily implementable in order to be effective (Carstairs *et al.* 2018).

A physical performance test is often preferred by organisations as the tests are easily replicable and less resource intensive, and lower technical proficiency is required by the participants (Roy *et al.* 2010). When developing a physical performance test, the key fitness components, such as muscular endurance, muscular strength and cardiovascular endurance, required to perform the operational tasks successfully must be understood in order to ensure that valid, appropriate physical fitness tests are selected (Siddall *et al.* 2021). If the key fitness components are identified correctly, a limited number of physical fitness tests can be utilised to predict performance across a range of operational tasks (Carstairs *et al.* 2018).

The physical performance test format was selected for the physical preparedness assessment tool for South African EMC students as it was seen as the preferred approach to assess general physical fitness as part of the Physical Preparedness module in the BHSc EMC programme. The HEIs accredited to present the BHSc EMC programme in South Africa by the Council on Higher Education (CHE) and the Professional Board for Emergency Care (PBEC) have approximately 120 students registered across the four years of the programme, with the majority in the first and second years of study, with limited technical proficiency. A task-oriented physical preparedness assessment in the form of a physical performance test is simple to administer to a large group of students, and the assessment is less resource-intensive (Carstairs *et al.* 2018).

Task-simulated assessments could perhaps be utilised as the approach to assess specific, physically strenuous, tasks within the different Medical Rescue modules in the BHSc EMC programme, as this would then ensure that the students are technically proficient in the required skillset to complete the selected tasks that comprise the task-simulated fitness test (Siddall *et al*. 2021).

8.6.2 Selected physical fitness tests for the different components of fitness

A total of seven physical fitness tests were selected for the scientifically validated physical preparedness assessment tool, developed to assess the task-oriented physical preparedness of EMC students registered for the BHSc EMC programme.

8.6.2.1 Flexibility

Flexibility was identified as an important component of fitness in the focus group interviews with the academic staff and fourth-year EMC students. Flexibility facilitates movement and may reduce the risk of injury (American College of Sports Medicine 2018; Kozlenia and Domaradzki 2021). As one of the student participants in the focus group interview succinctly stated when discussing the relationship between flexibility and injury reduction: *"… If you don't have good range of motion for your muscles, you're likely to get injured lifting something heavy…" (Student 4).* The modified sit-and-reach test was selected to assess the flexibility of the EMC students. This test is an indirect measure of flexibility and it assesses flexibility of the lower back, hips and hamstrings with a focus on hamstring flexibility (Hoffman 2006). The modified sit-and-reach test was selected over the sit-and-reach test as this allowed the researcher to note the zero point for each participant, which negated the bias due to the different limb lengths of the participants (Hoffman 2006).

8.6.2.2 Muscular strength and muscular endurance

Four tests were selected to assess the muscular strength and muscular endurance of the EMC students, namely the flexed-arm hang test, the maximum push-up test, the 7-stage abdominal strength test and the grip strength test. The participants were required to complete the flexed-arm hang test as part of the task-oriented physical preparedness test, and as there was a weak positive correlation with the grip strength test, a weak negative correlation with the 7-stage abdominal strength test, and a moderate-to-low correlation with the maximum push-up test, all four physical fitness tests were selected to form part of the scientifically validated task-oriented physical preparedness assessment for EMC students, as each of these tests focuses on a different aspect of muscular endurance and muscular strength required by an EMC student.

The flexed-arm hang test assesses upper body muscular strength and endurance as it is an isometric test assessing arm and shoulder girdle strength, upper body muscular endurance and weight relative muscular endurance (Clemons *et al.* 2004). The maximum push-up test assesses upper body muscular endurance of the pectoralis major, anterior deltoids and triceps. The 7-stage abdominal strength test assesses abdominal muscular endurance and the grip strength test assesses the maximum isometric strength of both the hand and forearm muscles (Hoffman 2006; Wood 2022a).

8.6.2.3 Cardiovascular endurance (aerobic capacity)

The Cooper 12-minute run test is a recognised physical fitness test of aerobic capacity, and during the task-oriented physical preparedness test, there was a high negative correlation between the Cooper 12-minute run test and the 5km run test (Hoffman 2006; Wood 2022b). This means that either of these two tests could be utilised to assess the aerobic capacity of EMC students in the context of the BHSc EMC programme. However, when one is given a choice between two valid tests, consideration should be given to economic implications, as well as ease of administration, when choosing between the two tests (National Strength and Conditioning Association 2016). When arranging the logistics for the task-oriented physical preparedness tests at the three participating HEIs, the researcher found that it was a challenge to source athletics tracks and/or other suitable terrain on which to administer the Cooper 12-minute run test within easy proximity to an accessible swimming pool in which to administer the swim test. It was also quite difficult to keep track of the laps completed, plus the additional distance covered in metres, within the 12-minute time limit for a large group of students for the Cooper 12-minute run test. The general feedback from the academic staff who assisted with the administration of the task-oriented physical preparedness test at the three participating HEIs was that the 5km run test was much easier to administer, and to monitor individual student performance, when compared to the Cooper 12-minute run test. Taking into consideration that a task-oriented physical preparedness assessment should be simple to administer to a large group of students, and that the assessment should not be resource-intensive, the researcher has elected to select the 5km run test as the test of aerobic capacity in the scientifically validated task-oriented physical preparedness assessment for EMC students (Carstairs *et al.* 2018).

8.6.2.4 Swimming aerobic capacity

A high positive correlation was found between the time taken to complete the 200m swim test and the 400m swim test, and as the purpose of the physical preparedness assessment is to assess general physical fitness, the 200m swim test was deemed sufficient to assess swimming aerobic capacity. The mean time to complete the 400m swim test for the total population was 10m 33.3s ± 1m 52.7s; and for the 200m swim test the mean time was 4m 40.2s ± 49.5s; and as the purpose of this test is to assess swimming aerobic capacity in the context of general physical fitness, the 200m swim test is more than adequate for this. The 400m swim test, along with other aquatic competencies such as an underwater swim and object retrieval, could, perhaps, be considered as part of a task-simulated assessment specifically designed for the Aquatic Rescue module.

8.7 GUIDELINES FOR THE IMPLEMENTATION OF THE TOOL

8.7.1 Description of the selected physical fitness tests

Table 8.1 provides a detailed description of the seven physical fitness tests which comprise the scientifically validated task-oriented physical preparedness assessment for EMC students. The detailed description will include the fitness component tested, the minimum equipment required for each test, a detailed description of each physical fitness test to assist with the movement standards, as well as the scoring method for the different tests. The intention of Table 8.1 is to assist as a guideline for the implementation of the scientifically validated task-oriented physical preparedness assessment tool, and this detailed description could be provided as a manual for the departments accredited to offer the BHSc EMC programme.

Table 8.1: Detailed guideline for the implementation of the seven physical fitness tests

Modified sit-and-reach test	**Fitness component**	Flexibility of the lower back, hips and hamstrings
	Equipment requirements	Sit-and-reach box with a ruler
	Test description	• The students must remove their shoes and wear comfortable clothing that will not restrict their movement. • The students must sit on the floor with their back and head against a wall with their hip joint at a 90° angle. • The students' legs must be straight with their knees flat against the floor and their feet flat against the sit-and-reach box. • The sit-and-reach box is placed in position against the students' feet by the academic staff member. • While seated against the wall, the student places one hand over the other while keeping in contact with the wall. • The academic staff member moves the ruler along the top of the box so that the zero point is at the tip of the student's fingertips. • Once the zero point has been established, the student is required to inhale and exhale slowly and, whilst exhaling, the student is required to slowly reach as far forward as possible, while pushing the sliding measurement scale along the top of the box. • The student's knees must not lift off the ground during this movement. • The student may not jerk or bounce to reach further. • The full reach position must be held for a period of two seconds. • At two seconds, the academic staff member records the score. • The same procedure of reaching as far forward as possible is repeated three times (American College of Sports Medicine 2018; Hoffman 2006; Wood 2022f).

	Scoring	The distance reached for the three attempts is recorded to the nearest centimetre, and the final score is the average of the three attempts.
Flexed-arm hang test	**Fitness component**	Upper body muscular strength and muscular endurance
	Equipment requirements	Horizontal overhead bar that is higher than the student's standing height, stopwatch and chair/step (optional)
	Test description	• The student may use a chair/step or the assistance of a spotter to raise themselves to a height at which their arms are flexed and their chin is above, but not touching, the bar. • The student is required to grasp the bar with an underhand grip (palms facing towards the body) with both their thumbs and fingers over the bar. The thumb may not wrap around the bar. • The student's legs must hang straight down, and they are not allowed to swing, bend their knees, or kick their feet. • The stopwatch is started as soon as the student is hanging in the correct position without any support. • The student is required to hang without support for the required time. • The time is stopped as soon as the student's chin touches or drops below the bar (Clemons *et al.* 2004; National Strength and Conditioning Association 2012; Wood 2022c)
	Scoring	The score is the total time in minutes and seconds.
Maximum push-up test	**Fitness component**	Upper body muscular endurance
	Equipment requirements	None
	Test description	• The student must complete as many push-ups as then can, with no time limit, until failure. • The student must start in the prone position with their hands and toes touching the floor.

		• The student's body and legs must be kept in a straight line and the arms must be shoulder-width apart with the fingers pointing forwards and the elbows pointing backwards. • The back and knees must be kept straight and the student must lower themselves down until their chest touches the clenched fist of an assistant, which should result in a 90° angle in the elbows of the student. • The student must push back up into the starting position with their arms in full extension and the elbows must lock with each extension. • This action is repeated without rest until the student cannot perform any more push-ups, or their push-up form is no longer correct. • Students are allowed two 'no touch' warnings, and on their third 'no touch' the test is stopped. • The push-up is performed with the same technique for both male and female students. There is no modified push-up for female students (American College of Sports Medicine 2018; Hoffman 2006; Wood 2022g).
	Scoring	The score is the number of repetitions completed with the correct form, as described above.
7-stage abdominal strength test	**Fitness component**	Abdominal muscular endurance
	Equipment requirements	2.5kg and 5kg weight plate
	Test description	• The student is required to lie supine on a flat surface with their knees flexed at right angles and their feet flat on the floor. • The student attempts one complete sit-up at each of the different levels (Table 8.2), in the prescribed manner, starting at Level 1. • A level is 'passed' if the student performs a single sit-up in the prescribed manner without their feet lifting off the floor. • A student is allowed a maximum of three attempts at a level before the test is stopped (Wood 2022a).

	Scoring	The highest level correctly performed by the student, out of the eight levels, is recorded.
Grip strength test	**Fitness component**	Muscular strength
	Equipment requirements	Digital hand dynamometer
	Test description	• The student is required to dangle their hands straight down next to the sides of their body ensuring that their hands do not touch the rest of their body. • The student is then required to squeeze the handgrip dynamometer as hard as they possibly can for approximately three seconds. • During this test, no other body movement is allowed, inclusive of any movement in the elbow joint. • This test is then repeated with the opposite hand. • Students have two attempts per hand, and if the scores differ by more than 5kg, the handgrip test is repeated for a third time with both hands (Hoffman 2006; Wood 2022d).
	Scoring	The final score is calculated, in kilograms, as the average score of the two or three attempts.
5km run test	**Fitness component**	Aerobic capacity
	Equipment requirements	400m athletics track or suitable route with limited elevation and road crossings; whistle and stopwatch
	Test description	• The students line up at the start line and wait for the whistle signalling the start. • The students run until they have completed the 5km distance. • If the test is administered on a 400m athletics track, the students are required to complete 12.5 laps of the 400m athletics track to complete the 5km distance; and the laps are marked off as the students cross the finish line marker.

	Scoring	The time taken to complete the 5km distance is recorded in minutes and seconds.
200m swim test	**Fitness component**	Swimming aerobic capacity
	Equipment requirements	25m or 50 swimming pool, whistle and stopwatch
	Test description	• The students are required to line up on one side of the pool and they are expected to start the swim test from in the water. • Students may not dive into the pool at the start of the test. • At the sound of the whistle, the stopwatch is started, and the students start swimming at their own pace. • The students may swim any stroke, although freestyle is recommended as it will maximise speed. • Students may make use of any turn, provided they touched the wall before turning. • Students may not walk or pull themselves along the wall and/or swimming lane to move forwards in the swimming pool. • Students swim until they have completed the 200m distance (4 lengths in a 50m swimming pool and 8 lengths in a 25m swimming pool). • No drafting is allowed.
	Scoring	The time taken to complete the 200m distance is recorded in minutes and seconds.

Table 8.2: Levels for the seven-stage abdominal strength test (Wood 2022a)

Level	Description
0	Cannot perform Level 1
1	With arms extended, the participant curls up so that their wrists reach their knees
2	With arms extended, the participant curls up so that their elbows reach their knees
3	With the arms held together across the abdomen, the participant curls up so that their chest touches their thighs
4	With the arms held across the chest, holding the opposite shoulders, the participant curls up so that their forearms touch their thighs
5	With the hands held behind the head, the participant curls up so that their chest touches their thighs
6	As per level 5, with a 2.5kg weight held behind the head, chest touching the thighs
7	As per level 5, with a 5kg weight held behind the head, chest touching the thighs

8.7.2 Rationale for the order of testing

A specific order in which the different physical fitness tests in the scientifically validated physical preparedness assessment tool for South African EMC students, as presented in Figure 8.1, should be administered has been suggested. The fundamental principle behind the selected testing sequence is that one physical fitness test should not affect the performance of a subsequent test and the testing sequence should allow for optimal performance in each test (National Strength and Conditioning Association 2016). The least-fatiguing tests should be performed first, and the most-fatiguing tests should be performed last (Hoffman 2006).

Any performance test that fatigues the athlete will confound the results of subsequent tests. As an example, an endurance exercise which precedes strength training appears to significantly decrease strength expression. However, no detrimental effects on endurance performance have been noted when strength is tested first (Hoffman 2006). A logical testing sequence would test in the following order: 1) non-fatiguing tests such as flexibility; 2) agility tests; 3) maximum power and strength tests; 4) sprint tests; 5) local muscular endurance tests; 6) fatiguing anaerobic capacity tests; and 7) aerobic capacity tests (National Strength and Conditioning Association 2016).

Based on this, the testing sequence for the seven physical fitness tests which make up the scientifically validated physical preparedness assessment tool for South African EMC students is as follows:

1. Non-fatiguing test of flexibility (modified-sit-and-reach test)
2. Local muscular endurance and strength tests (flexed-arm hang test / maximum push-up test / 7-stage abdominal strength test / grip strength test)
3. Aerobic capacity test (5km run test)
4. Swimming aerobic capacity test (200m swim test)

8.7.3 Recovery period between tests

When administering a battery of physical fitness tests, it is essential that time is included between tests to allow for adequate recovery. In general, tests that rely on the phosphagen energy system require between three to five minutes of rest for complete recovery; and after maximum performance, creatine phosphate recovery may take four minutes between maximal bouts. Maximal tests of the anaerobic glycolytic energy system, on the other hand, require at least 60 minutes for complete recovery (Hoffman 2006; National Strength and Conditioning Association 2016).

The selected physical fitness tests in the scientifically validated physical preparedness assessment tool for South African EMC students focus on flexibility, muscular endurance, muscular strength and aerobic capacity, and there are no tests that focus on anaerobic capacity. Taking this into consideration, it is recommended that there is at least a 15-minute rest to allow for full recovery between the following physical fitness tests: the four physical fitness tests selected to assess muscular strength and muscular endurance; the 5km run test and the 200m swim test.

The rest period between tests can be longer than the prescribed 15 minutes if logistical arrangements require this. An example could be that the traveling time between testing sites for the 5km run test and 200m swim test exceeds 15 minutes, and a time of 30 minutes is required to move between the two testing sites. If this is the case, consistency in the application of the adjusted rest time between different groups is critical to ensure that all students taking part in the physical preparedness assessment process have the same assessment experience.

8.7.4 Absolute standards for the normative standards

Statistically significant differences were found between the sexes (males vs. females) for several of the physical fitness tests in the task-oriented physical preparedness test, with males showing superior ability in muscular strength, muscular endurance and aerobic capacity (cardiovascular endurance). Despite these statistically significant differences, the male and female students registered for the BHSc EMC programme are assessed against the same minimum standards for all aspects of the programme, as determined by the Professional Board for Emergency Care (PBEC) (Professional Board for Emergency Care 2019). The purpose of the scientifically validated physical preparedness assessment tool for South African EMC students is to assess the minimum level of fitness required to perform the associated job tasks, and therefore this assessment focuses on the essential fitness components required for the student to engage successfully with the physically strenuous content of the BHSc EMC programme (Armstrong *et al.* 2019b; Roberts *et al.* 2016). This view was supported by the respondents in the questionnaire, as there was agreement amongst the student and academic staff respondents that the physical preparedness assessment should be the same for all students, irrespective of their age, sex, height or weight.

Based on this, absolute standards will be applied when determining the normative standards for the scientifically validated physical preparedness assessment tool for South African EMC students. Table 8.3 presents the mean results and standard deviations (SDs) of the total group, males and female participants, for the selected physical fitness tests which make up the scientifically validated physical preparedness assessment tool for South African EMC students. The determination of the normative standards for the different components of the assessment is beyond the scope of this particular study, as only the third and fourth-year EMC students were included as part of the population for this study; and it would not be accurate for the EMC student population as a whole if the normative standards were calculated based on the performance of the third and fourth-year EMC students without considering the performance of the first and second-year EMC students in the seven physical fitness tests.

Table 8.3: Mean results and standard deviations (SDs) of the total group, males and female participants, for the selected physical fitness tests

Variables	Combined (n=47)		Males (n=27)		Females (n=20)	
	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range
Modified Sit & Reach Test (centimetres)	30.3 ± 9.7	5.3–52.0	28.6 ± 9.3	5.3–44.7	32.7 ± 9.9	19.7–52.0
Flexed Arm Hang Test (seconds)	45.8 ± 19.1	7–93	51.5 ± 18.4	10-93	38.2 ± 17.6	7–70
Maximum Push Up Test (repetitions)	20.0 ± 14.8	1–61	26.7 ± 14.7	3-61	11.0 ± 9.3	1–33
7-Stage Abdominal Strength Test (level)	4.7 ± 2.3	0–7	4.2 ± 2.5	0-7	5.4 ± 1.7	0–7
Grip Strength Test (kilograms)	38.5 ± 9.7	21.9–57.7	45.7 ± 4.9	37.0-57.7	28.8 ± 4.7	21.9–38.1
5km Run Test (minutes/seconds)	28m59.6s ± 4m59.3s	20m30s–42m24s	26m37s ± 3m41s	20m30s–34m17s	32m13s ± 4m46s	24m09s–42m24s
200m Swim Test (minutes/seconds)	4m40.2s ± 49.5s	3m00s–6m05s	4m44s ± 45s	3m20s–5m56s	4m35s ± 55s	3m00s–6m05s

n = number of participants
SD = Standard deviation

8.8 CONCLUSION

This chapter has provided an explanation of the purpose of the physical preparedness assessment tool for EMC students, along with details of the structure of the assessment tool, with an overview of the selected format and physical fitness tests. A guideline for the implementation of the scientifically validated physical preparedness assessment tool for South African EMC students was also included to ensure that the HEIs accredited to present the BHSc EMC programme have a detailed guideline to implement the assessment tool. The chapter concluded with the setting of absolute standards as the normative standards for the selected physical fitness tests. In Chapter 9, an overview of the study will be provided, along with the conclusion, recommendations and limitations. The researcher believes that a larger number of students need to be tested in order to develop norms.

CHAPTER 9: SUMMARY, RECOMMENDATIONS AND CONCLUSION

9.1 INTRODUCTION

In this final chapter, the researcher will summarise and conclude the study. Its potential value and contribution to the profession are discussed, along with possible limitations and recommendations.

9.2 SUMMARY

In this study, the researcher developed a scientifically validated physical preparedness assessment tool for South African emergency medical care (EMC) students. The purpose of this tool is to assess task-oriented physical preparedness to ensure that the EMC students are physically prepared to engage successfully with the physically strenuous content of the Bachelor of Health Science Degree in Emergency Medical Care (BHSc EMC). The Professional Board for Emergency Care (PBEC), as the regulator of the profession, prescribes the minimum standards for the professional degree in emergency care. However, prior to this research, there were no regulated standards for the physical preparedness requirements, and the higher education institutions (HEIs) presenting the BHSc EMC programme were making use of physical preparedness assessment tools which had not been the focus of robust scientific scrutiny. The rationale, importance and benefit of designing a scientifically validated physical preparedness assessment tool was argued and discussed in Chapter 1.

The selected physical fitness tests which comprise the scientifically validated physical preparedness assessment tool were informed and validated by the application of a carefully selected mixed-method design, along with the associated research methods. The research methods for this study consisted of a literature review, a survey questionnaire, focus group interviews, and an assessment of physical preparedness. The selected research methods were described and discussed in detail in Chapter 4.

The results of the literature review were presented in Chapter 3. Although there was a significant amount of literature focusing on the physical preparedness requirements and assessment tools for paramedics, military personnel, police officers and firefighters, there was a paucity of literature focusing on the task-oriented physical preparedness and the assessment thereof for emergency care providers who engage in both EMC and medical rescue as part of their studies and operational duties. The knowledge obtained from the literature review was utilised to develop the content for the survey questionnaire.

Chapter 5 described and discussed the results and findings of the survey questionnaire. The intention of the questionnaire was to investigate and describe the opinions of the academic staff and emergency medical care students regarding the physical requirements and task-oriented activities linked to participation in the BHSc EMC programme, and to explore the extent to which they feel their current physical preparedness assessment tool adequately assesses task-oriented physical preparedness. The results of the questionnaire provided clarity on several key aspects concerning the assessment of task-oriented physical preparedness of the BHSc EMC students. The emergency medical care students and academic staff agreed that there were aspects of the BHSc EMC programme which were physically demanding and based on this, there was also agreement that BHSc EMC students and the lecturers presenting the programme content need to be physically fit. Swimming was also identified as an important life skill for a student on the BHSc EMC programme. There was also support from the academic staff and emergency medical care students that the physical training sessions are structured, and that attendance is compulsory. The academic staff and emergency medical care students also felt that the physical preparedness assessment tool should be standardised at the different universities and that the assessment criteria should be the same for all students irrespective of their age, sex, height or weight. The questionnaire contained (in the main) closed questions with preset response options, and the limitation of this approach was that it did not allow for the researcher to further explore, describe, and understand deeply the meaning of some of the responses. Key focus areas were identified to inform the agenda for the subsequent focus group interviews which would then allow for the deeper probing of these focus areas.

In Chapter 6, the researcher provided a description of the focus group interviews and the associated findings. The aim of the focus group interviews was to further investigate and describe the views and opinions of the academic staff and emergency medical care students regarding the physical requirements/task-oriented activities linked to participation in the BHSc EMC programme, and the extent to which they feel their current physical preparedness assessment tool adequately assesses task-oriented physical preparedness. Key focus areas were identified from the results of the survey questionnaire to inform the agenda for the focus group interviews. The focus group interviews allowed for a deeper probing of the understanding and feedback from both the emergency medical care students and academic staff involved in the Medical Rescue and/or Physical Preparedness modules of the BHSc EMC programme. The key focus areas which were identified for further enquiry and clarification included: 1) the current physical preparedness assessment being utilised, and which aspects are appropriate and/or not appropriate; 2) the use of task-simulated tests, versus physical performance tests, to assess the physical preparedness of the BHSc EMC students; and 3) the physically strenuous aspects of the BHSc EMC programme, and how these relate to the eleven components of fitness. There was agreement amongst the participants that the physical preparedness assessment tool should be standardised at the universities offering the BHSc EMC programme. The physical performance test was also determined to be the preferred type of physical fitness test to assess general physical fitness as part of the Physical Preparedness module on the BHSc EMC programme. The three core fitness components identified by both the academic staff and fourth-year students for the EMC students to engage successfully with the content of the physically strenuous Medical Rescue modules as well as the Clinical Learning module were cardiovascular endurance, muscular endurance, and muscular strength. One of the most important themes that emanated out of the focus group interviews was the need for a scientifically validated physical preparedness assessment tool which was specifically developed for the EMC student registered for the BHSc EMC programme.

The results from the focus group interviews were utilised to develop the assessment tool which was utilised to test the physical preparedness of the EMC student participants. Based on the feedback from the focus group interviews, the testing was conducted in the format of a physical performance test and the selected fitness tests tested the core fitness components which has been identified, namely: cardiovascular endurance, muscular endurance, and muscular strength. The aim of the physical performance testing was to scientifically determine if, and to what extent, the current physical preparedness assessment tool used by the universities is able to produce valid results which can be defended as an appropriate and accurate gauge of an emergency medical care student's ability to effectively participate in activities associated with the BHSc EMC.

Chapter 7 presented the results of the assessment of physical preparedness, along with a discussion of the results. The participants took part in testing which was conducted over six days – two days at each of the three participating universities. Demographic information as well as anthropometric measurements were collected from all the participants, and the results of all the physical fitness tests were captured. Statistical analysis which included descriptive statistics; regression analysis; Pearson's correlation; the independent samples t-test and the Mann-Whitney test. There was a high positive correlation ($r = 0.910$) between the 200m and 400m swim tests, however there were no significant differences between time taken by the male and female participants and none of the anthropometric measurements had a significant effect on either the 200m or 400m swim tests. There was a high negative correlation ($r = –0.751$) between the time taken to complete the 5km run test and the distance completed in the Cooper 12-minute run test. There were statistically significant differences in the distance completed by the male and female participants in the Cooper 12-minute run test ($p = 0.001$) and the time taken to complete the 5km run test ($p < 0.001$). Body fat percentage had a statistically significant effect ($p = 0.001$) on the distance completed by the participants in the Cooper 12-minute run test, as the higher the body fat percentage, the shorter the distance completed. In the 5km run test, height had a statistically significant effect on the time taken to complete the 5km distance, as the taller participants had longer strides, which resulted in faster times ($p = 0.027$).

Four physical fitness tests (flexed-arm hang test; grip strength test; maximum push-up test and 7-stage abdominal strength test) were utilised to assess muscular endurance and muscular strength. Applying Pearson's correlation for the flexed-arm hang test with the three additional tests of muscular endurance and muscular strength, there was a weak positive correlation ($r = 0.258$) with the grip strength test; a weak negative correlation ($r = –0.077$) with the 7-stage abdominal strength test; and a moderate-to-low correlation ($r = 0.452$) with the maximum push-up test. There was a significant difference in the times for the male and female participants in the flexed-arm hang test ($p = 0.016$) as well as a statistically significant difference between the number of repetitions completed by the male and female participants ($p < 0.001$). No statistically significant difference between the sexes was noted with the 7-stage abdominal strength test. There was however a statistically significant difference between the grip strength of the male and female participants ($p < 0.001$). Weight, body mass index (BMI) and body fat percentage all had an effect on the flexed-arm hang test as the heavier students recorded shorter times. Participants who were heavier, and with a higher BMI, but with a low body fat percentage, were able to complete a higher number of repetitions in the maximum push-up test and they had a better grip strength. Flexibility was the last component of fitness, which was tested, and there were no significant differences between the flexibility measurements of the male and female participants, and none of the anthropometric measurements had a significant effect on the results of the modified sit-and-reach test. The modified sit-and-reach test showed a very low correlation ($r = 0.099$ & $r = -0.010$) with the 200m and 400m swim tests. There was also a low correlation ($r = 0.207$) with the 5km run test.

The results of the assessment of physical preparedness enabled the researcher to scientifically determine if, and to what extent, the current physical preparedness assessment tool used by the universities is able to produce valid results which can be defended as an appropriate and accurate gauge of an emergency medical care student's ability to effectively participate in activities associated with the BHSc EMC, and to determine if there was a need to adjust and/or refine the historically-used physical preparedness assessment tool.

In Chapter 8, the researcher presented the validated physical preparedness assessment tool for South African EMC students which includes the modified sit-and-reach test, the flexed-arm hang test, maximum push-up test, 7-stage abdominal strength test, grip strength test, 5km run test and lastly the 200m swim test. A guideline for the implementation of the physical preparedness assessment tool was included and the guideline provides a detailed description of the selected physical fitness tests, the minimum equipment requirements for each test, and the rationale for the order of the testing and required recovery period between tests. Chapter 8 also includes the justification for selecting the physical performance test format to assess the task-oriented physical preparedness of the BHSc EMC students. The current physical preparedness assessment tool which was being utilised by the universities was able to produce valid results as this assessment consisted of the 200m swim test, the 5km run test and the flexed-arm hang test. All three of these physical fitness tests have been scientifically validated and included in the new physical preparedness assessment tool, however, additional physical fitness tests were included to address the shortfalls encountered with the current tool. These additions include the modified sit-and-reach test, grip strength test, 7-stage abdominal strength test and the maximum push-up test.

With the completion of this study, the researcher argues that the central aim, research questions and research objectives have been adequately addressed. The scientifically validated physical preparedness assessment tool for South African EMC students was developed through the triangulation and critical reflection of the new knowledge and findings which flowed from the literature review, the survey questionnaire, the focus group interviews and the assessment of physical preparedness.

9.3 VALUE AND UNIQUE CONTRIBUTIONS

Students enrolled in the BHSc EMC programme are exposed to both emergency medical care and medical rescue during their studies, as the two core modules for the programme are Emergency Medical Care and Medical Rescue. The learning outcomes of these two modules are physically strenuous and potentially hazardous. It is the responsibility of HEIs offering the BHSc EMC programme to develop, maintain, and assess the minimum level of task-oriented physical preparedness required for the EMC student to engage successfully with these physically strenuous learning outcomes. The minimum standards for the professional degree in EMC, as prescribed by the PBEC, identify physical preparedness as a fundamental component of the programme, as physical preparedness is mentioned under two of the exit level outcomes. However, no regulated standards for the physical preparedness requirements and assessment have been provided by the PBEC.

A significant amount of literature is available that deals with the physical preparedness requirements and related assessments for paramedics, military personnel, police officers and firefighters. However, there is a paucity of literature focusing on the assessment of physical preparedness for emergency care providers who engage in both EMC and medical rescue as part of their operational duties. During their studies, the EMC student is exposed to several different disciplines and learning environments, such as mountain rescue; water rescue; confined space rescue; rope rescue; and fire search and rescue. These diverse environments, in turn, mean that EMC students require physical abilities and attributes to allow them to participate successfully in each of the diverse learning experiences and environments they encounter during the course of their training which are physically strenuous. For this reason, universities offering emergency care programmes require a suitable assessment tool that is recognised as a pragmatic and valid way of assessing the physical preparedness of their students.

The lack of literature on this topic posed a challenge to the HEIs offering EMC programmes as, prior to this study, there was no scientific benchmark or set standard for the minimum physical preparedness requirements for EMC students. All the HEIs presenting the BHSc EMC programme require a certain level of physical preparedness of their EMC students. However, each HEI was utilising a different assessment tool, many of which were not scientifically validated and/or properly linked to the outcomes of the EMC and Medical Rescue modules.

This study has clearly identified the need for the continued inclusion of physical preparedness, and its assessment, within the BHSc EMC programme. In addition, the activities associated with the BHSc EMC programme which require the EMC student to be physically fit, and the fitness components which are required to engage successfully with the physically strenuous content of the BHSc EMC programme, were recognised. The validity and reliability of the current physical preparedness assessment tool (Table 3.6 in Chapter 3), which had found favour with, and anecdotal support from, the academic staff and EMC students at the three participating HEIs, was also tested during the assessment of physical preparedness. During the testing, the three physical fitness tests of the current physical preparedness assessment tool (Table 3.6 in Chapter 3), namely the 200m swim test, the 5km run test, and the flexed-arm hang test were scientifically validated. In addition, based on the findings from the focus group interviews and testing phases, a need was determined to include additional scientifically validated fitness tests to ensure a more holistic assessment of the EMC students' level of task-oriented physical preparedness.

The researcher's work provides a long-awaited, scientifically validated physical preparedness assessment tool to assess the task-oriented physical preparedness of South African emergency medical care (EMC) students registered on the BHSc EMC programme.

9.4 LIMITATIONS

Every effort was made by the researcher to enhance the validity and reliability of the research processes. However, as with any study, there were certain challenges and limitations. The researcher would like to acknowledge the following potential limitations associated with this study:

9.4.1 Limited published literature on the study focus area

The focus area for this study was BHSc EMC students, which are a unique group of emergency responders, as they are required to be proficient in both emergency medical care and medical rescue, due to the diverse nature of the curriculum. Several studies have been undertaken regarding the physical fitness requirements of police officers, paramedics, firefighters, and other emergency responders. However, there was a paucity of literature which focused specifically on emergency responders with a diverse operational skill set. Although the paucity of literature relating to the assessment of task-oriented physical preparedness in the context of EMC students required to function in both the emergency medical care and rescue environments was the driving factor behind the research topic, the lack of scientific literature did pose a challenge when the researcher was required to support findings and/or statements through references in the discussion of the results.

9.4.2 Impact of COVID-19

The COVID-19 restrictions in place at the three participating HEIs prevented the researcher from being able to conduct face-to-face interviews with the participants during the focus group interviews. Instead, the researcher made use of the online Microsoft Teams® platform to conduct the interviews. The limitation of this approach was that the researcher was unable to capture non-verbal cues during the interview process.

9.4.3 Facilities for the assessment of physical preparedness

The sporting facilities that the EMC departments use to administer their current physical preparedness assessments were utilised for the data collection in the assessment of physical preparedness. The current physical preparedness assessment uses the 5km run test as the test for aerobic capacity Not all the HEIs had access to an athletics track, which was required for the 12-minute Cooper run test, in close proximity to the municipal swimming pools which are utilised for the swim test. Based on these logistical challenges, a flat area large enough to administer the 12-minute Cooper run test was selected to administer the 12-minute Cooper run test at HEI 'B' and HEI 'C'.

9.4.4 Low response rate

The response rate for the survey questionnaire was 89.3% (117/131) for student respondents and 85.7% (12/14) for academic staff. The minimum sample size needed, with a 5% margin of error and a 95% confidence interval, was 98 students and 14 academic staff. The response rate by the academic staff was less than required. However, there were no additional academic staff who could be approached, and who met the inclusion criteria for the survey questionnaire. The researcher acknowledged that the academic staff sample size was very small, which may have affected some of the results for the survey questionnaire.

There was a low response rate for the assessment of physical preparedness, as only 47/112 (42.0%) students participated in the testing. Due to the low response rate, the researcher was unable to develop norms for the different physical fitness tests that were selected for the scientifically validated physical preparedness assessment tool for South African EMC students. A larger number of students will be needed to develop norms.

9.5 RECOMMENDATIONS

In this final section of the thesis, the researcher wishes to make selected recommendations regarding future practices, as well as the areas warranting further research.

9.5.1 Implementation of the developed tool

The scientifically validated physical preparedness assessment tool for South African EMC students registered on the BHSc EMC programme, along with the guidelines detailing the rationale behind the selected physical fitness tests, the test descriptions, equipment requirements, and scoring, should be presented to HEIs offering the programme. The researcher will make herself available to address any queries that either the academic staff and/or students may have regarding the selected physical fitness tests and the implementation of the tool.

9.5.2 Determination of normative standards

The determination of normative standards for the different components of the assessment was beyond the scope of this particular study, as only the third- and fourth-year EMC students were included in the population for this study, and it would not be accurate for the EMC student population as a whole if the normative standards had been calculated, based on the performance of the third- and fourth-year EMC students, without considering the performance of the first- and second-year EMC students in the selected physical fitness tests. In addition, the number of participants who took part in the testing during the assessment of physical preparedness was insufficient to develop norms.

It is recommended that further research is conducted in this area, and that an equally representative sample of both male and female EMC students across all four years of study on the BHSc EMC programme at the four HEIs offering the programme are selected as the population for a study. This study would aim to determine the normative standards for the scientifically validated physical preparedness assessment tool for South African EMC students.

9.6 Conclusions

Both the academic staff and student participants identified the need for EMC students to be physically fit to engage successfully with the physically strenuous content of the BHSc EMC programme. After analysis of the physically demanding activities associated with the BHSc EMC programme, it was determined that an EMC student requires the following fitness components: cardiovascular endurance (aerobic capacity); muscular endurance; muscular strength; flexibility; and swimming aerobic capacity. Scientifically validated physical fitness tests were then selected to test these different fitness components to design the scientifically validated physical preparedness assessment tool for South African EMC students.

REFERENCES

Aasa, U., Barnekow-Bergkvist, M., Ängquist, K. and Brulin, C. 2005. Relationships between work-related factors and disorders in the neck-shoulder and low-back region among female and male ambulance personnel. *Journal of Occupational Health,* 47(6): 481-489. Available: https://doi.org/10.1539/joh.47.481 (Accessed 7 March 2024).

Abel, M., Sell, K. and Dennison, M. 2011. Design and implementation of fitness programs for firefighters. *Strength and Conditioning Journal,* 33(4): 31-42. Available: https://doi.org/10.1519/SSC.0b013e318212f412

Adib-Hajbaghery, M. and Zohrehea, J. 2013. Back pain among paramedics: A pilot study. *Nursing and Midwifery Studies,* 2(4): 103-104. Available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4228908/

Adom, D., Hussein, E. and Agyem, J. 2018. Theoretical and conceptual framework: Mandatory ingredients of a quality research. *International Journal of Scientific Research*, 7(1): 438-441.

Adu, P. 2021. Qualitative data coding (conference presentation). Paper presented at the *VIIIth International Eurasian Educational Research Congress Online*.

Aljaloud, K. 2018. Do EMS college students fit enough for the future occupational? *Assiut Journal of Sport Science and Arts,* 3(5): 83-95. Available: https://doi.org/10.21608/ajssa.2018.138294

Allan, P. 2023. Learner guide 2023. Physical preparedness (VPHP 100-400). Department of Emergency Medical Care, Faculty of Health Sciences, Nelson Mandela University.

American Aquatics and Safety Training. 2022. *The lifeguard certification Test.* Available: https://lifeguardandsafetytraining.com/lifeguard-certification-test (Accessed 11 September 2022).

American College of Sports Medicine. 2018. *ACSM's guidelines for exercise testing and prescription*. 10th ed. Philadelphia, PA: Wolters Kluwer.

American College of Sports Medicine. 2019. *ACSM's health-related physical fitness assessment manual*. 5th ed. Baltimore: Lippincott Williams & Wilkins.

American College of Sports Medicine. 2023. *About ACSM*. Available: https://www.acsm.org/about (Accessed 4 April 2023).

American Council on Exercise. 2012. *Task performance and health improvement recommendations for emergency medical service practitioners*. United States of America: National Association of Emergency Medical Technicians.

Anney, V. 2014. Ensuring the quality of the findings of qualitative research: Looking at trustworthiness criteria. *Journal of Emerging Trends in Educational Research and Policy Studies*, 5(2): 272-281.
Available: https://www.scirp.org/reference/referencespapers?referenceid=3077301

Apuke, O. 2017. Quantitative research methods: A synopsis approach. *Arabian Journal of Business and Management Review (Kuwait Chapter),* 6(10): 40-47.
Available: https://doi.org/10.12816/0040336

Armstrong, D., Ross, G., Graham, R. and Fischer, S. 2019a. Considering movement competency within physical employment standards. *Work,* 63(4): 603-613.
Available: https://doi.org/10.3233/WOR-192955

Armstrong, D., Sinden, K., Sendsen, J., MacPhee, R. and Fischer, S. 2019b. Evaluating the effect of a strength and conditioning program to improve paramedic candidates' physical readiness for duty. *Work,* 63(4): 1-11.
Available: https://doi.org/10.3233/WOR-192953

Ashcroft, R., Dawson, A., Draper, H. and McMillan, J. 2007. *Principles of health care ethics*. 2nd ed. Hoboken, NJ: John Wiley & Sons, Ltd.

Auckland University of Technology. 2023. *Paramedicine Major - Bachelor of Health Science*. Available: https://www.aut.ac.nz/study/study-options/health-sciences/courses/bachelor-of-health-science/paramedicine-major
(Accessed 21 February 2023).

Baek, S., Park, J., Seo, D., Song, W., Lee, C., Lee, H., Ahn, Y. and Kang, H. 2018. Systematic review of varied exercise programs on body composition and physical fitness for firefighters. *The Asian Journal of Kinesiology,* 20(4): 1-11.
Available: https://doi.org/10.15758/ajk.2018.20.4.1

Barnekow-Bergkvist, M., Aasa, U., Angquist, K. and Johansson, H. 2004. Prediction of development of fatigue during a simulated ambulance work task from physical performance tests. *Ergonomics,* 47(11): 1238-1250.
Available: https://doi.org/10.1080/00140130410001714751

Bean, P. 2011. Perceptions amongst University of Johannesburg emergency medical care students towards mandatory physical training. Bachelor's Degree in Emergency Medical Care, University of Johannesburg.

Bennett-Woods, D. 2005. *Ethics at a glance*. Denver, CA: Regis University.

Beyera, G. K., O'Brien, J. and Campbell, S. 2021. Choosing a health behaviour theory or model for related research projects: a narrative review. *Journal of Research in Nursing,* 27(5): 436-446.
Available: https://doi.org/10.1177/17449871211051566

Blacker, S., Rayson, M., Wilkinson, D., Carter, J., Nevill, A. and Richmond, V. 2016. Physical employment standards for UK fire and rescue service personnel. *Occupational Medicine,* 66(1): 38-45.
Available: https://doi.org/10.1093/occmed/kqv122

Bolton, D. 2023. A revitalized biopsychosocial model: core theory, research paradigms, and clinical implications. *Psychological Medicine,* 53(16): 7504-7511. Available: https://doi.org/10.1017/s0033291723002660 (Accessed 9 February 2024).

Borg, G. 1998. *Borg's perceived exertion and pain scales*. Champaign, IL: Human Kinetics.

Burkholder, G., Cox, K., Crawford, L. and Hitchcock, J. 2019. *Research design and methods: An applied guide for the school practitioner*. Thousand Oaks, CA: SAGE Publications.

Busch, J. 2013. Are you fit for duty? *EMS World*, 42(10): 24-27.
Available: https://www.hmpgloballearningnetwork.com/site/emsworld/article/11143454/are-you-fit-duty

Buttar, K., Saboo, N. and Kacker, S. 2019. A review: Maximal oxygen uptake (VO2 max) and its estimation methods. *International Journal of Physical Education, Sports and Health*, 6(6): 24-32.
Available: https://www.kheljournal.com/archives/2019/vol6issue6/PartA/6-5-57-922.pdf

Buzga, M., Jirak, Z. and Buzgova, R. 2015. State of physical health and fitness of paramedics in Czech Republic. *Wulfenia*, 22(3): 205-212.

Callender, N., Ellerton, J. and Macdonald, J. 2011. Physiological demands of mountain rescue work. *Emergency Medicine Journal,* 29(9): 753-757.
Available: https://doi.org/10.1136/emermed-2011-200485

Campbell, P., Maupin, D., Lockie, R., Dawes, J., Simas, V., Canetti, E., Schram, B. and Orr, R. 2023. Evaluating the variability between 20-m multistage fitness test estimating equations in law enforcement recruits. *The Journal of Strength and Conditioning Research,* January: 1-7.
Available: https://doi.org/10.1519/JSC.0000000000004389

Campbell, S., Greenwood, M., Prior, S., Shearer, T., Walkem, K., Young, S., Bywaters, D. and Walker, K. 2020. Purposive sampling: complex or simple? Research case examples. *Journal of Research in Nursing,* 25(8): 652-661.
Available: https://doi.org/10.1177%2F1744987120927206

Carstairs, G., Ham, D., Savage, R., Best, S., Beck, B. and Billing, D. 2018. A method for developing organisation-wide manual handling based physical employment standards in a military context. *Journal of Science and Medicine in Sport,* 21(11): 1162-1167. Available: https://doi.org/10.1016/j.jsams.2018.02.008

Caspersen, C. J., Powell, K. E. and Christenson, G. M. 1985. Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. *Public Health Reports*, 100(2): 126-131. Available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1424733/

Chapman, D., Peiffer, J., Abbiss, C. and Laursen, P. 2015. A descriptive physical profile of Western Australian male paramedics. *Australasian Journal of Paramedicine,* 5(1). Available: https://doi.org/10.33151/ajp.5.1.403

Charles Sturt University. 2023. *Bachelor of Paramedicine*. Available: https://study.csu.edu.au/courses/allied-health-pharmacy/bachelor-paramedicine?utm_medium=referral&utm_source=seeklearning (Accessed 21 February 2023).

Cho, Y., Lee, Y., Lim, T. H., Chee, Y., Oh, J., Kim, W., Jang, S. and Kim, S. M. 2020. What muscles need to be trained for high-quality chest compression? *Australasian Emergency Care,* 23(4): 272-280. Available: https://doi.org/10.1016/j.auec.2020.06.002 (Accessed 9 February 2024).

Claessens, A. L., Van Langendonck, L., Moons, D. and Vandewiele, F. 2003. Physical fitness of professional firemen. *Kinesiology*, 35(2): 119-130. Available: https://hrcak.srce.hr/file/329877

Clemons, J., Duncan, C., Blanchard, O., Gatch, W., Hollander, D. and Doucet, J. 2004. Relationships between the flexed-arm hang and select measures of muscular fitness. *The Journal of Strength and Conditioning Research,* 18(3): 630-636. Available: https://pubmed.ncbi.nlm.nih.gov/15320679/

Coffey, B., MacPhee, R. and Fischer, S. Paramedic Association of Canada. 2014. *Paramedic physical demands analysis*. Canada: Defence R&D.

Coffey, B., MacPhee, R., Socha, D. and Fischer, S. 2016. A physical demands description of paramedic work in Canada. *International Journal of Industrial Ergonomics,* 53: 355-362. Available: https://doi.org/10.1016/j.ergon.2016.04.005

Conolly, M., Elder, C. and Dawes, J. 2015. Needs analysis for mountain search and rescue. *Strength and Conditioning Journal,* 37(4): 35-42. Available: https://doi.org/10.1519/SSC.0000000000000124

Cooney, G. M., Dwan, K., Greig, C. A., Lawlor, D. A., Rimer, J., Waugh, F. R., McMurdo, M. and Mead, G. E. 2013. Exercise for depression. *Cochrane Database of Systematic Reviews,* Issue 9: Article CD004366. Available: https://doi.org/10.1002%2F14651858.CD004366.pub6 (Accessed 7 March 2024)

Cooper, K. H. 2014. *The Cooper Institute: Law enforcement commonly asked questions*. Available: https://www.cooperinstitute.org/ (Accessed 10 February 2018).

Corbin, C. B. and Pangrazi, R. P. Arizona State University. 2012. *President's Council on Fitness, Sports & Nutrition*.

Council on Higher Education. 2016. *Council on Higher Education*. Available: http://www.che.ac.za/ (Accessed 7 August 2016).

Council on Higher Education. 2022. *Draft Qualification Standards Statement for the Diploma in Emergency Medical Care*, Communique 4 of 2021. Pretoria: Council on Higher Education.

Council on Higher Education. 2023. *CHE: About Us*. Available: https://www.che.ac.za/about-us/vision-mission-and-values (Accessed 4 April 2023).

Creswell, J. 2007. *Qualitative inquiry & research design: Choosing among five approaches*. 3rd ed. Thousand Oaks, CA: SAGE Publications.

Creswell, J. and Plano Clark, V. 2011. *Designing and conducting mixed methods research*. 2nd ed. Thousand Oaks, CA: SAGE Publications.

Creswell, J. W., Ebersohn, L., Eloff, I., Ferreira, R., Ivankova, N. V., Jansen, J. D., Nieuwenhius, J., Pietersen, J. and Plano Clark, V. L. 2016. *First steps in research 2*. 2nd ed. Pretoria: Van Schaik Publishers.

Dainty, R. and Gregory, D. 2017. Investigation of low back pain and shoulder demand during cardiopulmonary resuscitation. *Applied Ergonomics,* 58(1): 535-542. Available: https://doi.org/10.1016/j.apergo.2016.04.013

Davies, S., Naidoo, N. and Parr, B. 2008. Physical performance characteristics of South African male and female emergency care students. *Ergonomics,* 20(2): 3-14. Available: https://hdl.handle.net/10520/EJC33276

Davis, A. J., Maccarron, P. and Cohen, E. 2021. Social reward and support effects on exercise experiences and performance: Evidence from parkrun. *PLoS One,* 16(9): e0256546. Available: https://doi.org/10.1371%2Fjournal.pone.0256546 (Accessed 9 February 2024).

Davis, P., Dotson, C. and Santa Maria, D. 1982. Relationship between simulated fire fighting tasks and physical performance measures. *Medicine & Science in Sports & Exercise,* 14(1): 65-71.
Available: https://doi.org/10.1249/00005768-198201000-00013

De Vaus, D. 2001. *Research design in social research*. Thousand Oaks, CA: SAGE Publications.

de Waal, B. 2019. Study guide 2019. Physical assessment. Department of Emergency Medical Sciences, Faculty of Health & Wellness Sciences, Cape Peninsula University of Technology.

Di Bartolomeo, G. and Papa, S. 2019. The effects of physical activity on social interactions: The case of trust and trustworthiness. *Journal of Sports Economics,* 20(1): 50-71. Available: https://doi.org/10.1177/1527002517717299 (Accessed 9 February 2024).

Dilshad, R. and Latif, M. 2013. Focus group interview as a tool for qualitative research: an analysis. *Pakistan Journal of Social Sciences*, 33(1): 191-198. Available: https://www.bzu.edu.pk/PJSS/Vol33No12013/PJSS-Vol33-No1-16.pdf

Dlamini, T., Ndlovu, N. and Olifant, Y. 2019. Emergency medical care students' views on physical preparedness at a South African Higher Education Institute. Bachelor of Health Science in Emergency Medical Care, Durban University of Technology.

DUT Faculty of Health Sciences. 2020. Department of Emergency Medical Care and Rescue Handbook, Durban University of Technology

DUT Faculty of Health Sciences. 2023. Department of Emergency Medical Care and Rescue Handbook, Durban University of Technology

Edge Hill University. 2023. *Paramedic practice*.
Available: https://www.edgehill.ac.uk/course/paramedic-practice-bsc/#course-leaflet (Accessed 21 February 2023).

Eime, R. M., Young, J. A., Harvey, J. T., Charity, M. J. and Payne, W. R. 2013. A systematic review of the psychological and social benefits of participation in sport for adults: informing development of a conceptual model of health through sport. *International Journal of Behavioral Nutrition and Physical Activity,* 10, Article 135. Available: https://doi.org/10.1186%2F1479-5868-10-135 (Accessed 9 February 2024).

Elliott, R. and Timulak, L. 2007. Descriptive and interpretive approaches to qualitative research. *Psychology, Health & Medicine*, 12(1): 147-169.

Erasmus, E., Robertson, C. and van Hoving, D. J. 2018. The epidemiology of operations performed by the National Sea Rescue Institute of South Africa over a 5-year period. *International Maritime Health,* 69, 1: 1-7. Available: https://doi.org/10.5603/imh.2018.0001 (Accessed 9 February 2024).

Farlex. 2018. *The Free Dictionary by Farlex*. Available: https://www.thefreedictionary.com/Emergency+responders (Accessed 14 August 2019).

Farrell, S. 2017. *Fitness norms and fitness standards are apples and oranges*. Available: https://www.cooperinstitute.org/2017/05/17/fitness-norms-and-fitness-standards-are-apples-and-oranges (Accessed 14 August 2019).

Fass, B. 2016. *Why EMS personnel need a valid physical abilities test*. Available: https://www.ems1.com/ems-education/articles/149456048-Why-EMS-personnel-need-a-valid-physical-abilities-test/ (Accessed 14 August 2019).

Fetters, M. D., Curry, L. A. and Creswell, J. W. 2013. Achieving integration in mixed methods designs—Principles and practices. *Health Services Research,* 48(6 Pt 2): 2134-2156. Available: https://doi.org/10.1111%2F1475-6773.12117 (Accessed 9 February 2024).

Fischer, S., Sinden, K., MacPhee, R. and Team, T. O. P. S. R. 2017. Identifying the critical physical demanding tasks of paramedic work: Towards the development of a physical employment standard. *Applied Ergonomics,* 65(2): 233-239. Available: https://doi.org/10.1016/j.apergo.2017.06.021

Fortuin, J., Karangwa, I., Mahlalela, N. and Robertson, C. 2022. A South African epidemiological study of fatal drownings: 2016-2021. *International Journal of Environmental Research and Public Health,* 19(22): 15121. Available: https://doi.org/10.3390%2Fijerph192215121 (Accessed 9 February 2024).

Gamble, R., Stevens, A., McBrien, H., Black, A., Cran, G. and Boreham, C. 1991. Physical fitness and occupational demands of the Belfast ambulance service. *British Journal of Industrial Medicine,* 48(9): 592-596. Available: https://doi.org/10.1136/oem.48.9.592

Gillon, R. 1994. Medical ethics: Four principles plus attention to scope. *BMJ*, 309(6948): 184-188. Available: https://doi.org/10.1136/bmj.309.6948.184

Goddard, W. and Melville, S. 2001. *Research methodology: An introduction*. 2nd ed. Cape Town: Juta & Co, Ltd.

Gogo, S. and Musonda, I. 2022. The use of the exploratory sequential approach in mixed-method research: A case of contextual top leadership interventions in construction H&S. *International Journal of Environmental Research and Public Health,* 19(12): 1-20. Available: https://doi.org/10.3390/ijerph19127276 (Accessed 9 February 2024).

Goslin, A. 2020. Physical education in Gauteng schools, South Africa: A case study. *African Journal for Physical Activity and Health Sciences,* Supplement (December): 82-96. Available: https://doi.org/10.37597/ajphes.2020.s.6

Grace, L. 2012. Training and education for first response emergency personnel: an examination of physical fitness requirements for the State of California and the Federal Government. *Journal of Homeland Security Education*, 1(2): 29-41. Available: https://jsire.org/wp-content/uploads/sites/661/2018/09/finalgracetrainingeducation.pdf

Gravetter, F. and Forzano, L. 2015. *Research methods for the behavioral sciences*. 5th ed. Belmont, CA: Cengage Learning.

Gumieniak, R., Gledhill, N. and Jamnik, V. 2018. Physical employment standard for Canadian wildland firefighters: Examining test-retest reliability and the impact of familiarisation and physical fitness training. *Ergonomics,* 61(10): 1324-1333. Available: https://doi.org/10.1080/00140139.2018.1464213

Gutwirth, H., Williams, B. and Boyle, M. 2009. Rescuer fatigue in cardiopulmonary resuscitation: A review of the literature. *Journal of Emergency Primary Health Care,* 7(4): 1-9. Available: https://doi.org/10.33151/ajp.7.4.190

Hall, R. 2013. *Mixed methods: In search of a paradigm. In T. Lê & Q. Lê (eds.), Conducting research in a changing and challenging world*. New York: Nova Science Publishers, 71-78.

Halupa, C. 2023. *The impact and importance of instructional design in the educational landscape: Traditional and emerging instructional design models,* Ch. 9: 228-62. Available: http://dx.doi.org/10.4018/978-1-6684-8208-7.ch009 (Accessed February 2024).

Hansen, D., Vranckx, P., Broekmans, T., Eijnde, B., Beckers, W., Vandekerckhove, P., Broos, P. and Dendale, P. 2012. Physical fitness affects the quality of single operator cardiocerebral resuscitation in healthcare professionals. *European Journal of Emergency Medicine,* 19(1): 28-34. Available: https://doi.org/10.1097/MEJ.0b013e328347a2aa

Haripersad, D. 2023. Ladysmith flood death toll rises to 12 after bodies of father and son found. *The Citizen*, 28 December.
Available: https://www.citizen.co.za/news/ladysmith-flash-flood-christmas-death-toll-latest-28-december-2023/ (Accessed 9 February 2024).

Harman, E., Gutekunst, D., Frykman, P., Sharp, M., Nindl, B., Alemany, J. and Mello, R. 2008. Prediction of simulated battlefield physical performance from fieldexpedient tests. *Military Medicine,* 173(1): 36-41.
Available: https://doi.org/10.7205/MILMED.173.1.36

Heale, R. and Twycross, A. 2015. Validity and reliability in quantitative studies. *Evidence-Based Nursing,* 18(3): 66-67.
Available: https://doi.org/10.1136/eb-2015-102129

Health Professions Council of South Africa. 2018. *Overview of the Health Professions Council of South Africa*. Available: https://www.hpcsa.co.za/About (Accessed 28 July 2019).

Health Professions Council of South Africa. 2023. *Emergency care - Overview*.
Available: https://www.hpcsa.co.za/?contentId=0&menuSubId=45&actionName=For%20Professionals (Accessed 24 May 2023).

Hegg-Deloye, S., Brassard, P., Jauvin, N., Prairie, J., Larouche, D., Poirier, P., Tremblay, A. and Corbeil, P. 2014a. Current state of knowledge of post-traumatic stress, sleeping problems, obesity and cardiovascular disease in paramedics. *Emergency Medicine Journal,* 31(3): 242-247.
Available: https://doi.org/10.1136/emermed-2012-201672

Hegg-Deloye, S., Corbeil, P., Brassard, P., Prairie, J., Larouche, D., Jauvin, N., Carmichael, P., Poirier, P. and Tremblay, A. 2014b. Work-related and dietary factors associated with weight gain over the period of employment in paramedics. *Occupational Medicine and Health Affairs,* 2(4): 1-7.
Available: https://doi.org/10.4172/2329-6879.1000173

Hesse-Biber, S. and Leavy, P. 2011. *The practice of qualitative research*. 2nd ed. Thousand Oaks, CA: SAGE Publications.

Hoffman, J. 2006. *Norms for fitness, performance, and health*. Champaign, IL: Human Kinetics.

Hogya, P. and Ellis, L. 1990. Evaluation of the injury profile of personnel in a busy urban EMS system. *American Journal of Emergency Medicine,* 8(4): 308-311.
Available: https://doi.org/10.1016/0735-6757(90)90081-a

Humble, N. and Mozelius, P. 2022. Content analysis or thematic analysis – Similarities, differences and applications in qualitative research. In *European Conference on Research Methodology for Business and Management Studies*. University of Aveiro, Portugal.
Available: https://papers.academic-conferences.org/index.php/ecrm/article/view/316

Hunter, D., McCallum, J. and Howes, D. 2018. Defining exploratory-descriptive qualitative (EDQ) research and considering its application to healthcare (conference presentation). Paper presented at the *Worldwide Nursing Conference*.

Hunter, J., MacQuarrie, A. and Sheridan, S. 2019. Physical capacity of New South Wales ambulance paramedics. *Occupational Medicine,* 69: 534-540.
Available: https://doi.org/10.1093/occmed/kqz131

International Federation of Red Cross and Red Crescent Societies. 2022. *Emergency Plan of Action South Africa: Floods in KwaZulu Natal*.
Available: https://reliefweb.int/report/south-africa/south-africa-floods-kwazulu-natal-emergency-plan-action-epoa-dref-operation (Accessed 9 February 2024).

International Life Saving Federation. 2007. *Fitness testing for lifeguards*.
Available: https://www.ilsf.org/fitness-testing-for-lifeguards/ (Accessed 24 May 2023).

Iwinska, J. and Matei, L. 2014. *University Autonomy - A practical handbook*. The Yehuda Elkana Center for Higher Education at Central European University.

Kales, S. and Smith, D. 2017. Firefighting and the heart. *Circulation,* 135(14): 1296-1299. Available: https://doi.org/10.1161/CIRCULATIONAHA.117.027018

Kales, S., Soteriades, E., Christophi, C. and Christiani, D. 2007. Emergency duties and deaths from heart disease among firefighters in the United States. *The New England Journal of Medicine,* 356(12): 1207-1215.
Available: https://doi.org/10.1056/nejmoa060357

Kales, S., Tsismenakis, A., Zhang, C. and Soteriades, E. 2009. Blood pressure in firefighters, police officers, and other emergency responders. *American Journal of Hypertension,* 22(1): 11-20. Available: https://doi.org/10.1038/ajh.2008.296

Kapur, R. 2020a. Theories of pedagogy. Research paper, University of Delhi.
Available: https://www.researchgate.net/publication/345224426_Theories_of_Pedagogy (Accessed 9 February 2024)

Kapur, R. 2020b. Understanding the meaning and significance of pedagogical approaches. Research paper, University of Delhi.
Available: https://www.researchgate.net/publication/345317896_Understanding_the_Meaning_and_Significance_of_Pedagogical_Approaches (Accessed 9 February 2024)

Kaur, P., Stoltzfus, J. and Yellapu, V. 2018. Descriptive statistics. *International Journal of Academic Medicine,* 4(1): 60-63.
Available: https://doi.org/10.4103/IJAM.IJAM_7_18

Kesler, R., Deetjen, G., Bradley, F., Angelini, M., Petrucci, M., Rosengren, K., Horn, G. and Hsiao-Wecksler, E. 2018. Impact of SCBA size and firefighting work cycle on firefighter functional balance. *Applied Ergonomics,* 69(May): 112-119.
Available: https://doi.org/10.1016/j.apergo.2018.01.006

Kivunja, C. and Kuyini, A. 2017. Understanding and applying research paradigms in educational contexts. *International Journal of Higher Education*, 6(5): 26-41.
Available: https://doi.org/10.5430/ijhe.v6n5p26

Kozlenia, D. and Domaradzki, J. 2021. Prediction and injury risk based on movement patterns and flexibility in a 6-month prospective study among physically active adults. *PeerJ,* 9: e11399. Available: https://doi.org/10.7717%2Fpeerj.11399
(Accessed 9 February 2024).

Lad, U., Oomen, N., Callaghan, J. and Fischer, S. 2018. Comparing the biomechanical and psychophysical demands imposed on paramedics when using manual and powered stretchers. *Applied Ergonomics,* 70(6): 167-174.
Available: https://doi.org/10.1016/j.apergo.2018.03.001

Lavender, S. A., Conrad, K. M., Reichelt, P. A., Meyer, F. T. and Johnson, P. W, 2000. Postural analysis of paramedics simulating frequently performed strenuous work tasks. *Applied Ergonomics,* 31(1): 45-57.
Available: https://doi.org/10.1016/S0003-6870(99)00027-7 (Accessed 7 March 2024).

Lee, A., Steketee, C., Rogers, G. and Moran, M. 2013. Towards a theoretical framework for curriculum development in health professional education. *Focus on Health Professional Education*, 14(3): 64-77.
Available: http://researchonline.nd.edu.au/health_article/83/

Lehman, B., David, D. and Gruber, J. 2017. Rethinking the biopsychosocial model of health: Understanding health as a dynamic system. *Social and Personality Psychology Compass,* 11(8): 1-17. Available: https://doi.org/10.1111/spc3.12328

Lentz, L., Randall, J. R., Gross, D. P., Senthilselvan, A. and Voaklander, D. 2018. The relationship between physical fitness and occupational injury in emergency responders: A systematic review. *American Journal of Industrial Medicine,* 62(1): 3-13. Available: https://doi.org/10.1002/ajim.22929 (Accessed 9 February 2024).

Lesniak, A. 2017. The effect of personal protective equipment on firefighter occupational performance. Doctor of Philosophy, University of Kentucky.

Lessons, G., Bhakta, D. and McCarthy, D. 2022. Development of muscle mass and body fat reference curves for white male UK firefighters. *International Archives of Occupational and Environmental Health,* 95(5): 779-790. Available: https://doi.org/10.1007/s00420-021-01761-4

Leyk, D., Rohde, U., Erley, O., Gorges, W., Essfeld, D., Erren, T. and Piekarski, C. 2007. Maximal manual stretcher carriage: Performance and recovery of male and female ambulance workers. *Ergonomics,* 50(5): 752-762. Available: https://doi.org/10.1080/00140130701195063

Leyk, D., Rohde, U., Gorges, W., Ruther, T. and Witzki, A. 2017. Physical fitness of German soldiers 2010-2015. *Journal of Science and Medicine in Sport,* 20(2): S11. Available: https://doi.org/10.1016/j.jsams.2017.09.030

LifeMark. 2019. *LifeMark Health Management: The Paramedic Candidate - Physical Abilities Test (PC-PAT)*. Available: https://www.medaviehealthed.com/wp-content/uploads/2017/11/ParamedicCandidatepackageMedavieHealthEd.pdf (Accessed 25 October 2019).

Lindberg, A., Oksa, J., Gavhed, D. and Malm, C. 2013. Field tests for evaluating the aerobic work capacity of firefighters. *PLoS One,* 8(7): 1-8. Available: https://doi.org/10.1371/journal.pone.0068047

Liverpool John Moores University. 2023. *BSc (Hons) Paramedic Science*. Available: https://www.ljmu.ac.uk/study/courses/undergraduates/2023/paramedic-science (Accessed 21 February 2023).

Lockie, R. G., Dulla, J. M., Higuera, D., Ross, K. A., Orr, R. M., Dawes, J. J. and Ruvalcaba, T. J. 2022. Body composition and fitness characteristics of firefighters participating in a health and wellness program: Relationships and descriptive data. *International Journal of Environmental Research and Public Health,* 19(23): 15758. Available: https://doi.org/10.3390%2Fijerph192315758 (Accessed 7 March 2024).

Lockie, R., Dawes, J., Balfany, K., Gonzales, C., Beitzel, M., Dulla, J. and Orr, R. 2018. Physical fitness characteristics that relate to work sample test battery performance in law enforcement recruits. *International Journal of Environmental Research and Public Health,* 15(2477): 1-12. Available: https://doi.org/10.3390/ijerph15112477

López-Gonzalez, A., Sánchez-López, M., Garcia-Hermoso, A., López-Tendero, J., Rabanales-Sotos, J. and Martínez-Vizcaíno, V. 2016. Muscular fitness as a mediator of quality cardiopulmonary resuscitation. *American Journal of Emergency Medicine,* 34(9): 1845-1849. Available: https://doi.org/10.1016/j.ajem.2016.06.058 (Accessed 9 February 2024).

Louw, N. 2019. Learner guide 2019. Physical preparedness (VPHP 100-400). Department of Emergency Medical Care, Faculty of Health Sciences, Nelson Mandela University.

Lucía, A., de las Heras, J. F., Pérez, M., Elvira, J. C., Carvajal, A., Alvarez, A. J. and Chicharro, J. L. 1999. The importance of physical fitness In the performance of adequate cardiopulmonary resuscitation. *Chest,* 115(1): 158-164. Available: https://doi.org/10.1378/chest.115.1.158

Magness, S. 2024. Understanding stride rate and stride length. *Science of Running.* Available: https://www.scienceofrunning.com/2010/11/speed-stride-length-x-stride-frequency.html?v=47e5dceea252 (Accessed 9 February 2024).

Maguire, B. J., Hunting, K. L., Guidotti, T. L. and Smith, G. S. 2005. Occupational injuries among emergency medical services personnel. *Prehospital Emergency Care,* 9(4): 405-411. Available: https://doi.org/10.1080/10903120500255065 (Accessed 9 February 2024).

Maguire, B. J., O'Meara, P. F., Brightwell, R. F., O'Neill, B. J. and Fitzgerald, G. J. 2014. Occupational injury risk among Australian paramedics: an analysis of national data. *The Medical Journal of Australia,* 200(8): 477-480. Available: https://doi.org/10.5694/mja13.10941 (Accessed 9 February 2024).

Malm, C., Jakobsson, J. and Isaksson, A. 2019. Physical activity and sports—Real health benefits: A review with insight into the public health of Sweden. *Sports,* 7(5): 127. Available: https://doi.org/10.3390%2Fsports7050127 (Accessed 9 February 2024).

Martin, Z., Schlaff, R., Hemenway, J., Coulter, J., Knous, J., Lowry, J. and Ode, J. 2019. Cardiovascular Disease Risk Factors and Physical Fitness in Volunteer Firefighters. *International Journal of Exercise Science*, 12(2): 764-776. Available: https://pubmed.ncbi.nlm.nih.gov/31156744/

McDonald, C., Heggie, J., Jones, C., Thorne, C. and Hulme, J. 2013. Rescuer fatigue under the 2010 ERC guidelines, and its effect on cardiopulmonary resuscitation (CPR) performance. *Emergency Medicine Journal,* 30(8): 623-627. Available: https://doi.org/10.1136/emermed-2012-201610

McLafferty, I. 2004. Focus group interviews as a data collection strategy. *Journal of Advanced Nursing,* 48(2): 187-194. Available: https://doi.org/10.1111/j.1365-2648.2004.03186.x

Meadley, B., Caldwell, J., Perraton, L., Bonham, M., Wolkow, A., Smith, K., Williams, B. and Bowles, K. 2020. The health and well-being of paramedics – a professional priority. *Occupational Medicine,* 70(3): 149-151. Available: https://doi.org/10.1093/occmed/kqaa039

Meadley, B., Horton, E., Pyne, D., Perraton, L., Smith, K., Bowles, K. and Caldwell, J. 2021. Comparison of swimming versus running maximal aerobic capacity in helicopter rescue paramedics. *Ergonomics,* 64(3): 1-31. Available: https://doi.org/10.1080/00140139.2021.1910350

Mendez-Cornejo, J., Espinoza, R. V., Chau, G. K. H., Albornoz, C. U., Gomez-Campos, R. and Cossio-Bolanos, M. 2021. Body fat and aerobic capacity of physical education students from a Chilean university. *European Journal of Translational Myology,* 31(4). Available: https://doi.org/10.4081%2Fejtm.2021.10031 (Accessed 9 February 2024).

Merriam-Webster. 2023. *Pedagogy*. Available: https://www.merriam-webster.com/dictionary/pedagogy (Accessed 13 March 2023).

Michaelides, M., Parpa, K., Henry, L., Thompson, G. and Brown, B. 2011. Assessment of physical fitness aspects and their relationship to firefighters' job abilities. *The Journal of Strength and Conditioning Research,* 25(4): 956-965. Available: https://doi.org/10.1519/JSC.0b013e3181cc23ea

Millar, X. 2022. Physical assessment requirements for entry to BEMC rescue modules. Department of Emergency Medical Sciences, Faculty of Health & Wellness Sciences, Cape Peninsula University of Technology.

Mohajan, H. 2020. Quantitative research: A successful investigation in natural and social sciences. *Journal of Economic Development, Environment and People,* 9(4): 50-79. Available: https://doi.org/10.26458/jedep.v9i4.679

Morales, L., McEachern, B., MacPhee, R. and Fischer, S. 2016. Patient acuity as a determinant of paramedics' frequency of being exposed to physically demanding work activities. *Applied Ergonomics,* 56(3): 187-193. Available: https://doi.org/10.1016/j.apergo.2016.04.003

Morris, N. K., du Toit-Prinsloo, L. and Saayman, G. 2016. Drowning in Pretoria, South Africa: A 10-year review. *Journal of Forensic and Legal Medicine,* 37: 66-70. Available: https://doi.org/10.1016/j.jflm.2015.10.010 (Accessed 9 February 2024).

Mthombeni, S., Coopoo, Y. and Noorbhai, H. 2020a. Fitness levels of rural emergency medical and rescue service providers in the North West province, South Africa. *Occupational Health Southern Africa,* 26(3): 111-116. Available: https://hdl.handle.net/10520/EJC-1f3fb95fda

Mthombeni, S., Coopoo, Y. and Noorbhai, H. 2020b. Physical health status of emergency care providers in South Africa. *Asian Journal of Sports Medicine,* 11(2): 1-8. Available: https://doi.org/10.5812/asjsm.100261

Mthombeni, S., Coopoo, Y. and Noorbhai, H. 2021. Correlation between fitness parameters and an occupational rescue simulation among emergency care providers in North West Province, South Africa: A pilot study. *Australasian Journal of Paramedicine,* 18(1): 1-7. Available: https://doi.org/10.33151/ajp.18.862

Muhlbauer, D. 2022. Learner guide 2022. Physical preparedness study guide IV (PHYP401). Department of Emergency Medical Care and Rescue, Faculty of Health Sciences, Durban University of Technology.

Muijs, D. 2010. *Doing quantitative research in education with SPSS*. 2nd ed. Thousand Oaks, CA: SAGE Publications.

Munir, F., Clemes, S., Houdmont, J. and Randall, R. 2012. Overweight and obesity in UK firefighters. *Occupational Medicine,* 62(5): 362-365. Available: http://doi.org/10.1093/occmed/kqs077

Muştu Özyakan, E. and Saraç, L. 2018. Comparison of cardiopulmonary resuscitation skills of physically active and inactive university students. *Pamukkale Journal of Sport Sciences*, 9(2): 16-23. Available: https://dergipark.org.tr/en/pub/psbd/issue/38077/321866

NAEMT. 2023. *National Association of Emergency Medical Technicians Degree Programs in EMS*. Available: https://www.naemt.org/about-ems/degrees-in-ems (Accessed 21 February 2023).

National Ambulance Resilience Unit. 2022. *The PCA - A Guide for Managers*. Available: https://naru.org.uk/resources/useful-documents/ (Accessed 9 February 2024)

National Department of Health. 2017. *National emergency care education and training policy*.

National Health Service. 2006. *South East Coast Ambulance Service fitness test guidelines*. Available: https://www.secamb.nhs.uk/foi-disclosure-log/150712-new-fitness-test-guidelines-pdf/ (Accessed 4 May 2018).

National Strength and Conditioning Association. 2012. *NSCA's guide to tests and assessments*. Champaign, IL: Human Kinetics.

National Strength and Conditioning Association. 2016. *Essentials of strength training and conditioning*. 4th ed. Champaign, IL: Human Kinetics.

Nayak, V. R., Babu, A., Unnikrishnan, R., Babu, A. S. and Krishna, H. M. 2020. Influence of physical activity of the rescuer on chest compression duration and its effects on hemodynamics and fatigue levels of the rescuer: A simulation-based study. *Indian Journal of Critical Care Medicine,* 24(6): 409-413. Available: https://doi.org/10.5005/jp-journals-10071-23457 (Accessed 9 February 2024).

Nazari, G., MacDermid, J., Sinden, K. and Overend, T. 2018. The relationship between physical fitness and simulated firefighting task performance. *Rehabiltation Research and Practice,* 2018(1): 1-7. Available: https://doi.org/10.1155/2018/3234176

NFPA. 2000. *Standard on health-related fitness programs for fire fighters*, National Fire Protection Association 1583.

NMU Faculty of Health Sciences. 2023. Department of Emergency Medical Care Prospectus 2023, Nelson Mandela University

Noh, K., Song, W., Lee, C., Park, S., Park, J., Lee, H., Seo, D., Kang, H. and Ahn, Y. 2018. The study of Korea national firefighters' physical fitness over 6-year period (2011~2016). *International Journal of Human Movement Science,* 12(2): 103-116. Available: https://doi.org/10.23949/ijhms.2018.08.12.2.7

Nuzzo, J. L. 2024. Sex differences in skeletal muscle fiber types: A meta-analysis. *Clinical Anatomy,* 37(1): 81-91. Available: https://doi.org/10.1002/ca.24091 (Accessed 9 February 2024).

Orr, R., Lockie, R., Saari, A., Paavola, T., Muhlbauer, D. and Dawes, J. 2022. Load carriage for emergency responders. *Strength and Conditioning Journal,* December: 1-6. Available: https://doi.org/10.1519/SSC.0000000000000768

Otsuka, Y., Kasaoka, S., Oda, Y., Nakahara, T., Tanaka, R., Todani, M., Miyauchi, T., Kaneda, K., Kawamura, Y. and Tsuruta, R. 2014. Effects of uninterrupted chest compressions on the rescuer's physical condition. *The American Journal of Emergency Medicine,* 32(8): 909-912. Available: https://doi.org/10.1016/j.ajem.2014.05.008

Paakkonen, H., Ring, J. and Kettunen, J. 2018. Physical fitness of paramedic students during vocational training – a follow-up study. *Irish Journal of Paramedicine,* 3(1): 1-7. Available: https://doi.org/10.32378/ijp.v3i1.49

Paoli, A. and Bianco, A. 2015. What is fitness training? Definitions and Implications: A Systematic review article. *Iranian Journal of Public Health*, 44(5): 602-614.

Parker, R., Bayne, K. and Clifford, V. 2014. *Minimum fitness recommendations for rural fire personnel*. New Zealand Fire Service Commission.

Pattani, S., Constantinovici, N. and Williams, S. 2001. Who retires early from the NHS because of ill health and what does it cost? A national cross sectional study. *BMJ,* 322(7280): 208-209. Available: https://doi.org/10.1136/bmj.322.7280.208 (Accessed 7 March 2024).

Patterson, M. S., Gagnon, L. R., Nelon, J. L. and Spadine, M. N. 2020. A pilot study using egocentric network analysis to assess holistic health benefits among a sample of university employees involved in a worksite fitness program. *Work,* 66(1): 63-72. Available: http://dx.doi.org/10.3233/WOR-203151 (Accessed 9 February 2024).

Pham, M., Rajic, A., Greig, J., Sargeant, J., Papadopoulos, A. and McEwan, S. 2014. A scoping review of scoping reviews: advancing the approach and enhancing the consistency. *Research Synthesis Methods,* 5(4): 371-385. Available: https://doi.org/10.1002/jrsm.1123

Physical Literacy. 2023. What is *physical literacy*. Available: https://physicalliteracy.ca/physical-literacy/ (Accessed 13 June 2023).

Poggenpoel, M., Myburgh, C. and Van der Linde, C. 2006. Qualitative research strategies as prerequisite for qualitative strategies. *Education*, 122(2): 408-412.

Polit, D. E. and Beck, C. T. 2012. *Nursing research: generating and assessing evidence for nursing practice*. 9th ed. Philadelphia, PA: Wolters Kluwer.

Poplin, G., Roe, D., Peate, W., Harris, R. and Burgess, J. 2014. The association of aerobic fitness with injuries in the fire service. *American Journal of Epidemiology,* 179(2): 149-155. Available: https://doi.org/10.1093/aje/kwt213

Prieto, J., Gonzales, V., Del Valle, M. and Nistal, P. 2013. The influence of age on aerobic capacity and health indicators of three rescue groups. *International Journal of Occupational Safety and Ergonomics,* 19(1): 19-27. Available: https://doi.org/10.1080/10803548.2013.11076963

Professional Board for Emergency Care. 2019. *Minimum standards for the Professional Degree in Emergency Medical Care*. Pretoria: Health Professions Council of South Africa.

Putwain, D. 2008. Examination Stress and Test Anxiety. *The Psychologist*, 21(12): 1026-1029.

Qu, S. and Dumay, J. 2011. The qualitative research interview. *Qualitative Research in Accounting & Management,* 8(3): 238-264. Available: https://doi.org/10.1108/11766091111162070

Qureshi, F. and Memon, S. 2020. Sedentary lifestyle and health factors as leading cause of diseases: A multi centered study. *Rawal Medical Journal*, 45(3): 707-710. Available: https://www.rmj.org.pk/?mno=75721

Raosoft. 2004. *Raosoft sample size calculator*. Available: http://www.raosoft.com/samplesize.html (Accessed 14 August 2019).

Regents of the University of California. 2023. *Written Examination and Physical Ability Test (PAT)*. Available: https://police.ucla.edu/employment/written-examination-and-physical-ability-test-pat (Accessed 24 May 2023).

Reichard, A. A., Marsh, S. M. and Moore, P. H. 2011. Fatal and nonfatal injuries among emergency medical technicians and paramedics. *Prehospital Emergency Care,* 15(4): 511-517. Available: https://doi.org/10.3109/10903127.2011.598610

Reilly, T., Wooler, A. and Tipton, M. 2006. Occupational fitness standards for beach lifeguards. Phase 1: the physiological demands of beach lifeguarding. *Occupational Medicine,* 56(1): 6-11. Available: https://doi.org/10.1093/occmed/kqi169

Ren, K. and Li, J. 2013. Academic freedom and university autonomy: A higher education policy perspective. *Higher Education Policy,* 26(4): 507-522. Available: https://doi.org/10.1057/hep.2013.31

Riera, S., Gonzales, B., Alvarez, J., Fernandez, M. M. and Saura, J. 2007. The physiological effect on rescuers of doing 2 min of uninterrupted chest compressions. *Resuscitation,* 74(1): 108-112. Available: https://doi.org/10.1016/j.resuscitation.2006.10.031

Rikli, R. and Jones, C. 1999. Development and validation of a functional fitness test for community-residing older adults. *Journal of Aging and Physical Activity,* 7(2): 129-161. Available: https://doi.org/10.1123/japa.7.2.129

Roberts, D., Gebhardt, D., Gaskill, S., Roy, T. and Sharp, M. 2016. Current considerations related to physiological differences between the sexes and physical employment standards. *Applied Physiology Nutrition and Metabolism,* 41(6 Suppl 2): S108-120. Available: https://doi.org/10.1139/apnm-2015-0540

Rowland, M. 2021. Learner guide 2021. Physical preparedness (VPHP 100-400). Department of Emergency Medical Care, Faculty of Health Sciences, Nelson Mandela University.

Roy, T., Springer, B., McNulty, V. and Butler, N. 2010. Physical fitness. *Military Medicine,* 175(Suppl 8): 14-20. Available: https://doi.org/10.7205/MILMED-D-10-00058

Rue, C., Rayson, M., Walker, E., Doherty, J., Thompson, J., Myers, S. and Blacker, S. 2019. A job task analysis to describe the physical demands of specialist paramedic roles in the National Ambulance Resilience Unit (NARU). *Work,* 63(1): 1-11. Available: https://doi.org/10.3233/wor-192960

Russo, S. G., Neumann, P., Reinhardt, S., Timmermann, A., Niklas, A., Quintel, M. and Eich, C. B. 2011. Impact of physical fitness and biometric data on the quality of external chest compression: A randomised, crossover trial. *BMC Emergency Medicine,* 11(20): 1-9. Available: https://doi.org/10.1186/1471-227X-11-20

Rutberg, S. and Bouikidis, C. 2018. Focusing on the fundamentals: a simplistic differentiation between qualitative and quantitative research. *Nephrology Nursing Journal*, 45(2): 209-213.

Rutto, D. 2017. Pedagogical Theories. *International Journal of Scientific and Engineering Research*, 8(6): 2025-2030.

Ružbarská, I. and Turek, M. 2010a. Analysis of motor performance indicators of medical rescuers. *Studies in Physical Culture and Tourism*, 17(1): 47-52.

Ružbarská, I. and Turek, M. 2010b. Motor performance as a determinant of medical rescue profession (conference presentation). Paper presented at the *AIESEP, Faculty of Sports Slovakia*.

Sandalis, A. 2023. *Progression guidelines by 3 world class professionals for acheiving the chinup*. Available: https://alexanderemmanual.com/chinup/ (Accessed 13 June 2023).

SAQA. 2015. *South Africans Qualification Authority: Bachelor of Health Sciences in Emergency Medical Care (ID: 88920)*. Available: http://allqs.saqa.org.za/showQualification.php?id=71789 (Accessed 7 August 2016).

SAQA. 2023a. *NQF history and objectives*. Available: https://www.saqa.org.za/about-saqa/a-brief-history/ (Accessed 4 April 2023).

SAQA. 2023b. *What is the South African Qualifications Authority?* Available: https://www.saqa.org.za/about-saqa/#vision-mission-values (Accessed 4 April 2023).

Saunders, C., Sewduth, D. and Naidoo, N. 2018. Keeping our heads above water: A systematic review of fatal drowning in South Africa. *South African Medical Journal,* 108(1): 61-68. Available: http://www.samj.org.za/index.php/samj/article/view/12185

Schoonenboom, J. and Johnson, R. 2017. How to construct a mixed methods research design. *Kölner Zeitschrift für Soziologie I Sozialpsychologie,* 69(7): 107-131. Available: https://link.springer.com/article/10.1007/s11577-017-0454-1

Scotland, J. 2012. Exploring the philosophical underpinnings of research: Relating ontology and epistemology to the methodology and methods of the scientific, interpretive, and critical research paradigms. *English Language Teaching,* 5(9): 9-16. Available: https://doi.org/10.5539/elt.v5n9p9

Scott, W., Stevens, J. and Binder-Macleod, S. A. 2001. Human skeletal muscle fiber type classifications. *Physical therapy*, 81(11): 1810-1816. Available: http://dx.doi.org/10.1093/ptj/81.11.1810 (Accessed 9 February 2024)

Setia, M. 2016. Methodology series module 3: Cross-sectional studies. *Indian Journal of Dermatology,* 61(3): 261-264. Available: https://doi.org/10.4103/0019-5154.182410

Shannon-Baker, P. 2016. Making paradigms meaningful in mixed methods I. *Journal of Mixed Methods research,* 10(4): 319-334. Available: https://doi.org/10.1177/1558689815575861

Shenton, A. 2004. Strategies for ensuring trustworthiness in qualitative research projects. *Education for Information,* 22(2): 63-75. Available: https://doi.org/10.3233/EFI-2004-22201

Sheridan, S. 2019. Paramedic health status, fitness and physical tasks: A review of the literature. *Australasian Journal of Paramedicine,* 16(1): 1-7. Available: https://doi.org/10.33151/ajp.16.580

Siddall, A., Rayson, M., Walker, E., Doherty, J., Osofa, J., Flood, R., Hale, B., Myers, S. and Blacker, S. 2021. Development of physical employment standards of specialist paramedic roles in the National Ambulance Resilience Unit (Naru). *Applied Ergonomics,* 95(Suppl. 11): 1-12. Available: https://doi.org/10.1016/j.apergo.2021.103460

Sobuwa, S. and Christophers, L. 2019. Emergency care education in South Africa: Past, present and future. *Australasian Journal of Paramedicine,* 16: 1-5. Available: https://doi.org/10.33151/ajp.16.647

Sofianopoulos, S., Williams, B. and Archer, F. 2012. Paramedics and the effects of shift work on sleep: A literature review. *Emergency Medicine Journal,* 29(2): 152-155. Available: https://doi.org/10.1136/emj.2010.094342

Sothmann, M., Gebhardt, D., Baker, T., Kastello, G. and Sheppard, V. 2004. Performance requirements of physically strenuous occupations: Validating minimum standards for muscular strength and endurance. *Ergonomics,* 47(8): 864-875. Available: https://doi.org/10.1080/00140130410001670372

South Africa. Department of Health. 2017. *Emergency Medical Services Regulations*. National Health Act, 2003 (Act No. 61 of 2003): Pretoria: Government Printers.

South Africa. Department of Labour. 1998. *Employment Equity Act, 1998 (Act No. 55 of 1998).* Government Gazette 19370: 19 October. Pretoria: Government Printers.

South Africa. Professional Board for Emergency Care (PBEC). 2002. *Regulations defining the scope of the profession of emergency care*. Government Notice R48 in Government Gazette 23040, Health Professions Act 56 of 1974: Pretoria: Government Printers.

Stallman, R., Moran, K., Quan, L. and Langendorfer, S. 2017. From swimming skill to water competence: Towards a more inclusive drowning prevention future. *International Journal of Aquatic Research and Education,* 10(2): 1-38. Available: https://doi.org/10.25035/ijare.10.02.03

Statistics South Africa. 2018. *Mortality and causes of death in South Africa: findings from death notification*. Statistics South Africa.

Sterud, T., Ekeberg, O. and Hem, E. 2006. Health status in the ambulance services: A systematic review. *BMC Health Services Research,* 6(1): 1-10. Available: https://doi.org/10.1186/1472-6963-6-82

Stevenson, R., Siddall, A., Turner, P. and Bilzon, J. 2017. Physical employment standards for UK firefighters: Minimum muscular strength and endurance requirements. *Journal of Occupational and Environmental Medicine,* 59(1): 74-79. Available: https://doi.org/10.1097/JOM.0000000000000926

Stewart, I., McDonald, M., Hunt, A. and Parker, T. 2008. Physical capacity of rescue personnel in the mining industry. *Journal of Occupational Medicine and Toxicology,* 3(22): 1-6. Available: https://doi.org/10.1186/1745-6673-3-22

Stubbs, B., Koyanagi, A., Hallgren, M., Firth, J., Richards, J., Schuch, F., Rosenbaum, S., Mugisha, J., Veronese, N., Lahti, J. and Vancampfort, D. 2017. Physical activity and anxiety: A perspective from the World Health Survey. *Journal of Affective Disorders,* 208: 545-552. Available: https://doi.org/10.1016/j.jad.2016.10.028 (Accessed 7 March 2024).

Supples, M. W., Brichler, K. P., Glober, N. K., Lardaro, T. A. and O'Donnell, D. P. 2022. Functional movement screen did not predict musculoskeletal injury among emergency medical services professionals. *Work,* 71(3): 795-802. Available: https://doi.org/10.3233/wor-205328 (Accessed 9 February 2024).

Taukeni, S. 2020. Biopsychosocial model of health. Paper presented at the *International Conference on Natural products & traditional medicine*. *Psychology and Psychiatry: Open Access*, 4(1): 1-2.

Tee, J. 2020. Physical education in South Africa is disappearing fast – Are we okay with that? Available: https://www.jasonctee.co.za/post/physical-education-in-south-africa-is-disappearing-fast-are-we-okay-with-that/ (Accessed April 2023).

The Maharaja Bhupinder Singh Punjab Sports University. 2020. *Physical fitness test*. Available: https://mbspsu.ac.in/physical-fitness-test/ (Accessed 13 June 2023).

Thornton, K. E. and Sayers, M. G. 2014. Unfit for duty? Evaluation of 4 years of paramedic preemployment fitness screening test results. *Prehospital Emergency Care,* 17(2): 201-206. Available: https://doi.org/10.3109/10903127.2013.836264

Tofari, P., Treloar, A. and Silk, A. 2013. A quantification of the physiological demands of the army emergency responder in the Australian Army. *Military Medicine,* 178(5): 487-494. Available: https://doi.org/10.7205/MILMED-D-12-00423

Tremblay, M. S., Colley, R. C., Saunders, T. J., Healy, G. N. and Owen, N. 2010. Physiological and health implications of a sedentary lifestyle. *Applied Physiology, Nutrition and Metabolism,* 35(6): 725-740. Available: https://doi.org/10.1139/H10-079

Trifoni, A. and Shahini, M. 2011. How does exam anxiety affect the performance of university students? *Mediterranean Journal of Social Sciences*, 2(2): 94-101. Available: https://www.richtmann.org/journal/index.php/mjss/article/view/10785

Tsismenakis, A., Christophi, C., Burress, J., Kinney, A., Kim, M. and Kales, S. 2009. The obesity epidemic and future emergency responders. *Obesity,* 17(8): 1648-1650. Available: https://doi.org/10.1038/oby.2009.63

Tzarimas, C., Hobson-Powell, A., Johnson, R., Shaw, J., Askew, C., Davies, S. and Leemhuis, C. Australia, E. S. S. 2016. *A guide to physical activity in the workplace*.

U.S. News. 2023. *Why you should learn to swim: it could save your life*. Available: https://health.usnews.com/wellness/fitness/articles/2017-05-31/why-you-should-learn-to-swim-it-could-save-your-life (Accessed 21 February 2023).

UJ Faculty of Health Sciences. 2023. Department of Emergency Medical Care Rules and Regulations Undergraduate and Postgraduate Programmes, University of Johannesburg

United Kingdom, Government Equalities Office and Equality and Human Rights Commission. 2013. *Equality Act 2010*. Available: https://www.gov.uk/guidance/equality-act-2010-guidance (Accessed 7 March 2024).

United States, Equal Employment Opportunity Commission. 1991. *Civil Rights Act of 1991*. Available: https://www.eeoc.gov/civil-rights-act-1991-original-text (Accessed 7 March 2024).

University of Manitoba. 2023. *Paramedic physical fitness assessment*. Available: https://umanitoba.ca/sites/default/files/2022-12/Paramedic%20Assessment%20Description%202019.pdf (Accessed 24 May 2023).

University of South Alabama. 2023. *Bachelor of Science in Emergency Medical Services*. Available: https://www.southalabama.edu/colleges/alliedhealth/ems/bachelor.html (Accessed 21 February 2023).

University of Southern Queensland. 2023. *Bachelor of Paramedicine*. Available: https://www.unisq.edu.au/study/degrees/bachelor-of-paramedicine?utm_medium=referral&utm_source=seeklearning (Accessed 21 February 2023).

University of Texas Health Science Center at San Antonio. 2021. *Bachelor of Science in Emergency Health Sciences*. Available: http://catalog.uthscsa.edu/schoolofhealthprofessions/emergencyhealthsciences/bsehs/#text (Accessed 21 February 2023).

Vaismoradi, M., Turunen, H. and Bondas, T. 2013. Content analysis and thematic analysis: Implications for conducting a qualitative descriptive study. *Nursing and Health Sciences,* 15(3): 398-405. Available: https://doi.org/10.1111/nhs.12048 (Accessed 9 February 2024).

van der Ploeg, E. and Kleber, R. 2003. Acute and chronic job stressors among ambulance personnel: Predictors of health symptoms. *Occupational and Environmental Medicine,* 60(Suppl 1): i40-46. Available: https://doi.org/10.1136/oem.60.suppl_1.i40

Van Nugteren, B. 2023. Learning Guide 2023. Physical preparedness II, III, IV (PFP02Y2/PFP03Y3/PFP04Y4). Department of Emergency Medical Care, Faculty of Health Sciences, University of Johannesburg.

Varkey, B. 2019. Principles of clinical ethics and their application to practice. *Medical Principles and Practice,* 30(1): 17-28. Available: https://doi.org/10.1159/000509119

Vears, D. and Gillam, L. 2022. Inductive content analysis: A guide for beginning qualitative researchers. *Focus on Health Professional Education A Multi-Professional Journal,* 23(1): 111-127. Available: https://doi.org/10.11157/fohpe.v23i1.544

Vecteezy. 2023. *Push up pose* Available: https://www.vecteezy.com/vector-art/162135-push-up-pose-vector (Accessed 12 June 2023).

Vincent-Lambert, C. 2011. A framework for articulation between the emergency care technician certificate and the emergency medical care professional degree. Philosophiae Doctor in Health Professions Education, University of the Free State.

Vincent-Lambert, C., Bezuidenhout, J. and Jansen van Vuuren, M. 2014. Are further education opportunities for emergency care technicians needed and do they exist? *African Journal of Health Professions Education,* 6(1): 6-9. Available: https://journals.co.za/doi/epdf/10.7196/AJHPE.285

Vincent-Lambert, C., Coopoo, Y. and Van Nugteren, B. 2022. Learning guide 2022. Physical preparedness I, II, III, IV (PFP01Y1/PFP02Y2/PFP03Y3/PFP04Y4). Department of Emergency Medical Care, Faculty of Health Sciences, University of Johannesburg.

Vinciguerra, G., Belcaro, G., Bonanni, E., Cesarone, M. R., Rotondi, V., Ledda, A., Hosoi, M., Dugall, M., Cacchio, M. and Cornelli, U. 2013. Evaluation of the effects of supplementation with Pycnogenol® on fitness in normal subjects with the Army Physical Fitness Test and in performances of athletes in the 100-minute triathlon. *The Journal of Sports Medicine and Physical Fitness*, 53(6): 644-654. Available: https://pubmed.ncbi.nlm.nih.gov/24247188/

von Heimburg, E., Rasmussen, A. and Medbo, J. 2006. Physiological response of firefighters and performance predictors during a simulated rescue of hospital patients. *Ergonomics,* 49(2): 111-126. Available: https://doi.org/10.1080/00140130500435793

Vuori, I. 1998. Does physical activity enhance health? *Patient Education and Counseling,* 33(1): 95-103. Available: https://pubmed.ncbi.nlm.nih.gov/10889751/#:~:text=doi%3A-,10.1016/s0738%2D3991(98)00014%2D7,-

Waack, J., Meadley, B. and Gosling, C. 2023. Comparison of physical demanding paramedic work tasks between an Australian and Canadian ambulance service. *Applied Ergonomics,* 106(4): 1-8. Available: https://doi.org/10.1016/j.apergo.2022.103905

Wang, F., McDonald, T., Champagne, L. and Edington, D. 2004. Relationship of body mass index and physical activity to health care costs among employees. *Journal of Occupational and Environmental Medicine,* 46(5): 428-436. Available: https://doi.org/10.1097/01.jom.0000126022.25149.bf

Warburton, D. E. R. and Bredin, S. D. 2017. Health benefits of physical activity: A systematic review of current systematic reviews. *Current Opinion in Cardiology,* 32(5): 541-556. Available: https://doi.org/10.1097/HCO.0000000000000437 (Accessed 9 February 2024).

Wermke, W. and Salokangas. 2015. Autonomy in education: theoretical and empirical approaches to a contested concept. *Nordic Journal of Studies in Educational Policy,* 1(2): 1-7. Available: https://doi.org/10.3402/nstep.v1.28841

Western Sydney University. 2023. *Bachelor of Paramedicine*. Available: https://www.westernsydney.edu.au/future/study/courses/undergraduate/bachelor-of-paramedicine?utm_medium=referral&utm_source=seeklearning (Accessed 21 February 2023).

WHO. 2016. *Drowning fact sheet*. Available: http://www.who.int/mediacentre/factsheets/fs347/en/ (Accessed 8 September 2016).

WHO. 2020. *Basic documents*. 49th ed. Available: https://apps.who.int/gb/bd/pdf_files/BD_49th-en.pdf (Accessed 7 March 2024).

WHO. 2022. *Body mass index.* Available: https://www.who.int/data/gho/data/themes/topics/topic-details/GHO/body-mass-index (Accessed 7 September 2022).

WHO. 2023. *Health Topics - Drowning*. Available: https://www.who.int/health-topics/drowning#tab=tab_1 (Accessed 4 April 2023).

WHO. 2024. *Physical activity*. Available: https://www.who.int/news-room/fact-sheets/detail/physical-activity (Accessed 9 February 2024).

Wicks, C., Barton, J., Orbell, S. and Andrews, L. 2022. Psychological benefits of outdoor physical activity in natural versus urban environments: A systematic review and meta-analysis of experimental studies. *Applied Psychology: Health and Well-Being,* 14(3): 1037-1061. Available: https://doi.org/10.1111/aphw.12353 (Accessed 9 February 2024).

Williford, H. N., Duey, W. J., Olson, M. S., Howard, R. H. and Wang, N. 1999. Relationship between fire fighting suppression tasks and physical fitness. *Ergonomics,* 42(9): 1179-1186. Available: https://doi.org/10.1080/001401399185063 (Accessed 7 March 2024).

Wood, R. 2008a. *Eurofit Fitness Test Battery*. Available: https://www.topendsports.com/testing/eurofit.htm (Accessed 24 May 2023).

Wood, R. 2008b. *International Society for the Advancement of Kinanthropometry*. Available: https://www.topendsports.com/testing/isak.htm (Accessed 23 November 2022).

Wood, R. 2015. Topend Sports' fitness testing guide. Topend Sports.

Wood, R. 2022a. *7-Stage abdominal strength test*. Available: https://www.topendsports.com/testing/tests/abstrength.htm (Accessed 8 September 2022).

Wood, R. 2022b. *Cooper 12-minute run test*.
Available: https://www.topendsports.com/testing/tests/cooper.htm
(Accessed 9 September 2022).

Wood, R. 2022c. *Flexed-arm hang Test*.
Available: https://www.topendsports.com/testing/tests/flexed-arm-hang.htm
(Accessed 8 September 2022).

Wood, R. 2022d. *Handgrip strength test*.
Available: https://www.topendsports.com/testing/tests/handgrip.htm
(Accessed 8 September 2022).

Wood, R. 2022e. *Maximum push-up test*.
Available: https://www.topendsports.com/testing/tests/push-up-maximum.htm
(Accessed 8 September 2022).

Wood, R. 2022f. *Modified sit and reach test*.
Available: https://www.topendsports.com/testing/tests/sit-and-reach-modified.htm
(Accessed 8 September 2022).

Wood, R. 2022g. *Push up fitness test*. Available: https://www.topendsports.com/testing/tests/push-up.htm (Accessed 8 September 2022).

Yong, W., Huslin, M. and Kamarudin, S. 2021. Understanding research paradigms: A scientific guide. *Journal of Contemporary Issues in Business and Government,* 27(2): 5857-5865. Available: DOI: 10.47750/cibg.2021.27.02.588 (Accessed 9 February 2024).

Zogla, I. 2018. Science of pedagogy: Theory of educational discipline and practice. *Journal of Teacher Education for Sustainability,* 20(2): 31-43.
Available: http://dx.doi.org/10.2478/jtes-2018-0013 (Accessed 9 February 2024).

APPENDICES

APPENDIX 1: UNIVERSITY ETHICS CLEARANCE

Institutional Research Ethics Committee
Research and Postgraduate Support Directorate
2nd Floor, Berwyn Court
Gate 1, Steve Biko Campus
Durban University of Technology

P O Box 1334, Durban, South Africa, 4001

Tel: 031 373 2375
Email: lavishad@dut.ac.za
http://www.dut.ac.za/research/institutional_research_ethics

www.dut.ac.za

28 April 2020

Mrs D Muhlbauer
PO Box 45
Caledon
Zimbali
4418
Ballitoville

Dear Mrs Muhlbauer

A validated tool for assessing task-orientated physical preparedness of South African Emergency Medical Care students
Ethical Clearance number IREC 058/19

The Institutional Research Ethics Committee acknowledges receipt of your notification regarding the piloting of your data collection tools.

Kindly ensure that participants used for the pilot study are not part of the main study.

In addition, the IREC acknowledges receipt of your gatekeeper permission letters.

Please note that FULL APPROVAL is granted to your research proposal. You may proceed with data collection.

Any adverse events [serious or minor] which occur in connection with this study and/or which may alter its ethical consideration must be reported to the IREC according to the IREC SOP's.

Please note that any deviations from the approved proposal require the approval of the IREC as outlined in the IREC SOP's.

Yours Sincerely

Professor J K Adam
Chairperson: IREC

APPENDIX 2A: APPROVAL LETTERS FROM THE GATEKEEPERS

Directorate for Research and Postgraduate Support
Durban University of Technology
Tromso Annexe, Steve Biko Campus
P.O. Box 1334, Durban 4000
Tel.: 031-3732576/7
Fax: 031-3732946

26th August 2019

Mrs Dagmar Muhlbauer
c/o Department of Emergency Medical Care and Rescue
Faculty of Health Sciences
Durban University of Technology

Dear Mrs Muhlbauer

PERMISSION TO CONDUCT RESEARCH AT THE DUT

Your email correspondence in respect of the above refers. I am pleased to inform you that the Institutional Research and Innovation Committee (IRIC) has granted full permission for you to conduct your research "A validated tool for assessing task-oriented physical preparedness of South African Emergency Medical Care students" at the Durban University of Technology.

The DUT may impose any other condition it deems appropriate in the circumstances having regard to nature and extent of access to and use of information requested.

We would be grateful if a summary of your key research findings can be submitted to the IRIC on completion of your studies.

Kindest regards.
Yours sincerely

PROF KEVIN DUFFY
ACTING DIRECTOR: RESEARCH AND POSTGRADUATE SUPPORT DIRECORATE

APPENDIX 2B: APPROVAL LETTERS FROM THE GATEKEEPERS

NELSON MANDELA
UNIVERSITY

PO Box 77000, Nelson Mandela University, Port Elizabeth, 6031, South Africa mandela.ac.za

Chairperson: Research Ethics Committee (Human)
Tel: +27 (0)41 504 2347
Sharlene.Govender@mandela.ac.za

NHREC registration nr: REC-042508-025

Ref: [H19-HEA-EMC-EAP-001]

27 January 2020

Dear Prof Vincent-Lambert

TITLE: A VALIDATED TOOL FOR ASSESSING TASK-ORIENTATED PYSICAL PREPAREDNESS OF SOUTH AFRICAN EMERGENCY MEDICAL CARE STUDENTS

REF NR: **IREC 058/19**
PRP: **Prof C Vincent-Lambert**
PI: **Ms D Muhlbauer**

Your application for ethics approval to conduct research at Nelson Mandela University has been considered by the REC-H on the basis that the study has been duly vetted and approved by the Durban University of Technology Ethics Committee.

Kindly use the following ethics reference number **H19-HEA-EMC-EAP-001** together with your University's ethics clearance number in any correspondence with gatekeepers and participants at the University. Ethics clearance is valid for one year.

Please inform the REC-H, of any changes that may arise during the execution of the study, particularly to the methodology.

It must be noted that the Nelson Mandela University assumes that the Research Ethics Committee responsible for providing the original ethics approval/clearance has undertaken both ethics and scientific review of the protocol according to the National Health Research Ethics Committee (2015) Guidelines, and assumes primary responsibility for oversight with regard to any ethical issues that may arise in the course of the study. The Nelson Mandela University would also wish to be provided with an executive summary of the findings from the research.

We wish you well with the project.

Yours sincerely

Dr S Govender
Chairperson: Research Ethics Committee (Human)

cc: Department of Research Capacity Development

APPENDIX 2C: APPROVAL LETTERS FROM THE GATEKEEPERS

FACULTY OF HEALTH SCIENCES
RESEARCH ETHICS COMMITTEE

NHREC Registration: REC 241112-035

ETHICAL CLEARANCE LETTER
(RECX 2.0)

Student/Researcher Name	Ms. D. Muhlbauer	Student Number	21143532
Supervisor Name	Prof. C. Lambert	Co-Supervisor Name	Prof. Y. Coopoo/Dr K. Govender
Department	Emergency Medical Care & Rescue (Durban University of Technology)		
Qualification	PhD Emergency Medical Care		
Research Title	A VALIDATED TOOL FOR ASSESSING TASK-ORIENTED PHYSICAL PREPAREDNESS OF SOUTH AFRICAN EMERGENCY MEDICAL CARE STUDENTS		
Date	24 January 2020	Clearance Number	**REC-01-01-2020**

Approval of the research proposal with details given above is granted, subject to any conditions under 1 below, and is valid until 24 January 2021.

1. Conditions*:
Submission of a research proposal addendum on completion of the first two phases of the research (survey and focus groups) containing further methodological details of the experimental phase, together with any relevant attachments. This ethical clearance is valid for the first two phases of the research only.
***Non-compliance with any of the above conditions will invalidate ethical clearance.**

2. Renewal:
It is required that this ethical clearance is renewed annually, within two weeks of the date indicated above. Renewal must be done using the Ethical Clearance Renewal Form (REC 10.0), to be completed and submitted to the Faculty Administration office. *See Section 12 of the REC Standard Operating Procedures.*

3. Amendments:
Any envisaged amendments to the research proposal that has been granted ethical clearance must be submitted to the REC using the Research Proposal Amendment Application Form (REC 8.0) prior to the research being amended. Amendments to research may only be carried out once a new ethical clearance letter is issued. *See Section 13 of the REC Standard Operating Procedures.*

4. Adverse Events, Deviations or Non-compliance:
Adverse events, research proposal deviations or non-compliance must be reported within the stipulated time-frames using the Adverse Event Reporting Form (REC 9.0). *See Section 14 of the REC Standard Operating Procedures.*

The REC wishes you all the best for your studies.

Yours sincerely,

Prof. Christopher Stein
Chairperson: REC
Tel: 011 559 6564
Email: cstein@uj.ac.za

RECX 2.0 – Faculty of Health Sciences
Research Ethics Committee

Secretariat: Ms Raihaanah Pieterse
Tel: 011 559 6073 email: rpieterse@uj.ac.za

FACULTY OF HEALTH SCIENCES
RESEARCH ETHICS COMMITTEE

NHREC Registration: REC 241112-035

ETHICAL CLEARANCE LETTER
(RECX 2.0)

Student/Researcher Name	Ms. D. Muhlbauer	Student Number	21143532
Supervisor Name	Prof. C. Lambert	Co-Supervisor Name	Prof. Y. Coopoo/Dr K. Govender
Department	Emergency Medical Care & Rescue (Durban University of Technology)		
Qualification	PhD Emergency Medical Care		
Research Title	A VALIDATED TOOL FOR ASSESSING TASK-ORIENTED PHYSICAL PREPAREDNESS OF SOUTH AFRICAN EMERGENCY MEDICAL CARE STUDENTS		
Date	2 December 2022	Clearance Number	REC-01-01-2020

Approval of the research proposal with details given above is granted, subject to any conditions under 1 below, and is valid until 2 December 2023.

1. **Conditions*:**
Gatekeeper permission, as required.
*Non-compliance with any of the above conditions will invalidate ethical clearance.

2. **Renewal:**
It is required that this ethical clearance is renewed annually, within two weeks of the date indicated above. Renewal must be done using the Ethical Clearance Renewal Form (REC 10.0), to be completed and submitted to the Faculty Administration office. *See Section 12 of the REC Standard Operating Procedures.*

3. **Amendments:**
Any envisaged amendments to the research proposal that has been granted ethical clearance must be submitted to the REC using the Research Proposal Amendment Application Form (REC 8.0) prior to the research being amended. Amendments to research may only be carried out once a new ethical clearance letter is issued. *See Section 13 of the REC Standard Operating Procedures.*

4. **Adverse Events, Deviations or Non-compliance:**
Adverse events, research proposal deviations or non-compliance must be reported within the stipulated time-frames using the Adverse Event Reporting Form (REC 9.0). *See Section 14 of the REC Standard Operating Procedures.*

The REC wishes you all the best for your studies.

Yours sincerely

Prof. Christopher Stein
Chairperson: REC
Tel: 011 559 6564
Email: cstein@uj.ac.za

Secretariat: Ms Raihaanah Pieterse
Tel: 011 559 6073 email: rpieterse@uj.ac.za

APPENDIX 3: LETTER OF INFORMATION FOR THE QUESTIONNAIRE

Title of the Research Study: A validated tool for assessing task-oriented physical preparedness of South African Emergency Medical Care students

Researcher:
Mrs Dagmar Mühlbauer (BTech EMC; MTech EMC; PhD Candidate)

Supervisors:
Prof Craig Vincent-Lambert (PhD Health Professions Education) & Prof Yoga Coopoo (BA; BA Hons; MA; DPhil (UDW), FACSM)

Brief Introduction and Purpose of the Study: This study takes place within the broad domain of health professions education in the discipline of Emergency Medical Care (EMC). The study focuses on the development of new knowledge and aims to produce a scientifically validated tool for the assessment of physical preparedness of South African Emergency Medical Care (EMC) students. The study is premised on the understanding that emergency care and rescue environments (both operational and training) can be physically demanding, potentially hazardous and are consequently associated with a high number of work-related injuries and illnesses. This has resulted in employers placing an emphasis on developing task-oriented fitness programmes and assessments for their staff in an attempt to reduce the number and severity of injuries and resultant absenteeism from the workplace.

Aside from personal benefits associated with fitness and exercise, healthy persons who are physically prepared for their work environments are more effective and less likely to become fatigued. Taking the above into account, it is logical that Universities offering Emergency Medical Care programmes are responsible for the development, maintenance and assessment of their staff and student's levels of task-oriented physical preparedness. However, fulfilment of this responsibility becomes problematic in the absence of a scientifically validated tool to inform and guide such assessments. In this study, the researcher aims to develop a validated tool for assessing task-oriented physical preparedness of South African Emergency Medical Care students**.** The purpose of this study is to address the research problem and answer the questions described above, the central aim of the study is therefore to develop and validate a tool that can be used to assess task-oriented physical preparedness of South African emergency medical care students.

Outline of the Procedures: You will be expected to engage in an online questionnaire as part of the first phase of this study. The online survey should take approximately 10 minutes to complete and in order to complete the questionnaire you need to fulfill one of the following inclusion criteria:

- Academic staff must be engaged in the teaching of the Medical Rescue and/or Physical Preparedness for the 2020 academic year on the Bachelor's Degree in Emergency Medical Care (BEMC) programme at one of the four HEIs.
- Senior students must be registered for either their third or fourth year of study on the BEMC programme in the 2020 academic year.
- There is no age limitation to participate in this study, that is there is no minimum or maximum age.

Risks or Discomforts to the Participant: There are no foreseeable risks or discomforts for you when completing the online questionnaire.

Benefits: This study will result in presentations at both local and international conferences as well as publications in accredited journals. The benefit will also be to introduce a scientifically validated standardised physical preparedness assessment tool for the BEMC programme.

Reason/s why the Participant May Be Withdrawn from the Study: You may withdraw from the study at any stage during the questionnaire and there will be no adverse consequences should you choose to withdraw. Once you submit your final response to the questionnaire though, you will no longer be able to withdraw from the study.

Remuneration: There will be no remuneration for taking part in this study.

Costs of the Study: There will be no costs incurred at any stage of the study.

Confidentiality: No identifying data will be captured at any stage during the questionnaire, and all of the data collected from the questionnaires will be allocated a code during the data analysis process. The data collected will be stored in a password protected folder on a password protected laptop. Only the researcher and supervisors will have access to the data.

Persons to Contact in the Event of Any Problems or Queries:
Please contact the researcher, Mrs Dagmar Mühlbauer (082 444 3671), my supervisor, Prof Craig Vincent-Lambert (082 653 2125) or the Institutional Research Ethics Administrator on 031 373 2375. Complaints can be reported to the DVC: Research, Innovation and Engagement Prof S Moyo on 031 373 2577 or moyos@dut.ac.za.

APPENDIX 4: CONSENT FORM FOR THE QUESTIONNAIRE FOR ACADEMIC STAFF AND SENIOR STUDENTS

DISCLAIMERS

- I hereby confirm that I have been informed by the researcher, Mrs Dagmar Mühlbauer, about the nature, conduct, benefits and risks of this study – Research Ethics Clearance Number: **IREC 058/19**
- I have also received, read and understood the above participant information sheet regarding the study.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.
- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

I confirm that I agree to take part in this study.

Choose one of the following answers:

____ Agree

____ Disagree

APPENDIX 5A: QUESTIONNAIRE FOR THE ACADEMIC STAFF

This questionnaire is designed to obtain your views and opinions on physical preparedness for emergency medical care students. It is very important that you take the time to carefully read the questions, to ensure that you interpret the questions correctly, as your responses will form part of one of the important components that make up this study.

Section A – Demographics:

1. **State your age:** ____________________
2. **Gender:** Male / Female
3. **Facilitate and/or lecture:** Physical Preparedness YES/NO
   Medical Rescue YES/NO
4. **Academic Staff Member at:** CPUT / DUT / NMU / UJ

Section B – Background Content:

Physical fitness may be broadly divided into two categories: a) general physical fitness and b) task oriented or sport-oriented fitness. General physical fitness refers to the general state of health and well-being. Specific task-oriented fitness deals with the degree to which an individual is able to cope with the physical demands of their chosen profession without excessive fatigue. This study focuses predominantly on the assessment of task-oriented fitness and in this study we introduce the term "physical preparedness" which is to be read as an overarching term that includes task-oriented fitness.

5. Is physical preparedness a stand-alone module that is reflected on a student's academic record with a mark?

Yes	No

6. There are activities in which the students participate on the BEMC programme that are physically demanding.

Agree	Disagree

7. It is important for a BEMC student to be physically fit and healthy to engage safely and efficiently with the content of the BEMC programme at my university.

Strongly Agree	Agree	Disagree	Strongly Disagree

8. Lecturers presenting the Medical Rescue and Emergency Medical Care modules should also be physically fit.

Strongly Agree	Agree	Disagree	Strongly Disagree

9. The ability to swim is a valuable life skill.

Agree	Disagree

10. Persons engaging in emergency care and rescue work should be able to swim.

Agree	Disagree

11. It is important for students registered on the BEMC programme to be able to swim.

Agree	Disagree

12. Rating of perceived exertion (RPE) is a widely used and reliable indicator to assess and guide exercise intensity. The Borg Scale allows an individual to subjectively rate their own personal level of exertion during a physical activity. Making use of the revised category-ratio Borg Scale, please rate the level of perceived exertion for the 12 Medical Rescue modules that form part of the BEMC programme from 0 to 10. If you have not participated and/or lectured on any of the listed modules as part of the BEMC programme, please select the N/A column.

	High Angle I	Fire Search & Rescue	Motor Vehicle Rescue	Industrial & Agricultural	High Angle II	Wilderness Search & Rescue	Aviation Rescue	Aquatic Rescue	Structural Collapse Rescue	Trench Rescue	Confined Space Rescue	Hazardous Materials Rescue
N/A – Module not completed yet												
0 – At Rest												
1 – Very Easy												
2 – Somewhat Easy												
3 – Moderate												
4 – Somewhat Hard												
5 – Hard												
6 –												
7 – Very Hard												
8 –												
9 –												
10 – Very, Very Hard												

13. During my time as an academic lecturing on the BEMC programme, I felt that the following experiences, events and/or activities were the most physically challenging for the students:

____

____

____

Section C – Physical Training:

*When answering the questions relating to Section C, for the purpose of this study the term "**structured physical training**" refers to physical training sessions which are formally rostered on the academic timetable every week of the academic year, and these physical training sessions are led by a dedicated lecturer with clear aims and objectives that link to the content of the BEMC programme and the components of physical fitness which form part of the physical preparedness assessment used by the Department.*

14. Structured physical training is included as part of the first year of the BEMC programme at my institution.

Yes	No

15. Structured physical training is included as part of the second year of the BEMC programme at my institution.

Yes	No

16. Structured physical training is included as part of the third year of the BEMC programme at my institution.

Yes	No

17. Structured physical training is included as part of the fourth year of the BEMC programme at my institution.

Yes	No

18. The physical training is presented by one dedicated lecturer/facilitator who is solely responsible for all of the physical training across all four years on the BEMC programme at my institution.

True	False

19. The physical training is presented by a lecturer/facilitator; however, this lecturer differs either from session to session or year to year at my institution, e.g. the third-year coordinator is responsible for the physical training of the third-year students.

True	False

20. The physical training sessions start well at the beginning of the academic year at my institution, however, towards the end of the academic year, sessions are often cancelled and the structure is lost.

True	False

21. I believe that the physical training sessions form part of the BEMC programme, and I approach these sessions just as if they were any other lecture for which I was scheduled on the academic timetable at my institution.

True	False

22. There are set aims for each of the structured physical training sessions at my institution.

Yes	No

23. There are clear objectives which are outlined for each of the structured physical training sessions at my institution.

Yes	No

24. The structured physical training appears to be emotionally draining for all of the students.

Strongly Agree	Agree	Disagree	Strongly Disagree

25. The structured physical training appears to be emotionally draining for most of the students.

Strongly Agree	Agree	Disagree	Strongly Disagree

26. The structured physical training appears to be emotionally draining for some of the students.

Strongly Agree	Agree	Disagree	Strongly Disagree

27. I feel that the structured physical training has provided the students with greater mental endurance.

Strongly Agree	Agree	Disagree	Strongly Disagree

28. The structured physical training appears to have benefitted the students physically.

Strongly Agree	Agree	Disagree	Strongly Disagree

29. When someone in the class is unfit, the whole class gets slowed down to that student's pace.

Strongly Agree	Agree	Disagree	Strongly Disagree

30. I find it frustrating if there is an unfit student in the class that slows down the pace of the physical training sessions.

Strongly Agree	Agree	Disagree	Strongly Disagree

31. When the pace of the physical training sessions is slowed down due to an unfit student, this has a negative impact on the class dynamics.

Strongly Agree	Agree	Disagree	Strongly Disagree

32. Structured physical training sessions are important to ensure that an EMC student is adequately prepared to engage safely and efficiently with the learning activities of the BEMC programme.

Strongly Agree	Agree	Disagree	Strongly Disagree

Section D – Assessment of Physical Preparedness:

33. There should be structured physical training sessions.

Strongly Agree	Agree	Disagree	Strongly Disagree

34. The level of physical preparedness of the students should be assessed.

Strongly Agree	Agree	Disagree	Strongly Disagree

35. The attendance of physical training sessions should be elective.

Strongly Agree	Agree	Disagree	Strongly Disagree

36. The development and maintenance of physical preparedness should be left to the individual student and not be facilitated by the University.

Strongly Agree	Agree	Disagree	Strongly Disagree

37. All universities offering the BEMC programme should make use of a similar physical fitness standard and assessment.

Strongly Agree	Agree	Disagree	Strongly Disagree

38. My department currently makes use of a formal physical preparedness assessment to assess the level of physical preparedness of the students.

True	False

39. The physical preparedness assessment results should be weighted throughout the academic year towards a final module mark.

Strongly Agree	Agree	Disagree	Strongly Disagree

40. I feel that the physical preparedness assessment should be conducted:

Quarterly	Bi-annually	Once at the end of the academic year

41. The physical preparedness assessment utilised by my department is a good indicator of a student's level of physical preparedness and ability to engage safely and efficiently in the learning activities of the BEMC programme.

Strongly Agree	Agree	Disagree	Strongly Disagree

42. The current physical preparedness assessment is very difficult and it is a challenge to pass the assessment.

Strongly Agree	Agree	Disagree	Strongly Disagree

43. Students that are unfit and unable to engage safely and efficiently in the learning activities of the BEMC programme do not pass my department's physical preparedness assessment.

Strongly Agree	Agree	Disagree	Strongly Disagree

44. The physical preparedness assessment should be the same for all students irrespective of their age, gender, height or weight.

Strongly Agree	Agree	Disagree	Strongly Disagree

45. I feel that the following components of physical fitness are important to participate safely and efficiently in the BEMC programme:

Components of Physical Fitness			
Cardiovascular endurance – the ability of the cardiovascular and respiratory systems to provide oxygen during sustained physical activity, e.g. 5km run	YES	NO	UNSURE
Flexibility – relates to the range of motion within a joint, e.g. sit and reach test	YES	NO	UNSURE
Muscular endurance – relates to the ability of muscles to continue functioning without fatigue, e.g. flexed-arm hang test	YES	NO	UNSURE
Muscular strength – relates to the ability of the muscles to exert force, e.g. 1-rep max bench press or leg press	YES	NO	UNSURE
Agility – relates to the ability to quickly change the position of the body with accuracy and speed, e.g. run an agility circuit in both directions (left and right) in response to a stimulus	YES	NO	UNSURE
Balance – relates to the preservation of equilibrium whilst either moving or stationary, e.g. standing balance test	YES	NO	UNSURE
Coordination – relates to the ability to use senses such as hearing and vision together with the body to perform motor tasks efficiently, smoothly and precisely	YES	NO	UNSURE
Power – relates to the ability or rate at which one can perform work	YES	NO	UNSURE
Speed – relates to the ability at which one can perform a movement within a short period of time	YES	NO	UNSURE
Reaction time – relates to the time which elapses between the initial stimulation and the start of the reaction to it	YES	NO	UNSURE
Body composition – addresses the relative amounts of muscle, fat, bone and other vital body parts	YES	NO	UNSURE

Thank you for taking the time to complete the questionnaire component of this study. Your input is valued.

APPENDIX 5B: QUESTIONNAIRE FOR THE SENIOR STUDENTS

This questionnaire is designed to obtain your views and opinions on physical preparedness for emergency medical care students. It is very important that you take the time to carefully read the questions, to ensure that you interpret the questions correctly, as your responses will form part of one of the important components that make up this study.

Section A – Demographics:

1. **State your age:** ____________________
2. **Gender:** Male / Female
3. **Current year of study:** 3rd Year / 4th Year

   **Please select the year in which you are either registered for Emergency Medical Care and/or Medical Rescue*
4. **HEI registered with as a Bachelor's Degree in Emergency Medical Care (BEMC) student:** CPUT / DUT / NMU / UJ

Section B – Background Content:

Physical fitness may be broadly divided into two categories: a) general physical fitness and b) task oriented or sport-oriented fitness. General physical fitness refers to the general state of health and well-being. Specific task-oriented fitness deals with the degree to which an individual is able to cope with the physical demands of their chosen profession without excessive fatigue. This study focuses predominantly on the assessment of task-oriented fitness and in this study we introduce the term "physical preparedness" which is to be read as an overarching term that includes task-oriented fitness.

5. Is physical preparedness a module that is reflected on your academic record with a mark?

Yes	No

6. There are activities in which I have participated as a student on the BEMC programme that have been physically demanding.

Agree	Disagree

7. It is important for a BEMC student to be physically fit and healthy to engage safely and efficiently with the content of the BEMC programme at my university.

Strongly Agree	Agree	Disagree	Strongly Disagree

8. Lecturers presenting the Medical Rescue and Emergency Medical Care modules should also be physically fit.

Strongly Agree	Agree	Disagree	Strongly Disagree

9. The ability to swim is a valuable life skill.

Agree	Disagree

10. Persons engaging in emergency care and rescue work should be able to swim.

Agree	Disagree

11. It is important for students registered on the BEMC programme to be able to swim.

Agree	Disagree

12. I participated in strenuous sporting activities when I was at school.

Yes	No

13. I was surprised with the level of physical preparedness required on the BEMC programme?

Agree	Disagree

14. Rating of perceived exertion (RPE) is a widely used and reliable indicator to assess and guide exercise intensity. The Borg Scale allows an individual to subjectively rate their own personal level of exertion during a physical activity. Making use of the revised category-ratio Borg Scale, please rate the level of perceived exertion for the 12 Medical Rescue modules that form part of the BEMC programme from 0

to 10. If you have not yet completed the module as part of the BEMC programme yet, please select the N/A column.

	High Angle I	Fire Search & Rescue	Motor Vehicle Rescue	Industrial & Agricultural Rescue	High Angle II	Wilderness Search & Rescue	Aviation Rescue	Aquatic Rescue	Structural Collapse Rescue	Trench Rescue	Confined Space Rescue	Hazardous Materials Rescue
N/A – Module not completed yet												
0 – At Rest												
1 – Very Easy												
2 – Somewhat Easy												
3 – Moderate												
4 – Somewhat Hard												
5 – Hard												
6 –												
7 – Very Hard												
8 –												
9 –												
10 – Very, Very Hard												

15. During my time as an emergency medical care student on the BEMC programme, I felt that the following experiences, events and/or activities were the most physically challenging for me:

____

____

____

Section C – Physical Training:

*When answering the questions relating to Section C, for the purpose of this study the term "**structured physical training**" refers to physical training sessions which are formally rostered on your academic timetable every week of the academic year, and these physical training sessions are led by a dedicated lecturer with clear aims and objectives that link to the content of the BEMC programme and the components of physical fitness which form part of the physical preparedness assessment used by my Department.*

16. Structured physical training was included as part of my first year of the BEMC programme.

Yes	No

17. Structured physical training was included as part of my second year of the BEMC programme.

Yes	No

18. Structured physical training was included as part of my third year of the BEMC programme.

Yes	No

19. Structured physical training was included as part of my fourth year of the BEMC programme.

Yes	No

20. The physical training is presented by one dedicated lecturer/facilitator who is solely responsible for all of the physical training across all four years on the BEMC programme.

True	False

21. The physical training is presented by a lecturer/facilitator, however, this lecturer differs either from session to session or year to year, e.g. the third-year coordinator is responsible for the physical training of the third-year students.

True	False

22. The physical training sessions start well at the beginning of the academic year, however, towards the end of the academic year, sessions are often cancelled and the structure is lost.

True	False

23. I believe that the lecturer assigned to facilitate my physical training sessions sees these as part of the BEMC programme, just as if they were any other lecture scheduled on the academic timetable.

True	False

24. There are set aims for each of the structured physical training sessions.

True	False

25. There are clear objectives which are outlined for each of the structured physical training sessions.

True	False

26. The structured physical training has been emotionally draining for me.

Strongly Agree	Agree	Disagree	Strongly Disagree

27. The structured physical training has provided me with greater mental endurance.

Strongly Agree	Agree	Disagree	Strongly Disagree

28. The structured physical training has benefitted me physically.

Strongly Agree	Agree	Disagree	Strongly Disagree

29. When someone in the class is unfit, the whole class gets slowed down to that student's pace.

Strongly Agree	Agree	Disagree	Strongly Disagree

30. I find it frustrating if there is an unfit student in the class that slows down the pace of the physical training sessions.

Strongly Agree	Agree	Disagree	Strongly Disagree

31. When the pace of the physical training sessions is slowed down due to an unfit student, this has a negative impact on the class dynamics.

Strongly Agree	Agree	Disagree	Strongly Disagree

32. Structured physical training sessions are important to ensure that I, as an EMC student, am adequately prepared to engage safely and efficiently with the learning activities of the BEMC programme.

Strongly Agree	Agree	Disagree	Strongly Disagree

Section D – Assessment of Physical Preparedness:

33. There should be structured physical training sessions.

Strongly Agree	Agree	Disagree	Strongly Disagree

34. The level of physical preparedness of the students should be assessed.

Strongly Agree	Agree	Disagree	Strongly Disagree

35. The attendance of physical training sessions should be elective.

Strongly Agree	Agree	Disagree	Strongly Disagree

36. The development and maintenance of physical preparedness should be left to the individual student and not be facilitated by the University.

Strongly Agree	Agree	Disagree	Strongly Disagree

37. All universities offering the BEMC programme should make use of a similar physical fitness standard and assessment.

Strongly Agree	Agree	Disagree	Strongly Disagree

38. My department currently makes use of a formal physical preparedness assessment to assess my level of physical preparedness.

True	False

39. The physical preparedness assessment results should be weighted throughout the academic year towards a final module mark.

Strongly Agree	Agree	Disagree	Strongly Disagree

40. The physical preparedness assessment utilised by my department is a good indicator of a student's level of physical preparedness and ability to engage safely and efficiently in the learning activities of the BEMC programme.

Strongly Agree	Agree	Disagree	Strongly Disagree

41. My current physical preparedness assessment is very difficult and I find it a challenge to pass the assessment.

Strongly Agree	Agree	Disagree	Strongly Disagree

42. Students that are unfit and unable to engage safely and efficiently in the learning activities of the BEMC programme do not pass my department's physical preparedness assessment.

Strongly Agree	Agree	Disagree	Strongly Disagree

43. The physical preparedness assessment should be the same for all students irrespective of their age, gender, height or weight.

Strongly Agree	Agree	Disagree	Strongly Disagree

44. I feel that the following components of physical fitness are important to participate safely and efficiently in the BEMC programme:

Components of Physical Fitness			
Cardiovascular endurance – the ability of the cardiovascular and respiratory systems to provide oxygen during sustained physical activity, e.g. 5km run	YES	NO	UNSURE
Flexibility – relates to the range of motion within a joint, e.g. sit and reach test	YES	NO	UNSURE
Muscular endurance – relates to the ability of muscles to continue functioning without fatigue, e.g. flexed-arm hang test	YES	NO	UNSURE
Muscular strength – relates to the ability of the muscles to exert force, e.g. 1-rep max bench press or leg press	YES	NO	UNSURE
Agility – relates to the ability to quickly change the position of the body with accuracy and speed, e.g. run an agility circuit in both directions (left and right) in response to a stimulus	YES	NO	UNSURE

Balance – relates to the preservation of equilibrium whilst either moving or stationary, e.g. standing balance test	YES	NO	UNSURE
Coordination – relates to the ability to use senses such as hearing and vision together with the body to perform motor tasks efficiently, smoothly and precisely	YES	NO	UNSURE
Power – relates to the ability or rate at which one can perform work	YES	NO	UNSURE
Speed – relates to the ability at which one can perform a movement within a short period of time	YES	NO	UNSURE
Reaction time – relates to the time which elapses between the initial stimulation and the start of the reaction to it	YES	NO	UNSURE
Body composition – addresses the relative amounts of muscle, fat, bone and other vital body parts	YES	NO	UNSURE

Thank you for taking the time to complete the questionnaire component of this study. Your input is valued.

APPENDIX 6: LETTER OF INFORMATION FOR THE FOCUS GROUP INTERVIEW

Dear Participant

Title of the Research Study: A validated tool for assessing task-oriented physical preparedness of South African Emergency Medical Care students

Principal Investigator/s/researcher: Mrs Dagmar Mühlbauer (MTech EMC)

Supervisors:
Prof Craig Vincent-Lambert (PhD Health Professions Education) & Prof Yoga Coopoo (BA; BA Hons; MA; DPhil (UDW), FACSM)

Brief Introduction and Purpose of the Study: This study takes place within the broad domain of health professions education in the discipline of Emergency Medical Care (EMC). The study focuses on the development of new knowledge and aims to produce a scientifically validated tool for the assessment of physical preparedness of South African EMC students. The study is premised on the understanding that emergency care and rescue environments (both operational and training) can be physically demanding, potentially hazardous and are consequently associated with a high number of work-related injuries and illnesses. This has resulted in employers placing an emphasis on developing task-oriented fitness programmes and assessments for their staff in an attempt to reduce the number and severity of injuries and resultant absenteeism from the workplace.

Aside from personal benefits associated with fitness and exercise, healthy persons who are physically prepared for their work environments are more effective and less likely to become fatigued. Taking the above into account, it is logical that Universities offering Emergency Medical Care programmes are responsible for the development, maintenance and assessment of their staff and student's levels of task-oriented physical preparedness. However, fulfilment of this responsibility becomes problematic in the absence of a scientifically validated tool to inform and guide such assessments. In this study, the researcher aims to develop a validated tool for assessing task-oriented physical preparedness of South African Emergency Medical Care students**.**

The purpose of this study is to address the research problem and answer the questions described above, the central aim of the study is therefore to develop and validate a tool that can be used to assess task-oriented physical preparedness of South African emergency medical care students.

Outline of the Procedures: You will be required to participate in a focus group interview as part of the second phase of this study. The focus group interviews will take place online via Microsoft Team. The focus group interviews will be conducted by the researcher who will fulfil the role of the moderator for the discussions.

Risks or Discomforts to the Participant: There are no foreseeable risks or discomforts for you when participating in the focus group interview.

Benefits: This study may result in the development of a validated task-oriented physical preparedness assessment tool specific for the BEMC programme to ensure that the components of the tool are job related and that the assessment tool utilised by the relevant HEIs measures what is intended to be measured. The study may also address the role of discrimination against any of the protected characteristics when assessing the task-oriented physical preparedness of emergency medical care students.

Reason/s why the Participant May Be Withdrawn from the Study: You may withdraw from the study at any stage and there will be no adverse consequences should you choose to withdraw.

Remuneration: There will be no remuneration for taking part in this study.

Costs of the Study: There will be no costs incurred at any stage of the study.

Confidentiality: No identifying data will be captured at any stage during the focus group interview, all of the data from the focus group interviews will be coded. The data collected will be stored in a password protected folder on a password protected laptop. Only the researcher and supervisors will have access to the recordings and data from the focus group interviews.

Persons to Contact in the Event of Any Problems or Queries:
Please contact the researcher, Mrs Dagmar Mühlbauer (082 444 3671), my supervisor, Prof Craig Vincent-Lambert (082 653 2125) or the Institutional Research Ethics Administrator on 031 373 2375. Complaints can be reported to the Director: Research and Postgraduate Support Dr L Linganiso on 031 373 2577 or researchdirector@dut.ac.za.

General:
Potential participants must be assured that participation is voluntary and the approximate number of participants to be included should be disclosed. A copy of the information letter should be issued to participants. The information letter and consent form must be translated and provided in the primary spoken language of the research population e.g. isiZulu.

APPENDIX 7: CONSENT FORM FOR THE FOCUS GROUP INTERVIEW FOR ACADEMIC STAFF AND SENIOR STUDENTS

DUT DURBAN UNIVERSITY OF TECHNOLOGY — INSTITUTIONAL RESEARCH ETHICS COMMITTEE

CONSENT FOR THE FOCUS GROUP INTERVIEW

Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, Mrs Dagmar Mühlbauer (name of researcher), about the nature, conduct, benefits and risks of this study – Research Ethics Clearance Number: IREC 058/19,
- I have also received, read and understood the above written information (Participant Letter of Information) regarding the study.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.
- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

______________________________	__________________	_____________
Full Name of Participant	**Date**	**Time**

I, Dagmar Mühlbauer (name of researcher) herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

____________________	____________	______________________
Full Name of Researcher	**Date**	**Signature**

APPENDIX 8: CONSENT FORM FOR THE AUDIO RECORDING OF THE FOCUS GROUP INTERVIEW FOR ACADEMIC STAFF AND SENIOR STUDENTS

DUT DURBAN UNIVERSITY OF TECHNOLOGY
INSTITUTIONAL RESEARCH ETHICS COMMITTEE

INTERVIEW CONSENT FORM

Title of the Research Study: A validated tool for assessing task-oriented physical preparedness of South African Emergency Medical Care students

Principal Investigator/s/researcher: Mrs Dagmar Mühlbauer (MTech EMC)

Supervisors:
Prof Craig Vincent-Lambert (PhD Health Professions Education) & Prof Yoga Coopoo (BA; BA Hons; MA; DPhil (UDW), FACSM)

Thank you for reading the letter of information provided about the focus group interviews. If you are happy to participate, then please complete and sign the form below. Please initial the boxes below to confirm that you agree with each statement:

	Please Initial box:
I confirm that I have read and understood the letter of information and have had the opportunity to ask questions.	
I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason and without there being any negative consequences. In addition, should I not wish to answer any particular question or questions, I am free to decline.	

I understand that my responses will be kept strictly confidential. I understand that my name will not be linked with the research materials, and will not be identified or identifiable in the report or reports that result from the research.	
I agree for this interview to be audio-recorded. I understand that the audio recording made of this interview will be used only for analysis and that extracts from the interview, from which I would not be personally identified, may be used in any conference presentation, report or journal article developed as a result of the research. I understand that no other use will be made of the recording without my written permission, and that no one outside the research team will be allowed access to the original recording.	
I agree that my anonymised data will be kept for future research purposes such as publications related to this study after the completion of the study.	
I agree to take part in this interview	

____

Printed Name

______________________________ __________________

Participant’s Signature Date

______________________________ __________________

Researcher’s Signature Date

APPENDIX 9A: FOCUS GROUP INTERVIEW AGENDA FOR THE ACADEMIC STAFF

AGENDA FOR THE FOCUS GROUP INTERVIEW FOR ACADEMIC STAFF		
NO.	**AGENDA ITEM**	**ESTIMATED TIME**
Welcome, introduction and briefing		
1.	Welcome	5 minutes
2.	Introduce research team leading the focus group interview and clarify individual roles • Mrs Dagmar Muhlbauer – main moderator • Prof Craig Vincent-Lambert – supervisor & observer • Prof Yoga Coopoo – co-supervisor & subject expert	
3.	Establish informed consent by confirming that all participants have signed the letter of consent as well as the consent for audio recording of the focus group interview.	
4.	Indicate to focus group that this session will be recorded so that the researcher will be able to accurately interpret the focus group conversations.	
5.	Start recording	
6.	State the purpose of the focus group interview: • "Task Oriented Physical Preparedness forms an integral part of the BHSc EMC programme, and therefore should have a validated assessment tool in place to assess the level of physical preparedness of South African emergency medical care students." • The purpose of this focus group interview is to investigate and describe the views and opinions of academics and senior emergency medical care students regarding (a) the physical requirements/task-oriented activities linked to participation in the BHSc EMC programme and (b) the extent to which you feel that your current physical preparedness assessment tool adequately assesses task-oriented physical preparedness.	2 minutes

7.	Explain the ground rules for the focus group interview: • Remind participants that participation is voluntary and the participant may withdraw at any time during the focus group interview • Indicate that it is alright to abstain from discussing specific topics if you are not comfortable • All responses are valid – there are no right or wrong answers • Please respect the opinions of others even if you don't agree • Try to stay on topic, and don't be offended if members of the research team interrupt you as we will redirect the conversation if need be to cover all of the material • Speak as openly as you feel comfortable • Names of participants are anonymous	3 minutes
8.	Allow time to answer any questions requiring clarification prior to commencing with the main agenda of the focus group interview.	5 minutes
9.	Allow participants to briefly introduce themselves.	5 minutes
Topic A: Current physical preparedness assessment tool		
10.	When analyzing the data from the questionnaire, 3/12 (25.0%) of the academic staff disagreed with the following question: "The physical preparedness assessment tool utilized by my Department is a good indicator of a student's level of physical preparedness and ability to engage safely and efficiently in the learning activities of the BHSc EMC programme". **In your view, which aspects or components of your current physical preparedness assessment are not appropriate?**	15 minutes

11.	There was strong agreement 8/12 (66.7%) strongly agreed and 3/12 (25.0%) agreed), that the physical preparedness standard and assessment across all of the universities offering the BHSc EMC programme should be the same. **In your opinion, why do you feel that it should be similar?**	15 minutes
Topic B: Task-simulated tests vs. Physical performance tests		
12.	The physical fitness of emergency responders can either be evaluated by task-simulated tests or physical performance tests that represent the components of physical fitness such as muscular strength, muscular endurance, flexibility, etc. A task-simulated test would consist of either an obstacle test or an agility test with simulated tasks, e.g. carrying equipment up a flight of stairs, and then performing CPR for two minutes. Whereas a physical performance test will consist of a fitness test battery and the fitness tests are functionally specific and based on the components of physical fitness required for that emergency responder. **Having listened to this description of a task-simulated test and a physical performance test, talk a little bit about what your views are on these two different approaches?** **Which of the two different approaches would be more practical for the BHSc EMC students, and why do you feel that way?**	15 minutes

Topic C: Physically strenuous components of the BHSc EMC programme		
13.	In the questionnaire, academic staff were required to mention which aspects of the BHSc EMC programme they felt were physically strenuous for the students, however, this was a closed ended question. **Can you elaborate a bit about which aspects of the programme you feel are physically strenuous and why you say so?** **If you make mention of a specific module within the BHSc EMC programme as being strenuous, then what aspects of this module are strenuous or do you see students having difficulties with?**	30 minutes
Topic D: Components of physical fitness		
14.	Prof Coopoo as the subject expert will provide a brief overview of the different components of physical fitness as listed in Annexure A. **Now that you have a clearer understanding of the different components of physical fitness, which emergency medical care and/or medical rescue modules requires:** **Cardiovascular endurance - Give an example of an outcome and/or exercise where this specific component of fitness was an issue.** **Flexibility - Give an example of an outcome and/or exercise where this specific component of fitness was an issue** **Muscular endurance - Give an example of an outcome and/or exercise where this specific component of fitness was an issue**	30 minutes

	<u>Muscular strength</u> - **Give an example of an outcome and/or exercise where this specific component of fitness was an issue** <u>Agility</u> - **Give an example of an outcome and/or exercise where this specific component of fitness was an issue** <u>Balance</u> - **Give an example of an outcome and/or exercise where this specific component of fitness was an issue** <u>Coordination</u> - **Give an example of an outcome and/or exercise where this specific component of fitness was an issue** <u>Power</u> - **Give an example of an outcome and/or exercise where this specific component of fitness was an issue** <u>Speed</u> - **Give an example of an outcome and/or exercise where this specific component of fitness was an issue** <u>Reaction time</u> - **Give an example of an outcome and/or exercise where this specific component of fitness was an issue**	
15.	One of the components of fitness is body composition which addresses the relative amounts of muscle, fat, bone and other vital body parts. **What is your view on how important this component of fitness is for the EMC student to engage safely and efficiently in the learning activities of the BHSc EMC programme?**	5 minutes
Closing		
16.	Invite participants to reflect on the main ideas, and ask if they have any additional thoughts to share.	5 minutes
17.	Thank the participants.	
18.	Stop recording	

Annexure A: The 11 components of physical fitness (ACSM 2018)

Component	Brief definition
Cardiovascular endurance	Relates to the ability of the cardiovascular and respiratory systems to provide oxygen during sustained physical activity.
Flexibility	Relates to the range of motion available within a joint.
Muscular endurance	Relates to the ability of muscles to continue functioning without fatigue.
Muscular strength	Relates to the ability of the muscles to exert force.
Agility	Relates to the ability to quickly change the position of the body with accuracy and speed.
Balance	Relates to the preservation of equilibrium whilst either moving or stationary.
Coordination	Relates to the ability to uses senses such as hearing and vision together with the body to perform motor tasks efficiently, smoothly and precisely.
Power	Relates to the ability or rate at which one can perform work.
Speed	Relates to the ability at which one can perform a movement within a short period of time.
Reaction time	Relates to the time which elapses between the initial stimulation and the start of the reaction to it.
Body composition	Addresses the relative amounts of muscle, fat, bone and other vital body parts.

Reference:

ACSM. 2018. *ACSM's Guidelines for Exercise Testing and Prescription*. 10th ed. Wolters Kluwer.

APPENDIX 9B: FOCUS GROUP INTERVIEW AGENDA FOR THE SENIOR STUDENTS

AGENDA FOR THE FOCUS GROUP INTERVIEW FOR SENIOR STUDENTS		
NO.	**AGENDA ITEM**	**ESTIMATED TIME**
Welcome, introduction and briefing		
1.	Welcome	5 minutes
2.	Introduce research team leading the focus group interview and clarify individual roles • Mrs Dagmar Muhlbauer – main moderator • Prof Craig Vincent-Lambert – supervisor & observer • Prof Yoga Coopoo – co-supervisor & subject expert	
3.	Establish informed consent by confirming that all participants have signed the letter of consent as well as the consent for audio recording of the focus group interview.	
4.	Indicate to focus group that this session will be recorded so that the researcher will be able to accurately interpret the focus group conversations.	
5.	Start recording	
6.	State the purpose of the focus group interview: • "Task Oriented Physical Preparedness forms an integral part of the BHSc EMC programme, and therefore should have a validated assessment tool in place to assess the level of physical preparedness of South African emergency medical care students." • The purpose of this focus group interview is to investigate and describe the views and opinions of academics and senior emergency medical care students regarding (a) the physical requirements/task-oriented activities linked to participation in the BHSc EMC programme and (b) the extent to which you feel that your current physical preparedness assessment tool adequately assesses task-oriented physical preparedness.	2 minutes

1

7.	Explain the ground rules for the focus group interview: • Remind participants that participation is voluntary and the participant may withdraw at any time during the focus group interview • Indicate that it is alright to abstain from discussing specific topics if you are not comfortable • All responses are valid – there are no right or wrong answers • Please respect the opinions of others even if you don't agree • Try to stay on topic, and don't be offended if members of the research team interrupt you as we will redirect the conversation if need be to cover all of the material • Speak as openly as you feel comfortable • Names of participants are anonymous	3 minutes
8.	Allow time to answer any questions requiring clarification prior to commencing with the main agenda of the focus group interview.	5 minutes
9.	Allow participants to briefly introduce themselves.	5 minutes
Topic A: Current physical preparedness assessment tool		
10.	When analyzing the data from the questionnaire, 35/117 (29.9%) of the senior students disagreed and 6/117 (5.1%) strongly disagreed with the following question: "The physical preparedness assessment tool utilized by my Department is a good indicator of a student's level of physical preparedness and ability to engage safely and efficiently in the learning activities of the BHSc EMC programme". **In your view, which aspects or components of your current physical preparedness assessment are not appropriate?**	15 minutes

11.	There was strong agreement 59/117 (50.4%) strongly agreed and 44/117 (37.6%) agreed, that the physical preparedness standard and assessment across all of the universities offering the BHSc EMC programme should be the same. **In your opinion, why do you feel that it should be similar?**	15 minutes
Topic B: Task-simulated tests vs. Physical performance tests		
12.	The physical fitness of emergency responders can either be evaluated by task-simulated tests or physical performance tests that represent the components of physical fitness such as muscular strength, muscular endurance, flexibility, etc. A task-simulated test would consist of either an obstacle test or an agility test with simulated tasks, e.g. carrying equipment up a flight of stairs, and then performing CPR for two minutes. Whereas a physical performance test will consist of a fitness test battery and the fitness tests are functionally specific and based on the components of physical fitness required for that emergency responder. **Having listened to this description of a task-simulated test and a physical performance test, talk a little bit about what your views are on these two different approaches?** **Which of the two different approaches would be more practical for the BHSc EMC students, and why do you feel that way?**	15 minutes

Topic C: Physically strenuous components of the BHSc EMC programme		
13.	In the questionnaire, senior students were required to mention which aspects of the BHSc EMC programme they felt were physically strenuous for the students, however, this was a closed ended question. **Can you elaborate a bit about which aspects of the programme you feel are physically strenuous and why you say so?** **If you make mention of a specific module within the BHSc EMC programme as being strenuous, then what aspects of this module are strenuous or do you see fellow students having difficulties with?**	30 minutes
Topic D: Components of physical fitness		
14.	Prof Coopoo as the subject expert will provide a brief overview of the different components of physical fitness as listed in Annexure A. **Now that you have a clearer understanding of the different components of physical fitness, which emergency medical care and/or medical rescue modules requires:** **<u>Cardiovascular endurance</u> - Give an example of an outcome and/or exercise where this specific component of fitness was an issue.** **<u>Flexibility</u> - Give an example of an outcome and/or exercise where this specific component of fitness was an issue** **<u>Muscular endurance</u> - Give an example of an outcome and/or exercise where this specific component of fitness was an issue**	30 minutes

	Muscular strength - Give an example of an outcome and/or exercise where this specific component of fitness was an issue Agility - Give an example of an outcome and/or exercise where this specific component of fitness was an issue Balance - Give an example of an outcome and/or exercise where this specific component of fitness was an issue Coordination - Give an example of an outcome and/or exercise where this specific component of fitness was an issue Power - Give an example of an outcome and/or exercise where this specific component of fitness was an issue Speed - Give an example of an outcome and/or exercise where this specific component of fitness was an issue Reaction time - Give an example of an outcome and/or exercise where this specific component of fitness was an issue	
15.	One of the components of fitness is body composition which addresses the relative amounts of muscle, fat, bone and other vital body parts. **What is your view on how important this component of fitness is for the EMC student to engage safely and efficiently in the learning activities of the BHSc EMC programme?**	5 minutes
Closing		
16.	Invite participants to reflect on the main ideas, and ask if they have any additional thoughts to share.	5 minutes
17.	Thank the participants.	
18.	Stop recording	

Annexure A: The 11 components of physical fitness (ACSM 2018)

Component	Brief definition
Cardiovascular endurance	Relates to the ability of the cardiovascular and respiratory systems to provide oxygen during sustained physical activity.
Flexibility	Relates to the range of motion available within a joint.
Muscular endurance	Relates to the ability of muscles to continue functioning without fatigue.
Muscular strength	Relates to the ability of the muscles to exert force.
Agility	Relates to the ability to quickly change the position of the body with accuracy and speed.
Balance	Relates to the preservation of equilibrium whilst either moving or stationary.
Coordination	Relates to the ability to uses senses such as hearing and vision together with the body to perform motor tasks efficiently, smoothly and precisely.
Power	Relates to the ability or rate at which one can perform work.
Speed	Relates to the ability at which one can perform a movement within a short period of time.
Reaction time	Relates to the time which elapses between the initial stimulation and the start of the reaction to it.
Body composition	Addresses the relative amounts of muscle, fat, bone and other vital body parts.

Reference:

ACSM. 2018. *ACSM's Guidelines for Exercise Testing and Prescription*. 10th ed. Wolters Kluwer.

APPENDIX 10: LETTER OF INFORMATION FOR THE ASSESSMENT OF PHYSICAL PREPAREDNESS

LETTER OF INFORMATION

Dear Participant

Title of the Research Study: A validated tool for assessing task-oriented physical preparedness of South African Emergency Medical Care students

Principal Investigator/s/researcher: Mrs Dagmar Muhlbauer (MTech EMC)

Co-Investigator/s/supervisor/s: Prof Craig Vincent-Lambert (PhD Health Professions Education) & Prof Yoga Coopoo (BA, BA Hons, MA. DPhil (UDW), FACSM)

Brief Introduction and Purpose of the Study: This study takes place within the broad domain of health professions education in the discipline of Emergency Medical Care (EMC). The study focuses on the development of new knowledge and aims to produce a scientifically validated tool for the assessment of physical preparedness of South African EMC students. The study is premised on the understanding that emergency care and rescue environments (both operational and training) can be physically demanding, potentially hazardous and are consequently associated with a high number of work-related injuries and illnesses. This has resulted in employers placing an emphasis on developing task-oriented fitness programmes and assessments for their staff in an attempt to reduce the number and severity of injuries and resultant absenteeism from the workplace.

Aside from personal benefits associated with fitness and exercise, healthy persons who are physically prepared for their work environments are more effective and less likely to become fatigued. Taking the above into account, it is logical that Universities offering Emergency Medical Care programmes are responsible for the development, maintenance and assessment of their staff and student's levels of task-oriented physical preparedness. However, fulfilment of this responsibility becomes problematic in the absence of a scientifically validated tool to inform and guide such assessments. In this study, the researcher aims to develop a validated tool for assessing task-oriented physical preparedness of South African Emergency Medical Care students.

The purpose of this study is to address the research problem and answer the questions described above, the central aim of the study is therefore to develop and validate a tool that can be used to assess task-oriented physical preparedness of South African emergency medical care students.

Outline of the Procedures: You will be expected to take part in a physical fitness assessment consisting of anthropometric measurements and nine fitness tests over two days of data collection. This assessment should take approximately 60 minutes to complete and to take part in the assessment, you need to fulfil the following inclusion criteria:

1) You must be registered for either their third or fourth year of study on the BHSc EMC programme in the 2023 academic year; and
2) You must be 18 years or older to take part in the study, however there is no maximum age limitation to take part in the study.
3) You will also need to be healthy and free from any absolute contraindications for exercise testing as determined by the American College of Sports Medicine (PAR-Q). Should you answer "yes" to any of the questions on the PAR-Q questionnaire, you will automatically be excluded from the study.

Should you wish to take part in this study or should you require further information about this study, please contact the researcher, Mrs Dagmar Muhlbauer on 082 444 3671 or 21143532@dut4life.ac.za.

Risks or Discomforts to the Participant: The potential for harm and/or risk to you in this study is slightly above minimal risk as you are a registered senior students on the BHSc EMC programme at one of the three HEIs. As part of the initial recruitment and application process for the BHSc EMC programme, you were subjected to both a medical and fitness assessment to determine that you were healthy and had no illnesses or injuries that could predispose you to any risk of harm or injury. You will be required to complete a Physical Activity Readiness Questionnaire (PAR-Q) which will assess if you are healthy and free from any absolute contraindications for exercise testing. Should you have an acute injury or illness at the time of the study that could result in injury or harm, you would be excluded from participating in the study. You also engage in physical preparedness and medical rescue activities as part of the BHSc EMC programme, therefore your risk profile for injury is low as you do not represent sedentary physically unfit individuals. The experiment will be conducted in a controlled environment under the supervision of the researcher and at no time would you be subjected to physical activities that could cause harm or injury when done correctly. A demonstration of each of the physical activities will be provided by the researcher to ensure that you execute the exercises with the correct form which should limit the injury risk. Should you incur an injury whilst taking part in the experiment, you will be solely responsible for any associated medical costs (including transportation to hospital, if necessary). There is a risk of muscle soreness because of the testing as you may be exposed to exercises which you do not routinely perform. This muscle stiffness should dissipate within 24 hours. Throughout the experiment, a fully equipped operational Advanced Life Support (ALS) emergency response vehicle staffed with registered Advanced Life Support Practitioners will be available on site to manage any unforeseen injuries. In the event of an injury, the participant will be assessed and managed by the operational ALS practitioners and referred off site to the nearest hospital if required. Neither the researcher and/or supervisor will fulfil this role during the experimental phase of the research.

Benefits: There will be no direct benefits to you as a participant in this experiment.

Reason/s why the Participant May Be Withdrawn from the Study: You may withdraw from the study at any stage and there will be no adverse consequences should you choose to withdraw. Should you wish to withdraw form the study, please inform the researcher by one of the following methods: 1) in person, 2) via email on 21143532@dut4life.ac.za or 3) via telephone on 082 444 3671.

If you have already completed parts of the data collection process, the data that has been collected will not be utilized as part of the study, however, the data will still be stored for record keeping purposes on a password protected file for a period of fifteen years, after which the file will be destroyed.

Remuneration: There will be no remuneration for taking part in this study.

Costs of the Study: There will be no costs incurred at any stage of the study.

Confidentiality: All participants will be allocated a participant code for the duration of the experiment. No identifying personal data will be captured on the Physical Activity Readiness Questionnaire (PAR-Q) or the data collection template. The participant number, and not name will be captured on the PAR-Q and data collection template to ensure anonymity of the participants. The hard copies of the consent forms, PAR-Q and data collection templates will be stored in a lever arch file that will be stored in a secure cupboard at the researcher's place of residence and only the researcher and supervisors will have access to these hard copies. As the data is captured electronically it will be stored in a password protected folder on a password protected laptop which only the researcher will have access to. No additional electronic copies will be made of the data. At all times, only the researcher and supervisors will have access to any of the anonymised information related to this study.

Persons to Contact in the Event of Any Problems or Queries:
Please contact the researcher, Mrs Dagmar Muhlbauer (082 444 3671), my supervisor, Prof Craig Vincent-Lambert (082 653 2125) or the Institutional Research Ethics Administrator on 031 373 2375. Complaints can be reported to the Director: Research and Postgraduate Support Dr L Linganiso on 031 373 2577 or researchdirector@dut.ac.za.

General:
Potential participants must be assured that participation is voluntary and the approximate number of participants to be included should be disclosed. A copy of the information letter should be issued to participants. The information letter and consent form must be translated and provided in the primary spoken language of the research population e.g. isiZulu.

APPENDIX 11: CONSENT FORM FOR THE ASSESSMENT OF PHYSICAL PREPAREDNESS

DUT DURBAN UNIVERSITY OF TECHNOLOGY | INSTITUTIONAL RESEARCH ETHICS COMMITTEE

CONSENT

Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, Mrs Dagmar Muhlbauer, about the nature, conduct, benefits and risks of this study – Research Ethics Clearance Number: IREC 058/19.
- I have also received, read and understood the above written information (Participant Letter of Information) regarding the study.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.
- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

______________________	______________	__________
Full Name of Participant	**Date**	**Time**

APPENDIX 12: PHYSICAL ACTIVITY READINESS QUESTIONNAIRE (PAR-Q)

2023 PAR-Q+

The Physical Activity Readiness Questionnaire for Everyone

The health benefits of regular physical activity are clear; more people should engage in physical activity every day of the week. Participating in physical activity is very safe for MOST people. This questionnaire will tell you whether it is necessary for you to seek further advice from your doctor OR a qualified exercise professional before becoming more physically active.

GENERAL HEALTH QUESTIONS

Please read the 7 questions below carefully and answer each one honestly: check YES or NO.	**YES**	**NO**
1) Has your doctor ever said that you have a heart condition ☐ **OR** high blood pressure ☐?	☐	☐
2) Do you feel pain in your chest at rest, during your daily activities of living, **OR** when you do physical activity?	☐	☐
3) Do you lose balance because of dizziness **OR** have you lost consciousness in the last 12 months? Please answer **NO** if your dizziness was associated with over-breathing (including during vigorous exercise).	☐	☐
4) Have you ever been diagnosed with another chronic medical condition (other than heart disease or high blood pressure)? **PLEASE LIST CONDITION(S) HERE:** ______	☐	☐
5) Are you currently taking prescribed medications for a chronic medical condition? **PLEASE LIST CONDITION(S) AND MEDICATIONS HERE:** ______	☐	☐
6) Do you currently have (or have had within the past 12 months) a bone, joint, or soft tissue (muscle, ligament, or tendon) problem that could be made worse by becoming more physically active? Please answer **NO** if you had a problem in the past, but it **does not limit your current ability** to be physically active. **PLEASE LIST CONDITION(S) HERE:** ______	☐	☐
7) Has your doctor ever said that you should only do medically supervised physical activity?	☐	☐

If you answered NO to all of the questions above, you are cleared for physical activity.
Please sign the PARTICIPANT DECLARATION. You do not need to complete Pages 2 and 3.

- Start becoming much more physically active – start slowly and build up gradually.
- Follow Global Physical Activity Guidelines for your age (https://www.who.int/publications/i/item/9789240015128).
- You may take part in a health and fitness appraisal.
- If you are over the age of 45 yr and NOT accustomed to regular vigorous to maximal effort exercise, consult a qualified exercise professional before engaging in this intensity of exercise.
- If you have any further questions, contact a qualified exercise professional.

PARTICIPANT DECLARATION
If you are less than the legal age required for consent or require the assent of a care provider, your parent, guardian or care provider must also sign this form.

I, the undersigned, have read, understood to my full satisfaction and completed this questionnaire. I acknowledge that this physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if my condition changes. I also acknowledge that the community/fitness center may retain a copy of this form for its records. In these instances, it will maintain the confidentiality of the same, complying with applicable law.

PARTICIPANT NUMBER	
DATE	
SIGNATURE	
WITNESS	

Particpant Number								
SECTION C - DAY 1 FITNESS TESTING								
Test 1: 400m Swim Test	25m	50m	75m	100m	125m	150m	175m	200m
	225m	250m	275m	300m	325m	350m	375m	400m
	Record the distance in metres at the 8 minute mark if 400m has not been completed							metres
	Total time taken to complete the 400m swim							minutes/seconds
Test 2: Cooper 12-minute run test	Lap 1	Lap 2	Lap 3	Lap 4	Lap 5	Lap 6	Lap 7	Lap 8
	Lap 9	Lap 10	Lap 11	Lap 12	Lap 13	Lap 14	Lap 15	Lap 16
	Additional distance in metres							m
	Total distance covered in metres							m
Test 3: Max Push Up Test	Number of repetitions completed							reps
Test 4: 7-Stage Abdominal Strength Test	Level 0 Achieved				Level 4 Achieved			
	Level 1 Achieved				Level 5 Achieved			
	Level 2 Achieved				Level 6 Achieved			
	Level 3 Achieved				Level 7 Achieved			
Test 5: Grip Strength Test	Attempt 1 Left			kg	Attempt 1 Right			kg
	Attempt 2 Left			kg	Attempt 2 Right			kg
	Attempt 3 Left			kg	Attempt 3 Right			kg

Particpant Number								
SECTION D - DAY 2 FITNESS TESTING								
Test 1: 200m Swim Test	25m	50m	75m	100m	125m	150m	175m	200m
	Record the distance in metres at the 6 minute mark if 200m has not been completed							metres
	Time taken to complete the 200m swim (in minutes & seconds)							minutes/seconds
Test 2: 5km Run Test *Lap is only to be marked off once the lap is completed & student crosses finish line*	Lap 1/2	Lap 1	Lap 2	Lap 3	Lap 4	Lap 5	Lap 6	Lap 7
	Lap 8	Lap 9	Lap 10	Lap 11	Lap 12			
	Record the distance in metres at the 32m30s mark if 5km has not been completed							metres
	Time taken to complete the 5km run (in minutes & seconds)							minutes/seconds
Test 3: Flexed Arm Hang Test	Total time in minutes and seconds							minutes/seconds

APPENDIX 13: ASSESSMENT OF PHYSICAL PREPAREDNESS DATA COLLECTION TEMPLATE

SECTION A - DEMOGRAPHIC INFORMATION								
Particpant Number								
HEI	DUT		UJ		NMU			
Year of study	3rd Year			4th Year				
Sex								
Age								
How many days do you train per week?	1	2	3	4	5	6	7	
How long do you train on average per day in minutes?								(minutes)
SECTION B - ANTHROPOMETRIC MEASUREMENTS								
Weight (kg) - recorded to the nearest 0.1kg	Measurement 1							kg
	Measurement 2							kg
Height (cm) *Recorded to the nearest half a cm*								cm
Skinfold (right side) *Capture reading in mm to the nearest 0.5mm*	Bicep	1	mm	2	mm	3	mm	
	Tricep	1	mm	2	mm	3	mm	
	Subscapular	1	mm	2	mm	3	mm	
	Suprailiac	1	mm	2	mm	3	mm	
Modified Sit & Reach Test	Zero value in cm							cm
	Attempt 1 in cm							cm
	Attempt 2 in cm							cm
	Attempt 3 in cm							cm

APPENDIX 14: LETTER FROM STATISTICIAN

Gill Hendry B.Sc. (Hons), M.Sc. (Wits), PhD (UKZN)

Mathematical and Statistical Services

Cell: 083 300 9896

Email: gillhendrystats@gmail.com

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13 June 2023

Re: Assistance data analysis

Please be advised that I have assisted Dagmar Muhlbauer (Student number 21143532), who is currently studying for a Doctor of Philosophy: Emergency Medical Care at DUT, with the statistical analysis of her data.

Yours sincerely

Dr Gill Hendry

Private Consulting Statistician

APPENDIX 15: LETTER FROM THE PROFESSIONAL EDITOR

ETHEL ROSS

English language editing and proofreading

19 June 2023

To whomever it may concern:

This letter serves to confirm that I worked as the proofreader and language editor on DAGMAR MÜHLBAUER'S D. Phil. thesis:

A VALIDATED TOOL FOR ASSESSING TASK-ORIENTED PHYSICAL PREPAREDNESS OF SOUTH AFRICAN EMERGENCY MEDICAL CARE STUDENTS

In no way did I change the content.

Yours faithfully

Ethel Ross (BA Hons; H Dip Ed)

Email: clanross1@icon.co.za Tel: 083 954 5412