# The physical activity levels of students at a University of Technology in South Africa

**By**

**Gareth Hewer**

**November 2020**

Dissertation submitted in partial compliance with the requirements for the Masters' degree in Technology: Chiropractic

I, Gareth Hewer, do declare that this dissertation is representative of my own work in both conception and execution (except where acknowledgements indicate to the contrary)

___________________ _________________

**Gareth Hewer** **Date**

Approved for final submission by:

_________________ ________________

**Supervisor: Prof. Firoza Haffejee** **Date**

_________________ ________________

**Co-supervisor: Prof. Julian Pillay** **Date**

# Acknowledgements

To Karmen - thank you for all your love and support throughout this experience. I could not have gotten to this point without you. You are my rock and keep me grounded and help me to continue to have faith. You have also always made me want to achieve even greater things in life and having you in my life is my biggest blessing. Thank you and I love you with all my heart.

To my parents and sister - thank you for your support and for giving me the opportunity to study and to achieve in life. I am grateful for everything you have done for me.

To my supervisors - Professors F Haffejee and JD Pillay - thank you for all your guidance and help throughout the research procedure and for the many rounds of corrections, emails, phone calls and texts to get this right.

To all my other family and friends - thank you for all your love and support and believing in me. I am eternally grateful to have you.

# Abstract

## Introduction

Physical activity (PA) has been shown to play an important role in an individuals' health. Physically active individuals have a lower risk of acquiring chronic health diseases such as coronary heart disease, type 2 diabetes mellitus and hypertension. Physical activity is a compulsory component of the school curriculum in South Africa (SA), incorporated into the subject “Life Orientation”. However, in tertiary institutions PA is not included within the university curriculum and is only available as an additional extramural activity that not many students utilise. PA levels have been shown to decline with age in adulthood. University students are mostly young adults and it has been shown that individuals who practice healthy lifestyles when they are younger are more likely to continue those practices when they get older. Consequently, ensuring habitual PA during university years is an important and useful consideration. Knowing the physical activity levels of students provides a useful basis for intervention in this regard.

## Aim

To compare self-reported and objectively measured physical activity patterns of students at the Durban University of Technology.

## Methodology

This study used a cross sectional design, in a quantitative paradigm. The study was conducted among students at the Durban University of Technology from March 2019 to September 2019. The study was divided into two components. In the first, participants (*n*= 430) were randomly selected to complete the International Physical Activity Questionnaire (IPAQ) to ascertain their self-reported PA levels. The second part of the study involved objectively measuring the PA levels by wearing a pedometer for a period of at least seven days to determine the number of steps taken. The study further involved an aerobic fitness assessment using the Harvard step test and the recording of anthropometric measures such as body mass index, waist to hip ratio and body fat percentage. As only 60 participants were required for this aspect of the study, those who completed the

questionnaire were invited to participate in this aspect and sampling continued until a total of 60 participants was reached.

Descriptive statistics used for calculation in the study included means, standard deviations, medians and range. The relationships between variables were determined by using statistical tests such as chi-squared tests, post hoc tests and Pearsons' correlation test where a $p$ value less than 0.05 was considered significant.

## Results

Of the 430 questionnaires that were distributed, a total of 394 completed questionnaires were received, yielding a response rate of 91.6%. The mean age of the respondents was 21.7 ± 4 years with an even spread between gender. Most respondents were Black African (76.6%). Questionnaire data showed that most students (76.6%) reported a high level of PA. Pedometer and aerobic fitness assessment results showed that most students were either only moderately active or sedentary. It was also shown that males reported higher levels of PA in the questionnaire and had higher levels of ambulatory PA ($p$=0.038) and aerobic fitness ($p$=0.331) compared to females. In addition, males (17.9%) had a lower prevalence of obesity compared to females (47.6%; $p$<0.001).

## Conclusion

Self-reported PA levels appear to be over-estimated when compared to the more objective estimates obtained through the pedometer wear and aerobic fitness assessment in the study population. More than recommending the need interventions to increase PA in university students, the need to exercise caution in the use of self-reported measures as an absolute estimate of PA is noted. Adjusting such data through more objective measures in sub-samples may be a useful approach towards cost-effective approaches for gathering data.

# Table of Contents

# List of Tables

# List of Figures

# List of Appendices

# List of Abbreviations

BMI- Body Mass Index

IPAQ- International Physical Activity Questionnaire

MET- Metabolic equivalent

PA- Physical activity

PEI- Physical Efficiency Index

SA- South Africa

# CHAPTER ONE

# Introduction

This chapter briefly highlights the context of the study and why the study is needed. It gives background information for the study and highlights the aims and objectives for the study.

## 1.1 Background

Physical activity (PA) is the use of skeletal muscle in order to produce movement which results in energy expenditure (Frontera and Ochala 2015). Physical activity includes movements such as walking, running, sports, chores such as gardening or sweeping and leisure activities such as dancing (Frontera and Ochala 2015). Physical activity has been shown to enhance an individual's health, especially cardiovascular and respiratory health (Dhutia and Sharma 2015). There is a dose-response effect between PA levels and improvement in health, indicating that the higher an individual's PA levels, the greater the improvement in health and better physical and physiological conditioning (Arem *et al.* 2015a). The dose of PA takes intensity, mode of activity, frequency as well as volume (the amount of time doing the activity) into account (Arem *et al.* 2015a). Low levels of PA are known to be a risk factor for many chronic diseases such as heart disease, type 2 diabetes mellitus, cancer and many others (Kyu *et al.* 2016; Dhutia and Sharma 2015; Taylor *et al.* 2014).

PA as well as diet are modifiable lifestyle risk factors for many health conditions (Yoshino and Klein 2015). Adults are most susceptible to chronic health conditions such as hypertension, heart disease and diabetes mellitus and it has been shown that adults who participate in regular PA are less likely to develop these chronic health conditions (Adámková *et al.* 2015). There is a high incidence of these health conditions as well as physical inactivity worldwide including South Africa (SA)(Adámková *et al.* 2015).

There are many different ways to be physically active such as participating in sports, being involved at a gymnasium, walking, running, cycling, swimming and many other recreational activities (Ainsworth *et al.* 2011). Walking is an easy form of aerobic PA that has been shown to have health benefits (Mantovani *et al.* 2016; Tudor-Locke *et al.* 2011). It was initially reported that 10 000 steps per day were needed for sufficient health benefits (Hatano 1993). Since then it has been shown that even as many as 7 500 steps per day can result in health benefits (Mantovani *et al.* 2016; Tudor-Locke *et al.* 2011). These health benefits include a decrease in risk for health conditions such as diabetes, obesity and cardiovascular disease (Tudor-Locke *et al.* 2008).

Children and adolescents who are physically active are more likely to continue being so in adulthood (Janssen and LeBlanc 2010; Naidoo *et al.* 2009). Programmes in schools, such as Life Orientation, encourage pupils to participate in PA (Naidoo *et al.* 2009). College or university students around the world including countries such as the United States of America, Turkey and Saudi Arabia have high volumes of sedentary time as well as other unhealthy habits (Lukács *et al.* 2013; Arzu, Tuzun and Eker 2006; Reed and Phillips 2005). South African university students also seem to partake in the same unhealthy habits (Peltzer 2010). This indicates that physical activity decreases after secondary school, when it is no longer enforced (Naidoo *et al.* 2009).

It has also been shown that there is a low level of PA in the South African working population, with only 32.7% being physically active (Pillay *et al.* 2015). Primary and secondary school children also have low levels of PA, which are below the recommended requirements for children (Naidoo *et al.* 2009). A study done on University of Kwa-Zulu Natal students, showed that university students mostly had normal body mass indices and body fat percentage, but this did not give a clear indication regarding their physical activity levels (Ellapen *et al.* 2014). This study will fill the gap in the paucity of data on physical activity among South African university students.

## 1.2 Hypotheses

Null hypothesis: University students are not physically active.
Alternate hypothesis: University students are physically active.

## 1.3 Aim and Objectives

### 1.3.1 Aim

To compare self-reported and objectively measured physical activity patterns of students at the Durban University of Technology.

### 1.3.2 Objectives

1. To determine self-reported physical activity levels of students using the International Physical Activity Questionnaire.
2. To determine objectively measured physical activity patterns of students using pedometers
3. To establish aerobic fitness levels of students at the university through a fitness assessment.
4. To determine the association, if any, between pedometer-measured steps, self-reported physical activity levels and aerobic fitness.

# CHAPTER TWO

# Literature Review

## 2.1 Introduction

The literature review provides detailed information about PA among university students. The importance of physical activity is discussed as well as the health benefits of exercise and the barriers that may result in physical inactivity.
The following search engines were used to conduct the literature review: Google scholar, Durban University of Technology research summons and PubMed. Keywords in the search history included: ‘physical activity in students’, ‘physical activity levels of South African university students’, ‘health benefits of physical activity’, ‘South African pedometer studies’, ‘perceived barriers to physical activity in students’ and ‘physical activity in young adults.’

## 2.2 Definition of physical activity and recommended guidelines

Physical activity is the use of skeletal muscle to produce movement resulting in energy expenditure (Frontera and Ochala 2015). Physical activity includes cardiovascular exercise as well as sports, occupational activities, modes of transport such as walking and leisure time physical activity that results in energy expenditure (World Health Organisation, 2015). Exercise is the planned intention of performing physical activity to maintain physical fitness (Ellapen *et al.* 2018). The intensity of PA is the magnitude of effort that the individual expresses when performing physical activity (World Health Organisation, 2015). The two categories of intensity are moderate and vigorous PA (Dishman *et al.*, 2012). Moderate physical activity typically includes activities such as walking, household chores, occupational activities such as gardening, sports such as golf and carrying loads under 20kg (World Health Organisation, 2015). Vigorous intensity exercise typically includes activities such as running, swimming, cycling, most sports and carrying loads over 20kg (World Health Organisation, 2015). The World Health Organisation has recommended that 150 minutes of moderate intensity PA per week be performed for sufficient health benefits (World Health Organisation, 2015).

## 2.3 Types of Physical Activity

The two main categories of PA are aerobic and anaerobic PA (Joyner and Casey 2015). Aerobic PA includes the use of oxygen during physical activity which increases the heart and breathing rates whilst anaerobic PA occurs when oxygen demand surpasses oxygen supply which results in glycolysis, which is the break-down of stored glycogen into glucose for additional energy supply (Joyner and Casey 2015). Anaerobic activities include weightlifting and sprints where there is a short burst of physical activity (Joyner and Casey 2015). Anaerobic activity can help to reduce fat and increase muscle mass (Joyner and Casey 2015). Aerobic activity is considered to be the healthier form of PA from a physiological perspective because it can increase endurance, has a positive impact on cardiovascular and respiratory health and can reduce body fat (Joyner and Casey 2015). Aerobic physical activity usually occurs with prolonged activity whilst anaerobic physical activity occurs over a short time period (Joyner and Casey 2015). People have two types of muscle fibers namely fast-twitch and slow-twitch fibers (Joyner and Casey 2015). Anaerobic activity being over a short period uses fast-twitch muscle fibers to generate powerful bursts of movement whilst aerobic activity uses slow-twitch muscle fibers to allow for endurance of activity (Joyner and Casey 2015). This means the duration of physical activity determines which muscle fibers are activated (Joyner and Casey 2015). Types of aerobic activities include sports such as swimming, running, cycling, racket sports and team sports such as hockey and football (Joyner and Casey 2015). Aerobic activity can also be achieved during daily tasks such as walking, doing household chores and other occupational duties (Joyner and Casey 2015). Household chores such as vacuuming and lawn mowing are considered to be vigorous PA whilst other chores such as washing and gardening for a period of 30 minutes or more, are considered as moderate PA and have also been shown to improve health (Joyner and Casey 2015).

PA can be conducted during leisure time when adults play games such as tag and hide and seek with their children (Moore *et al.* 2016). PA can also be performed during certain leisure time hobbies that involve at least 30 minutes of sustained movement (Moore *et al.* 2016).

### 2.3.1 Walking

Walking is a form of aerobic PA and it is reported that 10 000 steps per day are required to accrue sufficient health benefits (Tudor-Locke *et al.* 2008; Rowe *et al.* 2007). It has been shown however that individuals can accrue health benefits by doing 7500 steps per day (Tudor-Locke *et al.* 2008). Individuals taking less than 5000 steps per day are considered sedentary and are more likely to be obese (Pillay *et al.* 2015; Tudor-Locke *et al.* 2008). A study by Pillay *et al*., 2015 showed that the average amount of steps taken per day in the South African working population was 6574 steps per day which indicates that the majority of working South Africans are not sufficiently active for health benefits. There are various speeds of walking, the faster the speed of walking the more energy is expended and the higher the metabolic equivalent (MET) value will be (Choi, Pak and Choi 2007). The MET value for walking around the house on a daily basis for example could be 2.5 to 3 METs whereas brisk walking can be as high as 5 METs (Choi, Pak and Choi 2007). Brisk walking is a simple and safe method of PA that can help to prevent certain diseases such as cardiovascular disease due to the beneficial effects it has on the resting heart rate, blood pressure and oxygen consumption (Tschentscher, Niederseer and Niebauer 2013). Brisk walking has very similar effects to running despite running being a vigorous PA and walking being a moderate PA (Williams and Thompson 2013). However, running can result in joint injury, particularly in the knee joints, whereas walking has a much lower chance of causing joint injury (Goss and Gross 2012).

### 2.3.2 Running and jogging

Running is a form of aerobic activity that is very popular around the world including SA (Colberg *et al.* 2016). Long distance running and short sprints are considered as vigorous physical activities with MET values ranging from 6 to 23 METs depending on the speed of running (Ainsworth *et al.* 2011; Byrne *et al.* 2005). For example running at 17.4km/h equates to using 18 METs (Byrne *et al.* 2005). Even a short jog can result in vigorous physical activity if this is at a speed of at least 6km/h (Byrne *et al.* 2005). In individuals who perform vigorous PA such as running, a minimum of 75 minutes per week is regarded as enough PA (World Health Organisation, 2015).

### 2.3.3 Swimming

Swimming is a form of aerobic PA that occurs in water where the legs and arms are used to propel the body (Harrison *et al.* 2017). Swimming is mostly a seasonal activity for most individuals with the highest prevalence being in the summer months (Harrison *et al.* 2017). Swimming is a moderate to vigorous form of PA due to water providing resistance to movement (Tanaka 2009). There is no weightbearing that occurs during swimming due to the buoyancy of water and hence there are less musculoskeletal injuries (Tanaka 2009). This makes swimming ideal for individuals with arthritis as well as overweight individuals in whom there is additional strain on the joints (Tanaka 2009).

### 2.3.4 Cycling

Cycling is a form of vigorous PA which involves pedalling a bicycle and is generally done more commonly during the warmer months of spring and summer (Harrison *et al.* 2017; Ainsworth *et al.* 2011). This can include cycling on the roads or mountain biking (Ainsworth *et al.* 2011). The MET value for cycling is 8.5 MET's but can be higher with longer distances and when cycling uphill (Ainsworth *et al.* 2011). Like swimming, cycling has less impact on the joints compared to other activities such as running (Tanaka 2009).

## 2.4 Sedentary behaviour

Sedentary behaviours are those that involve sitting down or reclining resulting in very little or no physical activity (Healy *et al.* 2011). These behaviours require an energy expenditure of only 1 to 1.5 times the resting metabolic rate which is very low (Healy *et al.* 2011). These sedentary behaviours include watching television, driving, sitting at a computer, playing video games and using a mobile phone or tablet (Healy *et al.* 2011). Increased sedentary time is a risk factor for diseases such as cardiovascular disease and diabetes mellitus (Wilmot *et al.* 2012; Koster *et al.* 2012). Excessive sitting can result in insulin resistance and hyperglycaemia resulting in diabetes (Wilmot *et al.* 2012; Koster *et al.* 2012). High levels of sedentary behaviour is associated with a 112% risk for diabetes mellitus, a 147% increase in the risk for cardiovascular disease and a 90% increase in risk for cardiovascular mortality (Wilmot *et al.* 2012). Cardiovascular mortality mostly occurs in sedentary individuals over the age of 50 years (Koster *et al.* 2012).

University students worldwide have been shown to partake in many sedentary activities such as watching television and other forms of screen-based media (Fountaine *et al.* 2011; Rouse and Biddle 2010). It has been shown that there is an inverse correlation between time spent on these sedentary activities and PA (Fountaine *et al.* 2011). Increased computer use has also been shown to occur in university students (Buckworth and Nigg 2004). Sedentary behaviour often starts in late adolescence at a time when the individual is more independent (Fountaine *et al.* 2011). This has been demonstrated in SA as well as in other African countries (Peltzer 2010).

## 2.5 Measurement of Physical Activity

PA is measured in various ways both subjectively and objectively. Measurement tools such as questionnaires can provide self-reported PA patterns and volumes (Bauman *et al.* 2009a). Pedometers and accelerometers can provide objective data on ambulatory PA whilst various forms of aerobic fitness assessments can measure aerobic PA (Tudor-Locke and Lutes 2009; Santo and Golding 2003).

### 2.5.1 Metabolic Equivalents (MET's)

Metabolic equivalents express energy expenditure in the human body in multiples of the resting metabolic rate which is one MET (Byrne *et al.* 2005). Metabolic equivalents can also be defined as the quantity of oxygen consumed by the body from inspired air under basal conditions (Byrne *et al.* 2005). One MET is equal to 3.5ml $O_2 \cdot kg^{-1} \cdot min^{-1}$ or 1kcal$\cdot kg^{-1} \cdot h^{-1}$ (Byrne *et al.* 2005). Physical activities are assigned intensity values in MET's (Byrne *et al.* 2005). For example running at 17.4 km/h is 18 MET's (Byrne *et al.* 2005). MET minutes per week is calculated by adding the MET values of the physical activities that an individual is involved in multiplied by the number of minutes of activity per day multiplied by the number of days per week that the individual engages in the activity (El Gilany *et al.* 2011).

### 2.5.2 The International Physical Activity Questionnaire

In this study the International Physical Activity Questionnaire (IPAQ) was used, which asks the participants questions related to PA at their place of work (paid or unpaid), the amount of PA at home as well as in their leisure time (Bauman *et al.* 2009a). The questions seek information about vigorous and moderate activity, as well as walking (Bauman *et al.* 2009a). The participant is also asked about the time spent sitting both on weekdays and weekends, which gives some insight to the amount of sedentary time in which the individual partakes (Bauman *et al.* 2009a). The questionnaire calculates scores for amounts of vigorous PA, moderate PA and walking in which the participant is involved. These categories are also divided into work, household and garden chores as well as leisure time PA (Bauman *et al.* 2009a). The IPAQ used in this study assigned 8 METs for vigorous physical activities such as heavy lifting, climbing up and down stairs, running, aerobics, cycling and swimming (Bauman *et al.* 2009a). Moderate physical activities were given specific MET values for each activity ranging from 3 METs to 5,5 METs (Bauman *et al.* 2009a). For example, yard work such as digging was assigned a MET value of 5,5 (Bauman *et al.* 2009a). Housework such as sweeping, washing windows, carrying light loads and scrubbing floors was assigned 3 METs (Bauman *et al.* 2009a). Yard work as well as leisure activities such as tennis, golf, slow swimming and slow cycling were assigned 4 METs (Bauman *et al.* 2009a).

The subtotals of vigorous activity, moderate activity and walking are added to give a grand total of MET minutes per week (Bauman *et al.* 2009a). A value greater than 3000 MET minutes per week or a value of at least 1500 MET minutes per week with at least 3 sessions of vigorous activity within the week is graded as "high" (Bauman *et al.* 2009a). Individuals doing either 3 sessions of vigorous activity for a period of at least 20 minutes or 5 sessions of moderate activity for a period of at least 30 minutes are graded as having a “moderate” level of PA (Bauman *et al.* 2009a). Individuals not achieving high or moderate PA levels are graded as having a “low” level of PA (Bauman *et al.* 2009a).

The IPAQ is regarded as the best questionnaire currently available to assess physical activity levels as MET values are assigned to activities, which can be scored (Bauman *et al.* 2009a). However, there are so many different types of activity, for example skateboarding or gymnastics, that have different MET values that are not included in the IPAQ (Bauman *et al.* 2009a). This means individuals doing these activities may not be getting scored correctly (Bauman *et al.* 2009a). Another issue with any self-reported data is that participants may be biased and in this case may inflate their answers to appear more physically active and for this reason physical measurements of activity are more accurate as they can eliminate bias (Bauman *et al.* 2009a).

### 2.5.3 Pedometers

Pedometers are portable devices worn on the body and count the number of steps that an individual takes per day (Hatano 1993). In this study the Omron HJ-322U-E pedometer was used. It measured the number of steps taken per day, aerobic steps taken per day, the distance covered by walking and the kilocalories burned per day by walking. A pedometer can sense every step made because of the swinging movement made when walking because of a swinging pendulum hammer inside the pedometer and can also calculate the distance covered whilst walking by using the length of each step (Tudor-Locke and Lutes 2009). Pedometers are fairly accurate but there are sometimes false movements that occur, which get counted as steps (Tudor-Locke and Lutes 2009).

### 2.5.4 Accelerometers

Accelerometers are instruments that measure acceleration of a moving body (Amini *et al.* 2011). Accelerometers are also devices worn on the body that can help to measure ambulatory PA (Amini *et al.* 2011). This is done by tracking the speed of movement over a certain distance. These devices are mostly designed to be worn near the waist and if worn elsewhere on the body such as the wrist they can overestimate or underestimate the speed of movement (Amini *et al.* 2011).

### 2.5.5 Aerobic fitness measurement

There are various fitness tests that exist to measure aerobic fitness (Santo and Golding 2003). Many fitness tests measure maximum oxygen intake ($VO_2$ max) which is considered the best indicator of aerobic fitness of an individual (Santo and Golding 2003). This method is however not always convenient, hence there are many other alternative tests which are used, including cycle tests such as PWC170, swimming tests and step tests (Santo and Golding 2003). Swim tests are not always ideal as they require a body of water and cycle tests require a cycle ergometer and require more time therefore making the step test quick and efficient (Burnstein, Steele and Shrier 2011a). There are various step tests that exist which require the participants to step up and down a step for a period of time, after which their heart rate is measured at intervals to calculate post exercise heart rate recovery in order to assess aerobic fitness (Burnstein, Steele and Shrier 2011a; Santo and Golding 2003).

## 2.6 Health benefits of physical activity

Physical inactivity is a risk factor for many chronic diseases such as cardiovascular disease, type 2 diabetes mellitus, cancer and various musculoskeletal conditions such as osteoporosis (Adámková *et al.* 2015; Dhutia and Sharma 2015; Taylor *et al.* 2014). This risk can be altered by participating in moderate aerobic exercise such as walking, running, jogging, swimming, cycling and various other sports (Adámková *et al.* 2015; Dhutia and Sharma 2015). It is recommended that an individual should participate in at least 150 minutes of aerobic PA per week or three to five 30-minute sessions of activity for optimum health benefits (Dhutia and Sharma 2015; Tudor-Locke *et al.* 2008). The positive effects of PA on some chronic conditions are elaborated on below.

### 2.6.1 Cardiovascular Disease

Aerobic PA such as running, brisk walking, cycling, rowing, cross country skiing and swimming increase cardiac output (Joyner and Casey 2015). After several weeks of this training maximal cardiac output can be increased (Joyner and Casey 2015). PA can also lead to an increase in stroke volume due to ventricle enlargement by 10-20% (Dhutia and Sharma 2015). Regular 30 minute low intensity PA has been shown to have more benefits than short strenuous activity especially for the cardiovascular system (Adámková *et al.* 2015). PA helps to improve skeletal muscle blood flow as well as regulate vascular tone and improve endothelial function in blood vessels (Nyberg, Gliemann and Hellsten 2015). Physically active individuals are able to have increased levels of oxygen consumption during aerobic exercise (Joyner and Casey 2015). Mitochondria play an important role in cellular metabolism within skeletal muscle (Barbieri *et al.* 2015). Physically active individuals are able to store more reserve energy (ATP) as a result of increased mitochondrial function, compared to sedentary individuals (Barbieri *et al.* 2015). This means that these physically active individuals will have a lower resting heart rate as well as a lower heart rate during activity which results in better cardiovascular health and allows the heart to maintain a healthy rhythm (Barbieri *et al.* 2015).

### 2.6.2 Hypertension

Hypertension is a common condition affecting approximately 40% of adults over the age of 25 years (Nyberg, Gliemann and Hellsten 2015). This condition is also a risk factor for other diseases such as cardiovascular disease (Hjerkind, Stenehjem and Nilsen 2017; Duclos *et al.* 2015; Nyberg, Gliemann and Hellsten 2015). Hypertensive individuals have reduced arterial compliance and vascular tone which leads to increased arterial blood pressure (Nyberg, Gliemann and Hellsten 2015). This also results in a decrease in blood and oxygen supply to tissues (Nyberg, Gliemann and Hellsten 2015). PA improves skeletal muscle blood flow, regulates vascular tone and improves endothelial function in blood vessels (Nyberg, Gliemann and Hellsten 2015) and hence blood pressure control is better in physically active individuals (Hjerkind, Stenehjem and Nilsen 2017; Duclos *et al.*

2015). Therefore, individuals who exercise more frequently are less likely to have hypertension (Diaz *et al.* 2017; Hjerkind, Stenehjem and Nilsen 2017).

### 2.6.3 Diabetes mellitus

Diabetes mellitus is an endocrine disease, with insufficient production of insulin to facilitate cellular absorption of glucose (Duclos *et al.* 2015). Body cells are sometimes not responsive to insulin, also resulting in increased blood glucose levels (Colberg *et al.* 2016; Duclos *et al.* 2015; Cooper *et al.* 2014). There are two types of diabetes mellitus, namely type 1 and type 2 diabetes mellitus (Duclos *et al.* 2015). Type 1 diabetes mellitus, also known as insulin dependent diabetes mellitus, occurs due to the individuals immune system attacking its own pancreatic cells resulting in decreased insulin production (Duclos *et al.* 2015). Type 2 diabetes mellitus is the more common form of diabetes mellitus, also known as non-insulin dependent diabetes mellitus, occurs due to high blood glucose levels as a result of poor diet control, lack of physical activity and obesity (Duclos *et al.* 2015). Diabetes mellitus is expected to affect 7.7% of the worlds' population by the year 2030 and is also a major risk factor for many chronic health diseases such as cardiovascular disease and kidney disease (Cooper *et al.* 2014; Chen, Magliano and Zimmet 2012). It has been shown that regular PA can help reduce triglycerides, blood pressure and insulin resistance (Colberg *et al.* 2016; Kyu *et al.* 2016). It is recommended that exercising daily or at least every second day can enhance the action of insulin in individuals with type 2 diabetes mellitus (Colberg *et al.* 2016; Taylor *et al.* 2014).

### 2.6.4 Obesity

Obesity is an accumulation of adipose tissue resulting in increased body mass (Ezzati, Di Cesare and Bentham 2018). The current prevalence of obesity worldwide is approximately between 30-32% (Chooi, Ding and Magkos 2019). In South Africa the prevalence of obesity was shown to be 30,8% in 2015 (Chooi, Ding and Magkos 2019). Obesity is increasing in modern society and is expected to affect over one billion people by the year 2030 (Phillips 2013). Obesity is a common risk factor for other diseases such as diabetes mellitus, hypertension and cardiovascular disease (Hjerkind, Stenehjem and Nilsen 2017; Yoshino and Klein 2015). Increased body mass index and increased waist circumference are considered to be good predictors for developing coronary heart disease and diabetes (Yoshino and Klein 2015). A body mass index between 18.5 and 24.9 is considered healthy whereas a body mass index above 24.9 is considered overweight (Yoshino and Klein 2015). A body mass index greater than 30 is considered to be obese (Yoshino and Klein 2015). The one limitation of BMI is that many muscular individuals may have high BMI values but are not actually overweight (Yoshino and Klein 2015). Approximately 30% of cardiovascular diseases occur in overweight individuals (Adámková *et al.* 2015). Although diet control is the most important aspect of dealing with obesity, PA can reduce body weight due to an increase in energy expenditure and burning of calories (Yoshino and Klein 2015). It has been shown that as little as 150 minutes of low intensity PA per week has positive effects in adults with abdominal obesity (Yoshino and Klein 2015). Regular 30 minute low intensity PA such as walking can result in decreased triglycerides and low density cholesterol and increase high density cholesterol (Adámková *et al.* 2015). High density lipids are considered to be healthier than low density lipids because low density lipids often get deposited in the arteries but high density lipids mostly aid in transport of cholesterol to the liver for excretion (Adámková *et al.* 2015).

### 2.6.5 Cancer

Cancer is abnormal or uncontrolled cell division resulting in disease (Schmid and Leitzmann 2014). Tumours can be benign or metastatic, with metastatic tumours being the most life threatening (Schmid and Leitzmann 2014). PA has been shown to decrease the incidence of certain cancers such as breast cancer, colorectal cancer and endometrial cancer (Kyu *et al.* 2016; Moore *et al.* 2016; Arem *et al.* 2015b; Schmid and Leitzmann 2014; Thomson *et al.* 2014). It has been suggested that PA as well as a good diet may help to reduce other types of cancer (Moore *et al.* 2016). A study comparing physically active and physically inactive women revealed that PA reduced the risk of cancer in postmenopausal women although the mechanism was unclear (Thomson *et al.* 2014). Conversely physical inactivity and sedentary behaviour such as watching television for long periods have been shown to be risk factors for cancer (Arem *et al.* 2015b). PA has also been shown to possibly reduce the risk of mortality in cancer survivors (Arem *et al.* 2015b; Schmid and Leitzmann 2014).

### 2.6.6 Osteoporosis

Osteoporosis is a common bone disorder characterised by decreased bone mass and bone density (Kirchengast 2015; Raimundo 2015). It is common in elderly individuals due to age related decreased bone density and in postmenopausal women due to hormonal changes (Raimundo 2015). In postmenopausal women there is a decrease in oestrogen which results in increased osteoclast activity leading to increased elimination of bone (Kirchengast 2015) but has also been shown to have a genetic link commonly occurring in women in the same family (Raimundo 2015). Smoking, malnutrition and certain medications such as corticosteroids can also result in osteoporosis (Raimundo 2015). Individuals with osteoporosis are prone to fractures such as hip fractures, due to decreased bone density (Kirchengast 2015). PA increases osteoblast activity increasing bone formation and therefore increasing bone density (Özgürbüz 2003). Muscle strength is also increased (Özgürbüz 2003). It has also been shown that PA throughout life helps to prevent osteoporosis due to increased muscle strength as well as the reduction of bone loss with PA (Özgürbüz 2003).

### 2.6.7 Low Back Pain

Low back pain is a common condition that most people experience in their lifetime occurring in approximately 90% of the world's population (Hurwitz, Morgenstern and Chiao 2005). It can be caused by poor posture, osteoporosis, vertebral fractures, subluxation complexes and many other pathologies (Hurwitz, Morgenstern and Chiao 2005; Christensen 2003). PA can help to decrease the incidence of osteoporosis as well as spinal fractures (Hurwitz, Morgenstern and Chiao 2005; Christensen 2003). Strengthening of the back extensor muscles has also been shown to improve posture and decrease symptoms such as low back pain (Christensen 2003). Low back pain often occurs in sedentary individuals however it can also occur in individuals participating in strenuous amounts of PA which causes biomechanical loading (Heneweer *et al.* 2011). Therefore moderate PA is recommended to avoid low back pain (Heneweer *et al.* 2011).

### 2.6.8 Psychological Benefits

PA has been shown to have positive psychological effects such as increased self confidence and self-esteem (Hills, Dengel and Lubans 2015; Hurwitz, Morgenstern and Chiao 2005). PA over a period of weeks or months can also result in a loss of weight and improved body type which is perceived as looking better (Hills, Dengel and Lubans 2015). PA has also been shown to reduce stress, anxiety and depression due to the production of endorphins, which are hormones that improve the ability to sleep, decrease pain and improve mood resulting in the reduction of stress, anxiety and depression (Hills, Dengel and Lubans 2015). It has also been shown that PA can also have positive effects on children's self-esteem and it can reduce depression, stress and anxiety (Wasfi *et al.* 2008; Hallal *et al.* 2006).

## 2.7 Barriers to physical activity

Barriers are environmental or psychological factors that may lead to an individual refraining from participating in PA (Arzu, Tuzun and Eker 2006). These barriers may either be internal or external (Arzu, Tuzun and Eker 2006). Internal barriers include factors such as lack of energy or motivation (Arzu, Tuzun and Eker 2006). External factors include lack of resources and lack of time (Arzu, Tuzun and Eker 2006). A study conducted in Saudi Arabia among college students showed that 58% of the students were physically inactive and that the main barriers to PA were lack of time, lack of resources, having other priorities and not having friends to encourage them to exercise (Awadalla *et al.* 2014). A similar study done in Turkey revealed that 69% of university health science students were also physically inactive and that lack of time and lack of energy were the most important factors leading to physical inactivity (Arzu, Tuzun and Eker 2006). An Egyptian study also revealed that lack of time, lack of resources and lack of social support were the largest barriers to PA (El Gilany *et al.* 2011). Studies in the United States of America suggested that self-efficacy, which is an individual's belief in his/her ability to achieve goals, was a large barrier to PA (Rovniak *et al.* 2002). Across the globe, including SA, physical education classes have been implemented to improve PA in children and adolescents (Hills, Dengel and Lubans 2015). Many schools do not have sufficient facilities and equipment for the physical education classes (Hills, Dengel and Lubans 2015). Insufficient time, often two hours per week or less, is often allocated to these lessons within the school curriculum (Hills, Dengel and Lubans 2015; Naidoo *et al.* 2009). It has also been shown that social support from peers can positively influence physical activity (Arzu, Tuzun and Eker 2006; Rovniak *et al.* 2002). In South Africa the Indian population of the country revealed that social support from peers encouraged individuals to participate in physical activity (Kader and Haffejee 2018). Another large barrier to physical activity in South Africa, especially for women, is safety during activities such as jogging or cycling, due to a high crime rate (Kader and Haffejee 2018). Thus many South Africans like to do these types of physical activities in groups to have safety in numbers (Kader and Haffejee 2018).

## 2.8 Provision of Facilities to Improve Physical Activity

Studies have shown that an increase in distance to sports facilities such as gymnasiums and sports fields as well as a decrease in the number of these facilities within an area can result in a decrease in physical activity within that area (Halonen *et al.* 2015). Therefore a greater number of these facilities increases the amount of physically active individuals within the vicinity (Halonen *et al.* 2015). There is often a lack of these facilities in rural areas and small towns compared to larger urban areas (Jones *et al.* 2015).

## 2.9 Prevalence of Physical Activity

The international prevalence of PA is estimated to range between 23% and 63% varying from country to country (Bauman *et al.* 2009b). In SA the prevalence of PA is estimated to range between 43% to 49% (Micklesfield *et al.* 2014). A study conducted among employed South African adults reported that only 12% took a minimum of 10 000 steps per day and that 36% of the participants took less than 5 000 steps per day (Pillay *et al.* 2015). A study done in the Indian population in Durban, South Africa, revealed that the residents participated in sports events such as soccer and cricket as well as marathons (Kader and Haffejee 2018). Many residents also participated in walking, jogging and cycling in the streets as well as along the promenade in Durban (Kader and Haffejee 2018). Weight lifting in gymnasiums was also a popular form of PA (Kader and Haffejee 2018).

### 2.9.1 Physical activity in adolescents and children

PA is important in youth because it improves aerobic endurance and muscle strength (Janssen and LeBlanc 2010; Wasfi *et al.* 2008). It is recommended that children should do between 30-60 minutes of moderate intensity PA per day (Janssen and LeBlanc 2010). Physically active children are also more likely to be physically active as adults and have fewer risk factors such as obesity and physical inactivity for conditions such as cardiovascular disease and osteoporosis (Janssen and LeBlanc 2010; Naidoo *et al.* 2009; Wasfi *et al.* 2008). Physically active adolescents were shown to have lower diastolic and systolic pressures than those not doing physical activity (Hallal *et al.* 2006). Swimming has been shown to aid in the treatment of asthma in adolescence (Hallal *et al.* 2006). This is due to swimming being an aerobic activity that helps the lungs to utilize oxygen more efficiently as well as strengthen the respiratory muscles (Hallal *et al.* 2006).

Children and adolescents in the United States of America, Australia and the United Kingdom were found to be relatively physically inactive, some of whom had chronic diseases such as type 2 diabetes mellitus and atherosclerosis (Hills, Dengel and Lubans 2015). They cited discomfort with the teachers in the physical education classes as well as lack of enjoyment doing PA and sports as reasons for their inactivity (Hills, Dengel and Lubans 2015).

In South Africa PA was incorporated into the school subject, Life Orientation, where primary and secondary school children have to participate in some form of PA for 30-60 minutes per week, which is still below the recommended amount of PA for children and adolescents (Naidoo *et al.* 2009). For instance, a study involving 256 students in rural Kwazulu-Natal, South Africa, revealed that PA levels are low in youth, with only 35% of learners being active (Naidoo *et al.* 2009). Another study done in rural areas in Mpumalanga in SA, with 381 students, revealed that approximately 55% of these students were physically active (Micklesfield *et al.* 2014). In Johannesburg it was shown that 43% of urban students were physically active (Micklesfield *et al.* 2014).

A study in rural SA showed that both a high and low socio-economic status may also be associated with increased sedentary time in adolescents (Micklesfield *et al.* 2014). The study revealed that South African adolescents from higher socio-economic strata spend more time in doing sedentary activities such as watching television and reading (Micklesfield *et al.* 2014). The rural South African adolescents, from lower socio-economic strata, spent more time walking as a means of transport and doing chores but in recent years spend more time watching television than before (Micklesfield *et al.* 2014). Furthermore, adolescents from higher socio-economic strata were more likely to participate in vigorous and moderate activities such as playing sport for a club whilst the adolescents from lower socio-economic strata participated in more low intensity activities such as walking (Micklesfield *et al.* 2014). The level of PA in children and adolescents in South Africa is still low and more initiatives are needed to increase the amount of moderate to vigorous PA (Micklesfield *et al.* 2014; Naidoo *et al.* 2009). These initiatives can include the provision of sport clubs and facilities especially in rural areas (Micklesfield *et al.* 2014; Naidoo *et al.* 2009).

### 2.9.2 Physical activity in university students

University students, worldwide partake in many unhealthy lifestyle habits such as smoking, alcohol consumption and sedentary behaviour (Lukács *et al.* 2013; Reed and Phillips 2005). Various studies have recently been conducted on university students worldwide regarding PA, as the number of students studying at universities increases (Awadalla *et al.* 2014). A study conducted in Saudi Arabia among health science students who were expected to have higher PA levels because of their awareness of the health benefits revealed that more than half of the students, particularly the females, were physically inactive (Awadalla *et al.* 2014). The barriers to physical activity in the Saudi Arabian students were time limitations, lack of sports facilities such as gyms and fields, not prioritising PA and lack of social encouragement to engage in PA (Awadalla *et al.* 2014). A study in

Turkey showed very similar results (Arzu, Tuzun and Eker 2006). Another study which used the International Physical Activity Questionnaire (IPAQ), compared Turkish students to Polish students and showed that the Polish students performed more vigorous PA than the Turkish students. However, the Turkish students engaged in more moderate PA than the Polish students (Bednarek *et al.* 2016). The study also revealed that males were more likely to engage in vigorous PA compared to females in both countries (Bednarek *et al.* 2016). A study done in the United Kingdom showed that college students had increased sedentary time on weekends compared to weekdays, since they watched more television and socialized over the weekends (Rouse and Biddle 2010). Similarly, a study conducted in the United States of America, using pedometers, revealed that two thirds of students performed at least 10 000 steps per day during weekdays but fewer steps were taken on weekends, with an increase of sedentary time on weekends (Behrens and Dinger 2005). Two other studies in the United States of America showed that only 40 to 50% of students were physically active, with females being less physically active (40%) than males (50%) (Fountaine *et al.* 2011; Keating *et al.* 2005). A possible reason for increased sedentary time on weekends is an increase in time spent doing leisure activities and an increased amount of time at home (Behrens and Dinger 2005). Another study found that college students were more physically active in the first two years of college and that the older students were more sedentary due to an increased amount of time spent studying (Buckworth and Nigg 2004). In South Africa, both male and female students at the University of Kwa-Zulu-Natal showed had normal BMI values but this did not directly indicate physical activity levels (Ellapen *et al.* 2014).

## 2.10 Summary

Low levels of PA have been shown to have many adverse health effects and can be a predisposing risk factor to many health conditions (Koster *et al.* 2012). PA decreases sedentary time and can help to decrease the incidence of many of these health conditions (Dhutia and Sharma 2015).

The use of questionnaires such as the IPAQ which asks questions about an individual's PA and sedentary time helps to obtain information about a populations'

PA (Bauman *et al.* 2009b). Other tools such as pedometers and various forms of fitness assessments can help to give a clearer, more accurate picture of PA (Burnstein, Steele and Shrier 2011a; Hatano 1993).

In many countries around the world PA levels of the population are well documented in schools, universities and the working population (Janssen and LeBlanc 2010; Arzu, Tuzun and Eker 2006). In SA research on PA has been conducted on children in schools as well as employed adults but not on university students. There is a paucity of data regarding PA levels of university students in SA. This study aims to address that gap in knowledge.

# CHAPTER THREE

# Methodology

## 3.1 Introduction

This chapter discusses the methodology used in the study. This includes the study design, sampling, measurement tools, research procedure, ethical considerations, data analysis and statistical analysis.

## 3.2 Study design

The study used a cross sectional study design, in a quantitative paradigm. The cross-sectional design assesses the prevalence of PA of students at the Durban University of Technology. There was a descriptive component to the study including the completion of the International Physical Activity Questionnaire (IPAQ; Appendix A) and using a pedometer over a one-week period, as well as an experimental component including the aerobic fitness assessment.

## 3.3 Sampling

### 3.3.1 Study Population

The population consisted of full-time university students studying at the Durban University of Technology from the faculties of Health Sciences, Management Sciences and Engineering and the Built Environment. It was estimated by the university that there was a total of 23,500 registered full-time students in the chosen faculties.

### 3.3.2 Sampling Method

The study was conducted at the Steve Biko, ML Sultan and Ritson campuses at the Durban University of Technology from March to September in 2019. This setting was chosen as these campuses are close to each other and easy for the researcher to access.

After permission was obtained to conduct the study (Appendix B), all departments that were based on the Ritson, Steve Biko and ML Sultan campuses from the faculties of Health Sciences, Engineering and the Built Environment and Management Sciences at the Durban University of Technology were put into a Microsoft excel document where computerised randomised selection was used to select different departments from the selected faculties. Permission was obtained to use the Chiropractic clinic to conduct the aerobic fitness assessments in one of the clinic rooms (Appendix C). The RANDBETWEEN formula was used to randomly select the order of the departments that would be approached. Each department had a random number between 1 to 50 assigned to it and the departments were then approached in numerical order. Electronic mails were sent to the Head of Department for each of the selected departments requesting permission to use the last ten to fifteen minutes of a lecture to approach the students (Appendix D). After permission was obtained, a date, time and venue was given to the researcher to access the students, with the lecturer present. Those who completed the questionnaire were invited to participate in the second part of the study.

### 3.3.3 Sample Size

The sample size was calculated by the statistician, Mr D. Singh, using the total student population of 23 500, a 5% margin of error and confidence interval of 95%. A minimum sample size of 384 participants was calculated for the questionnaire-based study. Assuming a response rate of 90% a total of 430 questionnaires were printed and distributed. A power analysis for chi square test was conducted in G-POWER version 3.1.9.2 to determine the pedometer and fitness assessment subgroup size of 60 using an alpha of 0.05, power of 0.80, a large effect size (w = 0.35) and 3 degrees of freedom.

### 3.3.4 Inclusion Criteria

- Students registered at the Durban University of Technology for full-time studies.
- Students over the age of 18 years.
- Students registered in the Faculties of Health Sciences, Management Sciences and Engineering and the Built Environment.

### 3.3.5 Exclusion Criteria

- Students with medical conditions that makes physical activity difficult or impossible.
- Students who would graduate before the measurements could be completed.
- Staff registered for postgraduate studies.
- Those who did not read or sign the informed consent form.
- Students from the Chiropractic Department.

## 3.4 Participant Recruitment

All participants were required to complete the questionnaire after reading a letter of information and signing the informed consent form (Appendix E). Participants who completed the questionnaire and who were also willing to participate in the next part of the study were provided with pedometers and required to complete an aerobic fitness assessment. A second letter of information and informed consent form (Appendix F) was then issued before the participant started the aerobic fitness assessment (Appendix G).

## 3.5 Data Collection

The data collection tool used in this study to obtain self-reported data was the International Physical Activity Questionnaire (IPAQ). The pedometer used to measure steps was the Omron HJ-322U-E. For the aerobic fitness assessment, the Omron Body Composition Monitor BF511 and Health-O-Meter beam scale were used as well as a Suunto Smart Sensor heart rate monitor. The step used for the step test was a Reebok step (Item number: RSP-16150).

### 3.5.1 The International Physical Activity Questionnaire (IPAQ)

The IPAQ (Appendix A) is a pre-validated questionnaire which asks the participants questions about their physical activity and the time spent on various activities per day. In addition, demographic data such as the age, gender, race, faculty and programme of study of the participant, was collected. The IPAQ has a high level of reliability and validity when assessing vigorous intensity physical activity but has a moderate level of reliability when assessing moderate intensity physical acivity and walking (Kim, Park and Kang 2013).The reliability score of the IPAQ was 0.65 for men and 0.57 for women (Kim, Park and Kang 2013).

The questionnaire was divided into five parts:

- Part 1: Job-related physical activity
- Part 2: Transportation physical activity
- Part 3: Housework, house maintenance and caring for family
- Part 4: Recreation, sport and leisure-time physical activity
- Part 5: Time spent sitting

Activities were graded as vigorous and moderate intensity physical activity. Metabolic equivalent values (MET minutes) were assigned to each activity so that a score could be given to the participants self-reported values to determine the level of physical activity.

### 3.5.2 Pedometers

The Omron Walking Style Pro 2.0 (HJ-322U-E) was the pedometer used in the study. The pedometer measured the number of steps and aerobic steps accumulated per day. Aerobic walking time, distance covered whilst walking and the number of calories burned whilst walking were also measured. Aerobic steps were defined as “steps taken at more than 60 steps per minute and for more than 10 consecutive minutes.’’ The results on the pedometer could be stored for up to

22 days before being overwritten. Pedometer results were uploaded electronically when the pedometers were returned by the participants. Pedometers were reset for every participant. The pedometer has been shown to have good validity and reliability with the Omron Walking Style Pro 2.0 (HJ-322U-E) calculating steps within a 2.1% margin of the actual number of steps taken (Ghaneapur *et al.* 2019; Vetrovsky *et al.* 2019).

### 3.5.3 Body Measurements and Aerobic Fitness Assessment

The participants height was first measured using a Health-O-Meter beam scale. The recorded height was then entered onto the Omron Body Composition Monitor BF511 along with the age and gender. The participants' body mass was then recorded when they stepped onto the monitor which allowed for the calculation of their body mass index (BMI). Hip and waist circumference were measured using a measuring tape. A Reebok step was used for the participants to do a five-minute step test. Heart rate was measured on the Suunto Smart Sensor heart rate monitor in conjunction with a Samsung Galaxy Prime smartphone. All fitness assessment data was captured on a fitness assessment form (Appendix G).

## 3.6 Research Procedure

The research was briefly explained to each class of students, who were chosen for the study. A letter of information and informed consent form (Appendix E) as well as the International Physical Activity Questionnaire (Appendix A) was distributed to the interested participants for completion. A ballot method was used to select participants. The completed questionnaires were collected in separate sealed boxes from the signed informed consent forms to ensure confidentiality.

Participants who answered the questionnaire were invited to participate in the second part of the study which involved the pedometer and fitness assessment. They were given an appointment approximately one week later, for participation in the second part of the study. The appointment was one week later to ensure that the participant would be able to wear the pedometer for several days allowing results to be more accurate.

Participants were assigned the same participant number, as recorded on the IPAQ questionnaire, for the pedometer and the aerobic fitness assessment component of the study. This was done so that comparisons could be made between the self-reported data, pedometer data and aerobic fitness assessment data.

Participants involved in the second part of the study were provided with pedometers which they had to wear for a minimum of seven days. The pedometers measured the daily steps taken by the participant and kept an electronic record of these. The data from the pedometers was retrieved and captured on a Microsoft Excel spreadsheet. Steps taken on weekdays and weekends were added separately.

The participants' height was recorded. The participants' height, age and gender were entered on the body composition monitor. Body mass was measured in kilograms using the body composition monitor along with body fat percentage. Body Mass Index (BMI) was then calculated using the height and weight measurements. BMI was calculated using the formula: body mass/height$^2$.

Hip and waist circumference were measured using a tape measure. Waist to hip circumference ratio was then calculated using the formula: waist circumference/hip circumference.

The sensors of the strap of the heart rate monitor were placed in water and then the heart rate monitor was given to the participants to wear around their chests. The heart rate readings were shown on the Suunto Movescount application on the smartphone used. Before the participants started the step test it was ensured that the heart rate monitor was working correctly. The participant then stepped up and down the step for a period of five minutes. After five minutes the participant was required to rest quietly on a chair whilst heart rate values were recorded at 30 second intervals for five minutes. The quicker the participants' heart rate decreases the better their aerobic fitness (Burnstein, Steele and Shrier 2011a).

The information from the questionnaires, pedometers and the aerobic fitness assessment were captured on Microsoft excel spreadsheets and later transferred to SPSS (version 26) for statistical analysis.

## 3.7 Ethical Considerations

Ethical approval to conduct the study was obtained from the ethics committee at the Durban University of Technology (IREC 038/18; Appendix B). Gatekeeper permission was subsequently obtained from Prof. Carin Napier, the acting Director of Research at the university (Appendix H). All participants received a letter of information and informed consent explaining the study before being issued the questionnaire, which they read and signed (Appendix E). The letter of information also mentioned the second part of the study for those who wished to participate in the pedometer step count and in the fitness assessment. However, those participants who were issued with pedometers and who performed the aerobic fitness assessment, were issued a second letter of information explaining the aerobic fitness assessment and pedometer step count, which they read and subsequently signed consent before participating in this aspect of the study (Appendix F). There were no personal identifying details on the questionnaires (Appendix A) or aerobic fitness assessment forms (Appendix G). The participants were informed that participation was voluntary and that they would be anonymous in the study and only the researcher and supervisors would have access to this information. Participants were also informed that there was no form of renumeration and were assured that they would not come to any harm by participating in the study. Participants were also advised that they were free to withdraw from the study at any point, without any adverse consequences. There was no bias or discrimination in the study and all participants were treated fairly and equally. The data obtained will be stored safely within the Chiropractic Department at the university for a period of five years before being shredded.

## 3.8 Data Analysis

### 3.8.1 Questionnaire Data

Activities listed in the questionnaire had specific MET values assigned to them. MET minutes are calculated by multiplying the MET value by the amount of time (minutes) spent doing the activity. Using the data obtained from the questionnaire the following were calculated:

- Total MET minutes per week at work (at university)
- Total transport MET minutes per week
- Total garden and domestic MET minutes per week
- Total recreation and leisure time MET minutes per week
- Total time spent sitting per week
- Total vigorous activity MET minutes per week
- Total moderate activity MET minutes per week
- Total walking MET minutes per week

The total physical activity MET minutes per week were calculated from the above categories of activity. The participants' level of physical activity was then categorised as follows:

High level of physical activity (Bauman *et al.* 2009a):

- Vigorous activity at least 3 times a week achieving a minimum of 1500 MET minutes per week.
- Or the participant achieved a total of 3000 or more total MET minutes per week.

Moderate level of physical activity (Bauman *et al.* 2009a):

- The participant performed vigorous physical activity on 3 or more days per week, for a period of at least 20 minutes per day.
- Or 5 or more days per week of moderate activity or walking for a period of at least 30 minutes per day.
- Or 5 or more days of any combination of vigorous activity, moderate activity and walking achieving a total of at least 600 MET minutes per week.

Low level of physical activity (Bauman *et al.* 2009a):

- Individuals who did not meet the criteria for high or moderate physical activity.

### 3.8.2 Pedometer Data

Pedometer data was uploaded from the HJ-322U-E pedometer onto an excel spreadsheet for analysis. The date, number of steps taken per day, aerobic steps taken per day, aerobic walking time, distance covered by walking and calories burned were captured. The average data was calculated for weekends and weekdays and these were compared. A level of activity was assigned to each participant based on the average number of steps taken per day (Tudor-Locke *et al.* 2011). These levels of activity are indicated in Table 3.1.

**Table 3.1 Pedometer steps/day classification for level of physical activity (Tudor-Locke *et al.* 2011)**

| Steps Per Day | Level of Activity |
|---|---|
| <2500 | Basal Activity |
| 2500-4999 | Limited Activity |
| 5000-7499 | Low Active |
| 7500-9999 | Somewhat Active |
| 10000-12499 | Active |
| >12500 | Highly Active |

### 3.8.3 Body Mass Index

Body Mass Index (BMI) is calculated as body mass/height$^2$ (kg/m$^2$). The World Health Organisation (World Health Organisation, 2019) has classified BMI into the following ranges as shown in Table 3.2:

**Table 3.2 Body Mass Index classification (World Helath Organisation, 2019)**

| BMI Classification | Body Mass Index |
|---|---|
| Underweight | <18,5 |
| Normal | 18,5-24,9 |
| Pre-obesity | 25,0-29,9 |
| Obesity class I | 30,0-34,9 |
| Obesity class II | 35,0-39,9 |
| Obesity class III | >40,0 |

### 3.8.4 Waist to Hip Circumference Ratio

Hip circumference, measured at the largest part of the buttocks, and waist circumference, measured just above the umbilicus, were used for the calculation of waist to hip ratio as follows: waist circumference/hip circumference. Classification was done according to risk of disease, such as chronic heart disease, in association to the hip to waist circumference ratio for both males and females (Larsson, Burgess and Michaëlsson 2017). This classification is shown in Table 3.3.

**Table 3.3 Waist to hip circumference ratio classification according to risk of chronic disease (Larsson, Burgess and Michaëlsson 2017)**

| **Classification** | **Waist to Hip Circumference Ratio** | |
|---|---|---|
| | Males | Females |
| Low risk of disease | 0,95 and below | 0,8 and below |
| Moderate risk of disease | 0,96-1,0 | 0,81-0,85 |
| High risk of disease | Above 1,0 | 0,86 and above |

### 3.8.5 Body Fat Percentage

Body fat percentage was calculated using the Omron BF511 body composition monitor. The range for body fat percentage was taken from the Omron BF511 manual. The ranges for males and females are as follows:

**Table 3.4 Body Fat Percentage classification**

| **Classification** | **Body Fat Percentage (%)** | |
|---|---|---|
| | Males | Females |
| Low | <8,0 | <21,0 |
| Normal | 8,0-19,9 | 21,0-32,9 |
| High | 20,0-24,9 | 33,0-38,9 |
| Very High | 25,0 and above | 39,0 and above |

### 3.8.6 Physical Efficiency Index

The physical efficiency index (PEI) was calculated using the formula below from values derived from the Harvard step test. Physical efficiency index has been shown to be a reliable method for demonstrating an individual's aerobic fitness (Lee, Roh and Kim 2016; Burnstein, Steele and Shrier 2011a).

The formula is PEI= D/(2xP) x100.
D= the duration of the physical activity (5 minutes)
P= First phase heart rate value (60-90seconds) + Second phase heart rate value (120-150seconds) + Third phase heart rate value (180-210seconds).

The following classification, shown in Table 3.5, was used to determine the participants' aerobic fitness:

**Table 3.5 Physical Efficiency Index classification (Burnstein, Steele and Shrier 2011a)**

| Classification | Physical Efficiency Index |
|---|---|
| Poor | <55 |
| Low Average | 55-64 |
| High Average | 65-79 |
| Good | 80-89 |
| Excellent | 90 and above |

## 3.9 Statistical Analysis

IBM SPSS version 26 was used by the statistician, T. Esterhuizen, to analyse the data. Continuous data was described using median and inter-quartile range overall and per group as the variables were not normally distributed. Non-parametric Kruskal-Wallis tests were used to compare medians across physical activity groups at a 0.05 level of significance. Where an overall significant result was found, Bonferroni adjusted multiple comparison tests were used to identify the groups which differed. Mann-Whitney tests were used to compare medians across two groups. Relationships between continuous variables were assessed using Spearman's rank correlation coefficient.

# CHAPTER FOUR

# Results

## 4.1 Demographic data

### 4.1.1 Demographic data of respondents

Of the 430 questionnaires handed out, 394 participants completed the questionnaire. Hence the response rate was 91.6%. The mean age of the respondents was 21.7 ±4 years (range 18-54) and 52.5% of the sample was male. Three quarters (76.6%; *n*=302) of respondents were Black African. The respondents were from various departments and faculties within the university. These and other demographics are illustrated in Table 4.1.

**Table 4.1 Demographic data of respondents who answered the questionnaire**

| | Number (*n*) | Percentage % |
|---|---|---|
| **Gender** | | |
| Male | 207 | 52.5 |
| Female | 187 | 47.5 |
| **Race** | | |
| Black African | 302 | 76.6 |
| Indian | 74 | 18.8 |
| White | 14 | 3.6 |
| Coloured/ Mixed Race | 4 | 1.0 |
| **Faculty** | | |
| Engineering and the Built Environment | 161 | 40.9 |
| Management Sciences | 55 | 14.0 |
| Health Sciences | 178 | 45.2 |

## 4.2 Self-reported physical activity levels

Activities in the IPAQ have specific MET values assigned to them. One MET is equal to 3.5ml $O_2 \cdot kg^{-1} \cdot min^{-1}$ or $1 kcal \cdot kg^{-1} \cdot h^{-1}$. For example, vigorous physical activity is assigned 8 METs. To determine MET minutes, the MET value of the activity is multiplied by the number of minutes performing the activity.

Self-reported PA was categorized into either high, moderate or low level of PA. If respondents did not meet one of the criteria for a high level of PA, they were then assessed to see if they met one of the criteria for a moderate level of PA. If the respondents did not meet any criteria for both high or moderate levels of PA, they were categorized as having a low level of PA.

Criteria for a high level of physical activity (Bauman *et al.* 2009a):

- Respondent reported vigorous activity at least 3 times per week achieving a minimum total of 1,500 MET minutes per week.
- Or the respondent achieved a minimum total of 3,000 MET minutes per week.

Criteria for a moderate level of physical activity (Bauman *et al.* 2009a):

- The respondent performed vigorous PA on at least 3 days of the week for a period of at least 20 minutes per day.
- Or the respondent performed moderate PA or walking for at least 5 days of the week for a period of at least 30 minutes per day.
- Or the respondent did any combination of vigorous PA, moderate PA and walking achieving a total of at least 600 MET minutes per week.

The self-reported PA for the full sample (*n*=394), showed that 76.6% (*n*=302) of respondents accumulated a high level of PA, 16.8% (*n*=66) accumulated a moderate level of PA and 6.3% (*n*=25) accumulated a low level of PA. This is illustrated in Figure 4.1.

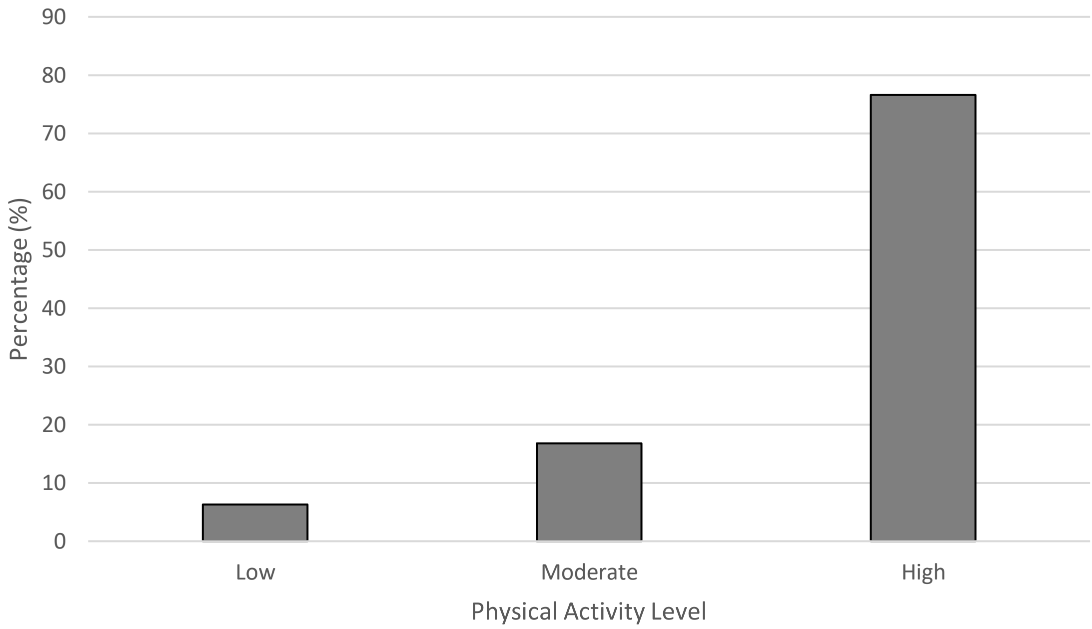


**Figure 4.1 Self-reported physical activity level (*n*=394)**

## 4.3 Physical activity estimates obtained from the International Physical Activity Questionnaire

Several estimates were made using data captured from the International Physical Activity Questionnaire (IPAQ). These included metabolic equivalent minutes (MET minutes) accumulated at university, home and during transportation. Total sitting time was used to estimate sedentary time. The median total PA per week was 6823 MET minutes (range 0-154,164). The values for the various categories of activities are indicated in Table 4.2.

**Table 4.2 Median and range for IPAQ measurements for all participants (*n*=394)**

| | Median | Range |
|---|---|---|
| Total MET minutes per week at university | 2,667.00 | 0.00-146,994.00 |
| Total transport MET minutes per week | 495.00 | 0.00-28,413.00 |
| Total domestic and garden MET minutes per week | 619.00 | 0.00-25,620.00 |
| Total recreation and leisure time MET minutes per week | 594.00 | 0.00-29,280.00 |
| Total walking MET minutes per week | 1,773.75 | 0.00-28,413.00 |
| Total moderate activity MET minutes per week | 1,600.00 | 0.00-34,500.00 |
| Total vigorous activity MET minutes per week | 1,440.00 | 0.00-148,800.00 |
| Total physical activity MET minutes per week | 6,823.75 | 0.00-154,164.00 |
| Total time spent sitting per week | 2,460.00 | 220.00-9,540.00 |

## 4.4 Associations between self-reported physical activity and participant demographics

The mean age of participants with a low (22.28 ±3.5 years), moderate (21.35 ±2 years) and high (21.75 ±4 years) level of PA was similar (*p*=0.6). There were no significant statistical correlations between any of the IPAQ measurements and age. However, due to the narrow age group range of university students, this is expected.

The self-reported levels of PA as measured in MET minutes were significantly different between the genders (*p*=0.020), with males reporting a higher level of PA (median= 7,829; range=0-62,634) than females (median=5,679; range=0-154,164). A high level of PA was achieved by 82.5% (*n*=170) of males compared to 70.6% (*n*=132) of females. Males were more involved in vigorous PA than females ($p$=0.007). More males were active in their leisure and recreation time than females ($p$=0.001). The MET minutes per week were similar between both genders for activity at university ($p$=0.121), transport ($p$=0.082), domestic and gardenwork ($p$=0.102) as well as walking ($p$=0.083). The time spent sitting per week was also similar between both genders ($p$=0.426).

There was no difference between the level of PA classification (e.g. high, moderate or low) and the participants' race ($p$=0.518). However, total MET minutes for the following differed significantly across the race groups: at university ($p$=0.006), for transport ($p$=0.001), vigorous activity ($p$=0.003) and total MET minutes per week ($p$=0.047); as seen in Table 4.3 below. Black African students reported lower levels of PA at university than the other race groups whilst Mixed Race and Indian students reported high levels of activity at university. Indian students reported lower volumes of transport PA than the other race groups. Mixed Race students reported the highest average volume of transport PA. Lower amounts of vigorous PA and total MET minutes per week were noted among Black African students compared to the other race groups. Mixed Race students reported the highest levels of vigorous PA and total MET minutes per week. There were no further statistically significant differences between the participants' race and any other IPAQ measurements such as domestic and garden MET minutes ($p$=0.875), recreation and leisure time MET minutes ($p$=0.084) and time spent sitting ($p$=0.879). These differences can be seen in Table 4.3 below.

**Table 4.3 IPAQ totals compared between race groups**

| | Median (Range) | | | | *p* value |
|---|---|---|---|---|---|
| | **Black African (*n*=302)** | **Indian (*n*=74)** | **White (*n*=14)** | **Mixed Race (*n*=4)** | |
| Total MET minutes per week at university | 1,960 (0-146,994) | 5,658 (0-46,956) | 3,921 (0-13,125) | 7,434 (0-20,568) | 0.006 |
| Total transport MET minutes per week | 511 (0-14,652) | 231 (0-28,413) | 544 (0-6,426) | 1,732 (594-4158) | 0.001 |
| Total domestic and garden MET minutes per week | 604 (0-25,620) | 645 (0-11,410) | 780 (0-5,700) | 1,065 (420-2,280) | 0.875 |
| Total recreation and leisure time MET minutes per week | 497 (0-29,280) | 760 (0-9,318) | 2,154 (0-6,864) | 1,737 (480-9,417) | 0.084 |
| Total moderate activity MET minutes per week | 1,535 (0-34,500) | 2,250 (0-14,130) | 2,100 (0-9,735) | 1,860 (420-6,930) | 0.294 |
| Total vigorous activity MET minutes per week | 1,040 (0-148,800) | 2,880 (0-27,360) | 2,640 (0-15,120) | 8,040 (0-17,280) | 0.003 |
| Total MET minutes per week | 6,218 (0-154,164) | 8,871 (376-47,525) | 9,544 (165-23,238) | 12,177 (1,707-35,793) | 0.047 |
| Total time spent sitting per week | 2,460 (220-8,640) | 2,370 (420-8,880) | 2,880 (630-9,540) | 2,880 (840-5,400) | 0.879 |

The level of PA across the three faculties was significantly different (*p*=0.004). Students from the Faculty of Health Sciences (81.9%; *n*=145) were more active than those from the Faculty of Engineering and the Built Environment (75.2%; *n*=121) and the Faculty of Management Sciences (65.5%; *n*=36). There were also differences in the type of activity between students across the faculties. Health Science students were more physically active at campus (*p*=0.023). Management Science students performed more PA through domestic chores in their home or garden compared to the other faculties (*p*<0.001). The transport MET minutes (*p*=0.836), recreation and leisure time MET minutes (*p*=0.591), MET minutes accumulated whilst walking (p=0.146), total vigorous PA (*p*=0.280) and time spent sitting (*p*=0.114) were similar for students from the different faculties.

## 4.5 Demographic data for respondents who participated in the pedometer wear and aerobic fitness assessment

Sixty participants were included in this part of the study. Their mean age was 20.8 ±3 years (range 18-35) and 65% (n=39) of the sample were male. Eighty percent (n=48) of respondents were Black African. The full demographic data is shown in Table 4.4 below.

**Table 4.4 Demographic data of respondents who participated in the pedometer study and aerobic fitness assessment**

| | **Number (*n*)** | **Percentage %** |
|---|---|---|
| **Gender** | | |
| Male | 39 | 65.0 |
| Female | 21 | 35.0 |
| **Race** | | |
| Black African | 48 | 80.0 |
| Indian | 8 | 13.3 |
| White | 4 | 6.7 |
| **Faculty** | | |
| Engineering and the Built Environment | 25 | 41.7 |
| Management Sciences | 2 | 3.3 |
| Health Sciences | 33 | 55.0 |

### 4.5.1 Questionnaire data of the respondents who participated in the pedometer study and aerobic fitness assessment

Self-reported PA for the group of 60 showed that 81,7% (*n*=49) of participants had a high level of PA. Fifteen percent (*n*=9) of participants had a moderate level of PA and 3,3% (*n*=2) had a low level of PA.

Self-reported PA data of those who participated in all components of the study, are shown below in Table 4.5.

**Table 4.5 IPAQ data for the group of 60 participants**

| | **Median** | **Range** |
|---|---|---|
| Total MET minutes per week at university | 3,663.65 | 0.00-30,990.00 |
| Total transport MET minutes per week | 552.75 | 0.00-8,910.00 |
| Total domestic and garden MET minutes per week | 815.00 | 0.00-6,240.00 |
| Total recreation and leisure time MET minutes per week | 1,022.25 | 0.00-15,570.00 |
| Total walking MET minutes per week | 1,980.00 | 0.00-17,820.00 |
| Total moderate activity MET minutes per week | 1375.00 | 0.0016,320.00 |
| Total vigorous activity MET minutes per week | 2,100.00 | 0.00-19,200.00 |
| Total physical activity MET minutes per week | 8,283.00 | 0.00-42,840.00 |
| Total time spent sitting per week | 2,220.00 | 220.00-6,000.00 |

## 4.6 Pedometer Results

Table 4.6 illustrates the pedometer results. The average number of steps taken per day was 4,853 and the average number of aerobic steps taken per day was 1,175.

**Table 4.6 Median and range for average daily pedometer values**

| | Median | Range |
|---|---:|---:|
| Average steps per day | 4,853.07 | 426.29-14,974.14 |
| Average aerobic steps per day | 1,175.43 | 0.00-7,664.14 |
| Average aerobic walking time per day | 7.29 | 0.00-64.29 |
| Average distance walked per day | 3.46 | 0.26-10.74 |
| Average calories burned per day | 80.43 | 5.86-287.14 |

A classification system was used to determine an individuals' PA level from the average number of steps taken per day. The classifications were: basal activity (<2,500 steps per day), limited activity (2,500-4,999 steps per day), low active (5,000-7,499 steps per day), somewhat active (7,500-9,999 steps per day), active (10,000-12,499 steps per day) and highly active (>12,500 steps per day). As previously mentioned in Chapter Two, health benefits are said to occur from 7,500 steps per day and above.

Most students (76.6%; *n*=46) demonstrated a low level of PA (below 7,500 steps per day) achieving either basal activity (18.3%; *n*=11), limited activity (35.0%; *n*=21) or the low active (23.3%; *n*=14) classification. The participants PA levels, based on their number of steps per day, are shown in Table 4.7 below.

**Table 4.7 Participant activity levels obtained from pedometer readings**

| **Activity classification** | **Number (*n*)** | **Percentage %** |
|---|---:|---:|
| Highly Active | 3 | 5.0 |
| Active | 2 | 3.3 |
| Somewhat active | 9 | 15.0 |
| Low active | 14 | 23.3 |
| Limited activity | 21 | 35.0 |
| Basal activity | 11 | 18.3 |

There was a positive correlation between age and the number of aerobic steps taken (*p*=0.048), meaning that there was an increase in aerobic steps with an increase in age. However, there was no association between age and the total number of steps accumulated (*p*=0.141), average walking time (*p*=0.072), calories burned (*p*=0.122) and distance covered whilst walking (*p*=0.142).

When comparing pedometer results between genders there was a significant relationship between calories burned whilst walking (*p*=0.038), showing that males were burning more calories than females. Males burnt a median of 85.14 kcal. compared to females who burnt a median of 54.43 kcal. There were no associations between gender and the total number of steps accumulated (*p*=0.087), aerobic steps taken (*p*=0.064), average walking time (*p*=0.087) and distance covered whilst walking (*p*=0.091).

When comparing pedometer results between the race groups of the participants there were significant relationships between race and average number of steps taken (*p*=0.038), average aerobic steps taken (*p*=0.001), average walking time (*p*=0.001), calories burned (*p*=0.005) and distance covered whilst walking (*p*=0.038). When pairwise comparisons were made using post hoc tests, it was found that Black African students (median 1414.79 steps) achieved a significantly higher number of average aerobic steps compared to Indian students (median 147.93 steps; *p*=0.001). A significant correlation was also found when comparing average walking time (*p*=0.002), with Black African students (10.43 minutes) doing longer periods of aerobic walking than Indian students (1.21 minutes). Furthermore, Black African students burnt significantly more calories (84.71 kcal) compared to Indian students (30.43 kcal; *p*=0.005). There were no other associations found when making pairwise comparisons across the other race groups.

There were no associations between faculty of study and number of steps taken (*p*=0.204), average aerobic steps (*p*=0.389), average walking time (*p*=0.317), calories burned (*p*=0.304) and distance covered whilst walking (*p*=0.211).

There was a higher average number of steps taken on weekdays (4068.86) compared to weekends (639.14) indicating increased sedentary time on weekends compared to weekdays (*p*<0.001).

## 4.7 Fitness Assessment Results

### 4.7.1 Physical Efficiency Index

The participants' physical efficiency index (PEI) scores were classified as follows: Scores below 55 were classified as poor, between 55 and 64 were low average, between 65 and 79 were high average, between 80 and 89 were good and scores of 90 and above were classified as excellent.

Over half of the students (53.3%; *n*=32) were classified as high average and 38.3%(*n*=23) were classified as low average. Only 8.3%(*n*=5) achieved a poor classification. There were no participants who achieved a good or excellent classification. The median PEI was 65.36, which falls below the high average classification.

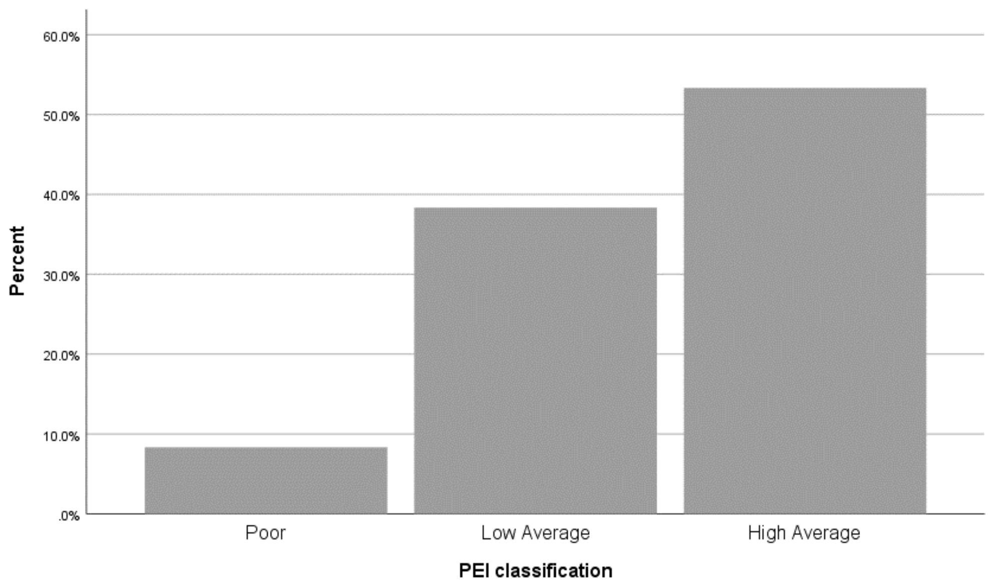


**Figure 4.2 Physical Efficiency Index of the respondents**

There were no significant relationships between PEI versus age (*p*=0.782), gender (*p*=0.331), race (*p*=0.139) or faculty (*p*=0.063).

### 4.7.2 Body Measurements

The World Health Organisation classification was used to categorize BMI. The ranges are underweight (<18.5), normal (18.5-24.9), pre-obese (25.0-29.9), obesity class I (30.0-34.9), obesity class II (35-39.9) and obesity class III (>40.0). As shown below in Table 4.9 the median BMI for males was 22.31 and for females was 24.60 hence both males and females had BMI values within the normal range (18.5-24.9).

**Table 4.8 Median and range for the respondents' body measurements**

| | Male | Female | *p* value |
|---|---|---|---|
| **BMI** | | | |
| Median | 22.31 | 24.60 | 0.248 |
| Range | 18.80-32.90 | 16.90-33.10 | |
| **Waist to hip circumference** | | | |
| Median | 0.94 | 0.92 | 0.110 |
| Range | 0.85-1.04 | 0.81-1.00 | |
| **Body Fat Percentage** | | | |
| Median | 18.1 | 37.6 | <0.001 |
| Range | 5.7-35.3 | 8.8-50.2 | |

More than three quarters (77.5%; *n*=31) of male respondents had a normal BMI. Only 57.14% (*n*=11) of females had a normal BMI, however these differences were not statistically significant (*p*=0.248). Furthermore, 38.09% (*n*=8) of females were classified as pre-obese. None of the participants were classified as obesity class II or class III. This is illustrated in Figure 4.3.

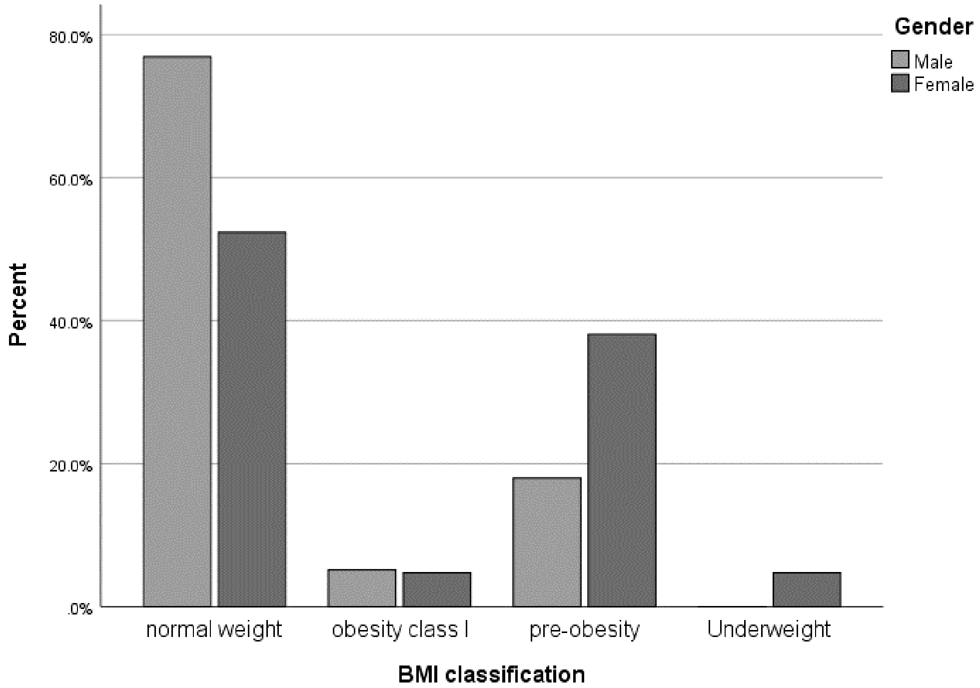


**Figure 4.3 Body Mass Index of the respondents**

Classification for waist to hip circumference was done according to risk of chronic disease (Larsson, Burgess and Michaëlsson 2017). The classification for males is as follows: low risk of disease (0.95 and below), moderate risk of disease (0.96-1.0) and high risk of disease (Above 1.0). The classification for females is as follows: low risk of disease (0.8 and below), moderate risk of disease (0.81-0.85) and high risk of disease (0.86 and above). Males had a median waist to hip ratio of 0.94 which is within normal range for males (0.95 and below). The median waist to hip ratio for females was 0.92, which is higher than the normal recommendation for females (0.8 and below). Figure 4.4 below reveals the level of risk to health indicated by the waist to hip ratio scores. Most male respondents (65%; *n*=25) had a low level of risk to health. Most females (85.71%; *n*=18), however, showed a high risk to their health by virtue of their waist to hip ratio being greater than 0.8.

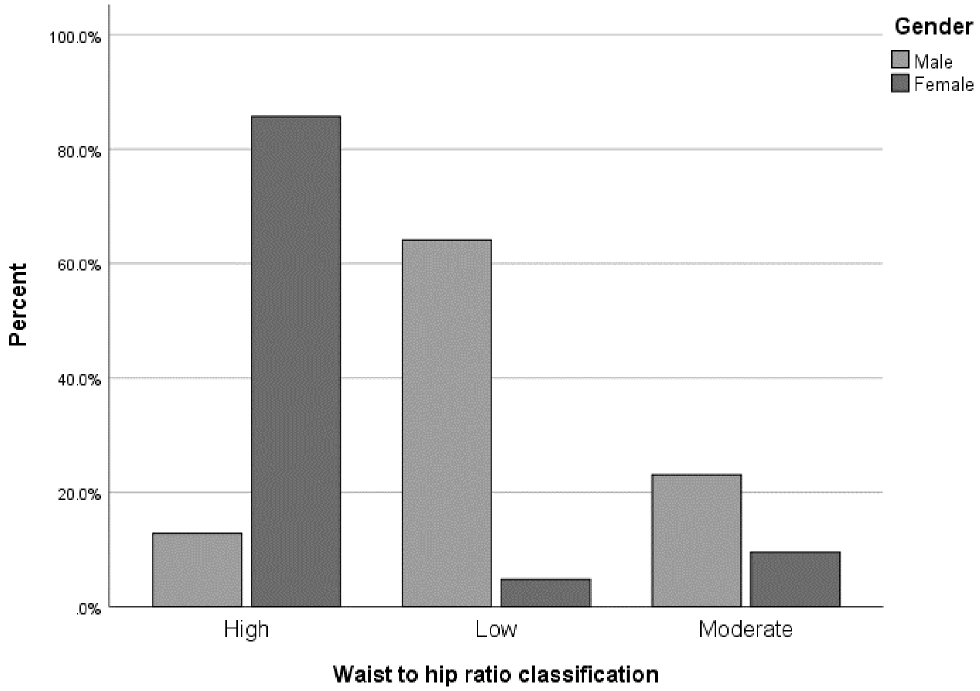


**Figure 4.4 Waist to hip ratio classification with regard to the level of health risk**

The body fat percentage of males was 18.1% which is within the normal range of 8.0-19.9. As depicted in Figure 4.5 just over half (52.5%; *n*=20) of male students had a normal body fat percentage (8.0-19.9). In contrast, females had a considerably high median body fat percentage of 37.6%, which is above the normal range of 21.0-32.9 for females. Only 23.81% (*n*=5) of females had a normal body fat percentage (21.0-32.9). The respondents' body measures can be seen in Table 4.8 above.

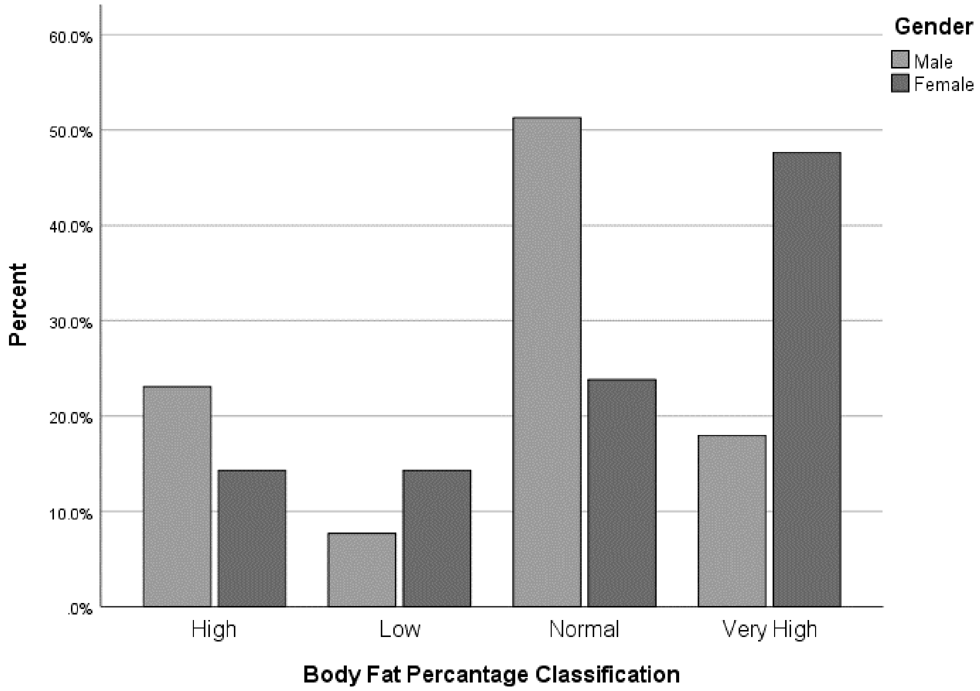


**Figure 4.5 Body fat percentage classification of respondents**

Table 4.9 below indicates that the BMI of participants from different race groups was similar (*p*=0.239). Waist to hip ratio (*p*=0.347) and body fat percentage (*p*=0.101) were also similar between the different race groups. However, the post hoc test showed that there was a significant difference (p=0.028) in the waist to hip ratio of Black African and Indian males, with Black African males having a lower waist to hip ratio than Indian males.

**Table 4.9 Body measurements comparisons across race**

| | Male | | | Female | | | *p* value |
|---|---|---|---|---|---|---|---|
| | **Black African** | **Indian** | **White** | **Black African** | **Indian** | **White** | |
| **Body Mass Index** | | | | | | | |
| Median | 22.20 | 22.31 | 32.90 | 25.10 | 20.50 | 22.00 | 0.239 |
| Range | 18.80-31.11 | 19.40-23.60 | 32.90-32.90 | 19.80-33.10 | 16.90-24.60 | 19.50-26.70 | |
| **Waist to hip ratio** | | | | | | | |
| Median | 0.93 | 0.99 | 0.94 | 0.94 | 0.88 | 0.91 | 0.347 |
| Range | 0.85-1.03 | 0.95-1.04 | 0.94-0.94 | 0.81-1.00 | 0.88-0.89 | 0.85-0.93 | |
| **Body Fat Percentage** | | | | | | | |
| Median | 18.1 | 12.6 | 30.9 | 39.9 | 32.5 | 34.8 | 0.101 |
| Range | 5.7-35.3 | 5.8-19.0 | 30.9-30.9 | 8.8-50.2 | 19.1-39.5 | 25.7-43.7 | |

Table 4.10 below shows that there were no significant differences when comparing the participants from the three faculties with respect to BMI ($p$=0.432) and waist to hip ratio ($p$=0.419). Females from the Faculties of Engineering and the Built Environment and Management Sciences had median BMI values within the pre-obesity (25.0-29.9) range. Female students from the Faculty of Health Sciences had a median BMI score in the normal (18.5-24.9) range. Body fat percentage was significantly different across the three faculties ($p$=0.023) with students from the Faculty of Management Sciences having a higher body fat percentage than Health Sciences and Engineering students.

**Table 4.10 Body measurements comparisons between faculties**

| | Male | | | Female | | | *p* value |
|---|---|---|---|---|---|---|---|
| | **Engineering** | **Management** | **Health** | **Engineering** | **Management** | **Health** | |
| **Body Mass Index** | | | | | | | |
| Median | 22.20 | - | 22.70 | 26.85 | 25.50 | 22.30 | 0.432 |
| Range | 18.80-31.11 | - | 18.90-32.90 | 24.60-29.10 | 24.80-26.20 | 16.90-33.10 | |
| **Waist to hip ratio** | | | | | | | |
| Median | 0.93 | - | 0.95 | 0.90 | 0.88 | 0.93 | 0.419 |
| Range | 0.85-1.03 | - | 0.91-1.04 | 0.89-0.92 | 0.82-0.94 | 0.81-1.00 | |
| **Body Fat Percentage** | | | | | | | |
| Median | 16.8 | - | 19.3 | 42.9 | 42.6 | 34.2 | 0.023 |
| Range | 5.7-35.3 | - | 5.8-30.9 | 39.5-46.3 | 42.4-42.8 | 8.8-50.2 | |

### 4.7.3 Correlations Between Body Measurements

Both males and females had a strong positive correlation between BMI and body fat percentage ($p<0.001$), indicating that respondents with a high BMI also had a high body fat percentage. This is expected as both indices measure obesity, indicating that the higher an individual's BMI, the higher the likelihood of an increased body fat percentage. There was however no correlation between BMI and waist to hip circumference ($p=0.092$) or between body fat percentage and waist to hip circumference ($p=0.345$).

## 4.8 Comparison between pedometer data and self-reported data

There was no association between the level of PA obtained from the IPAQ and pedometer data such as steps taken ($p=0.962$), aerobic steps ($p=0.941$), aerobic walking time ($p=0.824$), calories burned ($p=0.999$) and distance covered whilst walking ($p=0.957$).

The mean number of steps accumulated per day was very similar across all three levels of self-reported activity, as demonstrated in Figure 4.6 below.

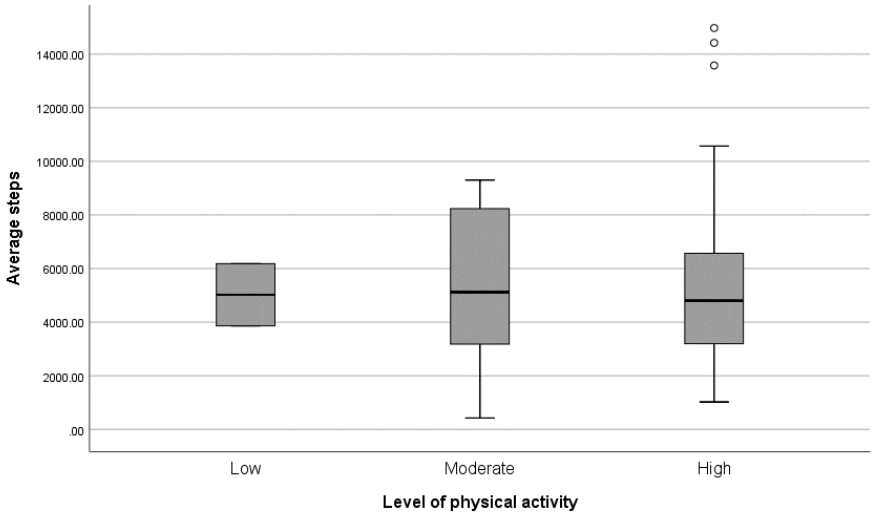


**Figure 4.6 Average number of steps per day compared to level of self-reported physical activity**

Figure 4.7 shows that the mean number of aerobic steps accumulated per day was also very similar across all three levels of self-reported PA.

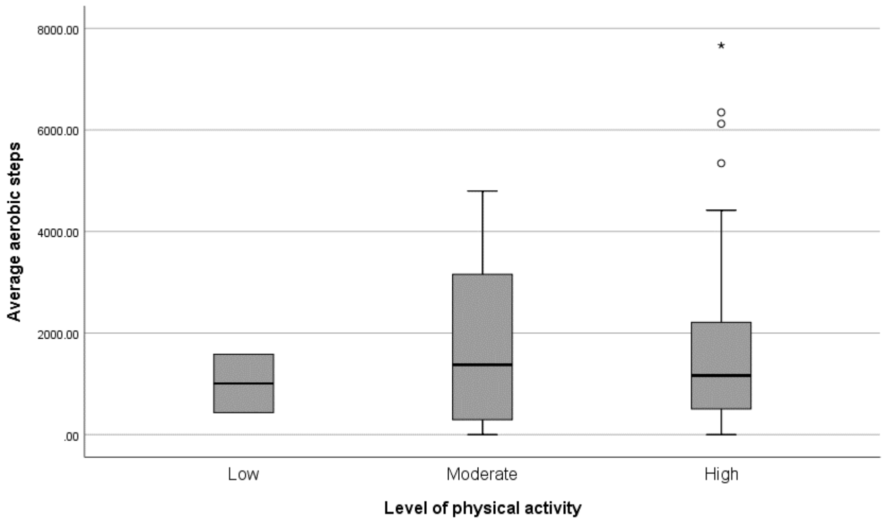


**Figure 4.7 Average number of aerobic steps accumulated per day compared to level of self-reported physical activity**

There was also no statistical difference in the median number of weekday ($p$=0.917) or weekend steps ($p$=0.650) between the three PA groups.

Most respondents (76.6%; $n$=38) who had a high self-reported score achieved less than a mean number of 7,500 steps per day.

## 4.9 Association between aerobic fitness and pedometer data

There was no correlation between PEI and any of the pedometer values. The PEI was not associated with the average number of steps per day ($p$=0.646), average aerobic steps per day ($p$=0.695), average walking time ($p$=0.996), average calories burned ($p$=0.876) and the average distance covered whilst walking ($p$=0.640). BMI was positively correlated with average aerobic steps ($p$=0.042) and average calories burnt ($p$=0.024) in females. Males instead showed a negative, although minor, correlation between BMI and average aerobic steps ($p$=0.270), which is expected as aerobic activity should increase the number of calories burnt and thus decrease BMI. There was no correlation between BMI and average calories burnt ($p$=0.578) in males. There were no other significant correlations when comparing pedometer results and body measurements.

## 4.10 Fitness Assessment Data Compared to Self-reported Data

There was a significant negative association between the level of self-reported PA obtained from the questionnaire and the PEI scores ($p$=0.009). This indicates that individuals scoring a high level of PA in the questionnaire did not score high PEI values. Of the participants who had a high questionnaire score, 57.1% had a PEI score in the category of high average and the remainder scoring even lower. No participants scored a PEI value above high average.

When comparing the three groups of self-reported PA (high, moderate and low) to BMI and body fat percentage there was no difference between the three groups with BMI ($p$=0.983) or body fat percentage ($p$=0.450). There was a significant difference however, when comparing the self-reported PA level and waist to hip circumference ratio ($p$=0.022). Post hoc tests were then done to compare the three groups. The mean waist to hip circumference was lower (mean 0.84 ±0.04) in respondents with a low self-reported PA level compared to the respondents who had high self-reported PA ($p$=0.023) or a moderate level of self-reported PA ($p$=0.021). However, it must be noted that there were only two participants in the low self-reported physical activity group. There was no correlation between the waist to hip ratio of respondents with a high self-reported PA level and those that had a moderate self-reported PA level ($p$=1.000).

## 4.11 Summary

Self-reported results from the questionnaire for the full group of 394 respondents and the sub-group of 60 respondents who completed the pedometer and fitness assessments have been presented. Comparisons were made between the different aspects of the study and will be discussed further in the Discussion chapter to follow.

The self-reported questionnaire results indicated that most respondents had a high level of PA. The more objective measures, as obtained from the pedometer component of the study and aerobic fitness assessment, showed most students to be either moderately active or sedentary. Males had higher levels of PA in all aspects of the study. Males also showed lower levels of obesity when comparing body measurements. Health Sciences students reported higher levels of activity in the questionnaire, however, did not show higher levels of PA in the pedometer and aerobic fitness assessment components of the study.

# CHAPTER FIVE

# Discussion

## 5.1 Introduction

This study, in determining the PA patterns of university students in SA, used three different measurement instruments viz. self-reported physical activity (IPAQ questionnaire); ambulatory physical activity (pedometer) and aerobic fitness (aerobic fitness assessment). The study thus provides useful comparisons between these three measurement instruments. These findings included participants reporting higher subjective PA levels but achieving moderate to low objective levels of actual PA. Females also had lower PA levels than males in all three parts of the study.

## 5.2 Self-reported physical activity

Results from the self-reported PA indicate that 76.6% (sample of 394) had high levels of PA. A systematic review of PA across 20 different countries shows that a high percentage of respondents (range 21.2%-62.9%) report high PA as per IPAQ scores (Bauman *et al.* 2009b). The lowest scores were mostly seen in older populations showing a decrease in PA with an increase in age (Bauman *et al.* 2009b). However, a percentage of high levels of PA of more than 70% in a population, is uncommon, indicating that the self-reported PA results obtained in this study are unusually high (Bauman *et al.* 2009b). A possible reason for this is that the university students are at their prime level of activity, which often declines with an increase in age (Bauman *et al.* 2009b). Students from Poland had reported a similar percentage (78%) of high PA and also reported very high levels of vigorous PA (Bednarek *et al.* 2016). This was also seen in this sample, who also reported high levels of vigorous PA such as heavy lifting, climbing stairs, swimming, running and other aerobic activities. Notwithstanding this, when comparing the level of activity to university students in other countries, the South African students in this study had a higher percentage (76.6%) of high IPAQ scores compared to students from Saudi Arabia (12.9%), Turkey (26%), Egypt (36.7%), Greece (13.8%), Czech Republic (66.8%) and China (32.5%) (Bednarek *et al.* 2016; Awadalla *et al.* 2014; El Gilany *et al.* 2011; Papathanasiou *et al.* 2009; Zhao *et al.* 2007). There were also 36 students from various classes that did not wish to complete the questionnaire. It is possible that these individuals may have reported lower levels of PA which may have changed the overall results of the questionnaire study.

Male respondents had a higher percentage (82.5%) of high self-reported PA scores than females (70.6%). This trend has also been noted in many countries in various age groups and in most instances it was due to males reporting higher volumes of vigorous PA than females, through activities such as running, heavy lifting and swimming (Awadalla *et al.* 2014; El Gilany *et al.* 2011; Bauman *et al.* 2009b; Papathanasiou *et al.* 2009). This was also the case in this study with males reporting more vigorous activity than females. Males also reported higher volumes of PA in their recreation time compared to females. High volumes of recreational activity are often due to individuals using gymnasiums as well as other facilities for PA (Bauman *et al.* 2009b).

When comparing the various race groups, it was noted that Indian students had a lower volume of transportation PA compared to the other race groups. Many of the Black African students lived near campus or stayed in residence at the university and hence walked between residence and campus. Mixed Race students had the highest levels of transport PA, however there were only 4 Mixed Race students in this study. Many of the Indian students reported using a motor vehicle as a means of transport rather than walking. Black African students reported lower volumes of PA on campus and lower volumes of vigorous PA compared to students from the other race groups. Mixed Race students reported the highest amounts of PA on campus and vigorous PA although there were only 4 Mixed Race students in the study.

Health Sciences students were more physically active than students from the Faculty of Engineering and the Built Environment and Faculty of Management Sciences. This has also been seen in other studies where Health Sciences students were more physically active (El Gilany *et al.* 2011). This may be due to Health Sciences students being better educated on the health benefits of PA or having a greater interest in health and wellbeing than the general student population. Health Sciences students in this study reported more PA whilst on campus compared to students from the other faculties. Most students at the university walk between different campuses daily, however, certain departments from the Faculty of Health Sciences have additional tasks which the students are required to do. For instance, students from the Radiography Department had to do hospital rounds, in addition to their regular studies. They would hence be walking during these hospital visits which would add to their levels of activity. Students from the Department of Emergency Medical Care and Rescue are required to have regular fitness drills and tests throughout the year as part of their curriculum. This would have increased the level of activity of these students. Conversely, students from the Faculties of Management Sciences were more physically active at home, reporting more housework and garden chores than the students from the other two faculties. It is possible that these students may be more independent and living on their own. However, there is no known reason for this. However, in some countries, a large proportion of Health Sciences students were not active. In Turkey 69% and in Saudi Arabia, 58% of Health Sciences students were not physically active (Awadalla *et al.* 2014; Arzu, Tuzun and Eker 2006). In both these studies the Health Sciences students expressed that they prioritized studying over PA and that they did not have the time to exercise due to heavy workloads (Awadalla *et al.* 2014; Arzu, Tuzun and Eker 2006).

## 5.3 Ambulatory Physical Activity

The pedometer results revealed that the average number of steps taken per day was 4,853 steps per day. This is below the daily recommendation of 10,000 steps or 7,500 steps where health benefits become evident (Tudor-Locke *et al.* 2011). Only 23.3% of students walked 7,500 steps or more per day and only 8.3% walked more than 10,000 steps per day. In other countries in the general adult population there has been a higher average number of steps taken per day, which includes the United States of America (5,100), Japan (7,200), Belgium (9,600), Australia (9,600) and Canada (6,685) (Tudor-Locke *et al.* 2011; Choi, Pak and Choi 2007). Although the average is lower in this study, there is a fair amount of variance between countries. In the South African working population, 12.2% of respondents had an average of 10,000 or more steps per day (Pillay *et al.* 2015). Although the respondents of the current study were younger than those in the employed adult population, they were less active in terms of ambulatory PA. This is unexpected as PA generally decreases with an increase in age (Bauman *et al.* 2009b). The increased activity in youth is shown in an American study where university students had an average of 11,474 steps per day, with 67.4% achieving an average of 10,000 or more steps per day (Behrens and Dinger 2005). Another two American studies showed that students from two other universities accumulated an average of 9,527 and 10,475 steps per day respectively (LeCheminant *et al.* 2011; Sisson, McClain and Tudor-Locke 2008). In an intervention study that used a pedometer to increase walking among American university students, there was an average of 7,013 steps per day in the first week, with an increase up to 9,000 steps per day, 6 weeks into the intervention (Jackson and Howton 2008). Results from many of the first world countries showed higher amounts of ambulatory PA, however globally the average adult takes between 4,000 to 6,000 steps per day (Tudor-Locke *et al.* 2008). The results from this study as well as those by Pillay *et al*. (2015) fall within this latter range. With SA having a higher crime rate than other countries as well as limited public recreational areas, it is possible that this would deter people from performing sustained recreational walking in public. This was reported as a discouraging factor among Indian South Africans in Durban who stated that the fear of crime was a barrier to walking in public areas (Kader and Haffejee 2018). The average number of aerobic steps taken in this study was 1,175 steps per day. The study done on the South African working population reported that the average number of aerobic steps was 694 steps per day (Pillay *et al.* 2015).

In this study males, had a higher average number of steps than females (5,122 versus 4,175, respectively). This was similarly observed in the study on the South African working population where males had an average of 7,476 compared to females who had an average of 5,769 steps per day (Pillay *et al.* 2015). This has also been seen in some other countries such as Switzerland where males did more walking as a means of recreational PA than females (Tudor-Locke *et al.* 2011). In this study males also reported more recreational PA than females, in the

IPAQ questionnaire, which could explain the difference in steps between the genders.

When comparing PA and race it was noted that Black African students were doing significantly more ambulatory PA than the other race groups, hence accumulating more steps and aerobic steps. This may be linked to the increased transport PA, as noted from the questionnaire data. Many of the Black African students also stayed in residence in the university and did not have motor vehicles and would have had to rely on walking as a means of transport.

In this study there was an increased number of steps taken on weekdays (4,069) compared to weekends (639). This has also been seen in other studies including a study on American college students (Behrens and Dinger 2005). The reason for this is that most people, including university students, have an increase in sedentary time on weekends compared to weekdays (Keating *et al.* 2005).

## 5.4 Aerobic fitness

Aerobic fitness was determined by the respondents' physical efficiency index. The PEI of many respondents was low with no respondents achieving "good" or "excellent" classifications which are considered highly active classifications (Lee, Roh and Kim 2016; Burnstein, Steele and Shrier 2011b). Notwithstanding this, only 8.3% were classified as "poor", 38.3% having a "low average" classification and most respondents (53.3%) achieving a "high average" classification, which is the middle classification. This indicates that none of the respondents were highly active, few were low active/inactive, and most were moderately active. This contrasts with the data obtained from the IPAQ questionnaires and will be discussed in more detail below. Furthermore, there were no associations between participant demographics and PEI.

## 5.5 Comparison between physical activity estimates

There were three measures used in this study to determine the respondents' PA levels for the group of 60 respondents. These included the self-reported data from the questionnaires, ambulatory PA and aerobic fitness. Anthropometric data such as BMI, waist to hip circumference ratio and body fat percentage was also obtained. When assessing the self-reported data, it was found that 81.7% of respondents reported a high level of PA in the questionnaire however, only 8.3% achieved more than 10,000 steps per day in the pedometer aspect of the study. It was also shown that 53.3% of students achieved less than 5,000 steps per day, revealing sedentary behaviour. Furthermore, the aerobic fitness assessment using the Harvard step test revealed that 53.3% of respondents had “high average” scores, with no students achieving “good” or “excellent” scores which show a moderate level of PA in just over half of the participants. When comparing ambulatory PA and aerobic fitness little difference was seen with students generally showing moderate to low PA levels.

Female students showed lower volumes of self-reported PA than males, especially vigorous PA and recreational PA. In the pedometer aspect of the study, females were also shown to have a lower number of steps accumulated per day (4,175) compared to males (5,121) revealing a lower amount of ambulatory PA. Furthermore, females showed a slightly lower amount of aerobic fitness than males, as obtained from the Harvard step test. This shows that females had lower PA levels than males in all three measures. This may be due to females engaging in less vigorous PA, as reported in the questionnaire, which as stated earlier has been seen in other studies done in countries such as Poland, Egypt and Saudi Arabia (Bednarek *et al.* 2016; Awadalla *et al.* 2014; El Gilany *et al.* 2011).

Although Health Sciences students indicated more PA in the self-assessed questionnaire data, they did not have a higher level of ambulatory PA. The pedometer data showed that they accumulated less steps (4,534) and aerobic steps (989) per day than students from the other faculties. Students from the Engineering and the Built Environment had the highest number of steps (5,905) and aerobic steps (1,494) per day. Possible reasons for the Engineering and the Built Environment students having a higher number of steps per day is that these students often have to climb several flights of stairs on the Steve Biko campus between lectures and many of these students who participated in this study may stay in residence and walk between residence and campus compared to the other faculties. In terms of aerobic fitness, students from all three faculties were very similar and did not score high results. Health Sciences students did, however, have lower BMI values than students from the other two faculties.

Results from the questionnaire data showed that Black African students were doing less vigorous PA than students from the other race groups. A possible reason for Black African students having lower vigorous activity scores than the other race groups could be that the latter students are using facilities such as gymnasiums for PA. However, Black African students performed more ambulatory PA than the students from the other race groups in the pedometer study achieving a higher number of steps and aerobic steps. The increased ambulatory PA may be due to Black African students relying more on walking as a means of transportation than the other race groups. Indian students, who reported lower volumes of transport PA in the questionnaire and more time traveling by motor vehicle, also performed lower volumes of ambulatory PA. No significant difference was observed between the various race groups when comparing aerobic fitness.

The results have indicated that the high volume of self-reported PA was not seen in the pedometer study or aerobic fitness assessment. The pedometer aspect of the study and aerobic fitness assessment indicated that most students were achieving moderate to low PA levels. This shows that the subjective PA levels were higher than the objective PA measures. Because the data is self-reported it decreases the validity of the fitness activity levels (Bauman *et al.* 2009a). Higher levels of subjective PA were reported compared to objectively measured PA in other studies as well, such as a study using the IPAQ questionnaire and an accelerometer where there was statistical significance showing much higher subjective self-reported PA compared to objective accelerometer results (Hagstromer *et al.* 2010). Similarly, the study by Hagstromer *et al*. (2010) also showed that there was a large amount of self-reported vigorous activity which produced high IPAQ scores. The pedometer study and aerobic fitness results are more reliable, with the aerobic fitness assessment being most reliable since it is conducted in a more controlled environment (Buckworth and Nigg 2004). The pedometer results do however give insight to the ambulatory PA patterns of the students with the only shortfall being that students may not have worn the pedometer for the full duration of seven days which would mean that the actual number of steps taken could be greater than the results obtained. Some individuals may also prefer to swim rather than run or walk to achieve vigorous PA. The pedometer cannot be worn during swimming and therefore swimmers in this study may have a low level of ambulatory PA which does not reflect their true volume of vigorous PA, which could be higher. The true PA level would then be best demonstrated in the aerobic fitness assessment which has shown that most students are only moderately active and that the rest are fairly sedentary.

## 5.6 Anthropometric measures and their relationship to physical activity

An increase in PA can result in a decrease in body fat as body fat is used as a source of additional energy during PA (Yoshino and Klein 2015). Individuals who are physically active will therefore usually have a lower BMI, waist to hip circumference ratio and body fat percentage than those who are not physically active (Yoshino and Klein 2015). In this study, there was no association between levels of self-reported PA, ambulatory PA or aerobic PA when compared to BMI and body fat percentage. There was a correlation however when comparing waist to hip circumference ratio with self-reported PA levels showing that participants with low self-reported PA levels had a low waist to hip circumference ratios. This is the opposite of the expected outcome as mentioned earlier, however there were only 2 students in the group of 60 that had low self-reported PA scores. A larger sample would be required to get a more accurate result. This study also showed that students who had high BMI scores also had high body fat percentages. However, waist to hip ratio was not strongly correlated to BMI ($r$=0.274) or body fat percentage ($r$=0.155). Waist to hip ratio is usually the best predictor for cardiovascular events and metabolic disease such as insulin resistant diabetes mellitus (Czernichow *et al.* 2011). This is because increased abdominal fat resulting in a larger waist has been shown to be up to three times more effective in predicting cardiovascular disease than other measures such as BMI (Czernichow *et al.* 2011). All three anthropometric measurements showed that females have higher levels of obesity than males. This is supported by the IPAQ results, where females reported less PA, especially vigorous and recreational PA. Furthermore, the pedometer results also showed that females performed less ambulatory PA and aerobic PA than males.

Most participants (68.9%) in the study had a normal BMI, however 38.09% of female respondents were categorized as pre-obese which indicates that females may be less physically active than males as decreased PA may lead to an increase in obesity (Yoshino and Klein 2015). This further indicates that females are less physically active than males, as also seen in the questionnaire, pedometer study and aerobic fitness assessment. The prevalence of obesity in this study was 4.91% which is low compared to the prevalence of 30.8% obesity among South African adults (Chooi, Ding and Magkos 2019). However, 25% of respondents were classified as pre-obese and BMI often increases in these individuals with an increase in age resulting in obesity (Chooi, Ding and Magkos 2019). It was also noted that Health Sciences students had better BMI scores than students from the Faculty of Engineering and the Built Environment and the Faculty of Management Sciences. This indicates that Health Sciences students may be following better diets and doing more PA than students from the other faculties as increased PA and better diets lead to a lower risk of obesity (Yoshino and Klein 2015). This is also supported by the IPAQ results which showed Health Sciences students to be more physically active than those from the other faculties. There were no associations between BMI and race.

Increased abdominal fat is a risk factor for cardiac disease as well as metabolic diseases such as insulin resistant (type 2) diabetes mellitus (Vargas-Vázquez *et al.* 2019). As mentioned previously it is also usually the best predictor for cardiac events and metabolic disease (Czernichow *et al.* 2011). Waist to hip ratio measures hip circumference (around the largest part of the buttocks) as well as waist circumference (measured around the level of the umbilicus) and compares them as a ratio. A high waist circumference is associated with increased abdominal fat. Waist to hip ratio scores revealed that 65% of males had a low risk to health whilst only 5% of females had a low risk to health. For males, a waist to hip circumference ratio less than 0.95 is considered a low risk to health whilst in females a waist to hip circumference ratio less than 0.8 is considered a low risk to health. In contrast 85.71% of females had a high risk to their health. This could be due to females being less physically active than males, as decreased physical activity can result in increased abdominal fat (Chooi, Ding and Magkos 2019). Similarly, a study on Nigerian university students also showed that females (92.3%) had a higher risk to health compared to males (67.7%), when waist to hip circumference ratios were measured (Orendu *et al.* 2016). There were no associations between waist to hip circumference and race.

The Omron body composition monitor, which measures body fat percentage, supports the findings of the waist to hip circumference ratios and BMI results. This monitor indicated that more females (47.62%) had a very high body fat percentage compared to males (17.5%). Additionally, 52.5% of males had a normal body fat percentage compared to only 20% of females. Students from the Faculty of Management Sciences had higher body fat percentages than the other two faculties suggesting that they may be the least physically active students. Health Sciences students had lower body fat percentages than the other faculties. This is supported by the self-assessed PA data from the IPAQ questionnaire. There were no associations between body fat percentage and race.

## 5.7 Summary

This study showed that the self-reported PA levels obtained from IPAQ were much higher than those obtained from the more objective PA levels obtained from the pedometer study and aerobic fitness assessment. The IPAQ scores were also higher than in other studies which also used the IPAQ questionnaire in various other countries. There was particularly high reporting of vigorous PA. However, the aerobic fitness assessment did not reflect this, showing moderate to low levels of aerobic PA. The pedometer study also revealed moderate to low levels of ambulatory PA. Another trend seen throughout the study is the difference in activity levels between males and females, with females having lower PA levels, as shown by all three measurements. In addition, females had higher indications of obesity, which is linked to the lower PA than the male students. Health Sciences students in this study reported higher levels of PA in the IPAQ compared to the other faculties but did not demonstrate higher PA levels when assessing physical activity through the objective measures. Black African students showed higher levels of ambulatory PA in the pedometer study which may be due to many of those students staying in residence and hence relying on walking as a means of transport to a greater extent than the other race groups. The aerobic fitness assessment showed that all students regardless of race, age or faculty had moderate to low levels of aerobic PA.

# CHAPTER SIX

# Conclusion and Recommendations

## 6.1 Conclusion

This study showed that there was a higher level of self-reported PA than the more objectively determined PA (through pedometer and aerobic fitness data) among students. The self-reported data indicated high levels of PA. The more objective measures, i.e. the pedometer data and aerobic fitness data, showed moderate to low levels of PA in the students. The levels of activity were different between the genders. The trend of males showing higher activity than females was present throughout the study, which was also supported by the anthropometric measures, which showed females to have higher levels of obesity. Self-reported and objective ambulatory PA suggested that Black African students did more walking than the other race groups which may be as a result of many of the Black African students staying in university residence. The self-reported PA levels obtained from the IPAQ were high compared to other studies using the IPAQ. The students reported high levels of vigorous PA which significantly increases the IPAQ score. Health Sciences students reported higher levels of PA and showed a lower prevalence of obesity in the anthropometric measures. However, they did not achieve higher levels of activity in the objective measures. In the pedometer study students from the Faculty of Engineering and the Built Environment showed more ambulatory PA. The aerobic fitness assessment did not indicate any differences between faculties with all students regardless of faculty showing moderate to low levels of aerobic PA. It is therefore inconclusive as to which Faculty was more active than the others.

Considering the high levels of self-reported PA were not consistent in both objective measures (i.e. the step count using the pedometer as well as the aerobic fitness assessment), indicates that self-reported assessments are less reliable and should be carefully considered for use, unless adjusted accordingly through more objective measures.

## 6.2 Limitations

A limitation in this study was that not all students who answered the IPAQ questionnaires participated in the pedometer study and aerobic fitness assessment, as only 60 students were required for the latter parts of the study. The IPAQ questionnaire is a subjective measure meaning that the actual PA levels could be different to what was reported. It is possible for respondents to also report biased levels of activity and it is possible that some respondents may have over-reported or under-reported levels of activity. The limitations of the pedometer study were that it was not done in a controlled environment over the one-week period and respondents may have forgotten to wear it for a full day on days when data was collected. This could lead to pedometer results being lower than the actual level of ambulatory PA. It also would have been better in this study to use a pedometer that is capable of showing the amount of use throughout the day to get a better picture of the respondents' sedentary time and to determine if the respondent adhered to wearing the device throughout the day for more accurate results to be obtained. Anthropometric measurements such as BMI do not take increased muscle mass into account which can give a false positive for obesity however, these results compared well with other measures of body fat.

## 6.3 Recommendations

This study warrants further investigation and should be researched at other South African tertiary institutions in other provinces. This would give a clearer picture of students' PA throughout the country and increase the reliability of the results. The Omron Walking Style Pro 2.0 (HJ-322U-E) data was uploaded to an Omron webpage which was designed for consumers to track their own personal fitness and was not ideal for using on several respondents at once, although it was still possible. It is therefore recommended to use a different pedometer where it is easier to track several respondents. The aerobic fitness assessment was the most controlled measure used to determine PA levels and may give a clearer picture of the actual PA level of students. It is therefore recommended that future studies use the aerobic fitness assessment rather than the other two measures to determine a more accurate level of PA. There are also other methods of measuring aerobic fitness such as cycle tests, swim tests and others that may also prove useful in measuring aerobic fitness.

Due to the objective measures showing moderate to low levels of PA in university students it is also recommended that tertiary institutions may need to adopt an exercise regimen similar to primary and secondary schools. Alternatively, facilities to support or encourage PA should be more available for the students to utilise. There is a gymnasium on campus as well as other sport facilities such as a Sports Centre, which offers some indoor activities such as indoor football, volleyball and table tennis. Although the Durban University of Technology does have these facilities, they are often not available for use, for example when the Sports Centre is closed, as it is also used as an examination or test venue. It is recommended that the Sports Centre be available for use throughout the year and that alternative venues be sourced as examination venues. This will enable students to use the Sports Centre facilities for PA throughout the year.

# References

Adámková, V., Belohoubek, J., Adámek, V., Juhanáková, M. and Pirk, J. 2015. Physical activity and exercise as a basic preventive measure (primary prevention, prevention after renal transplantation). *Central European journal of public health*, 23: S3.

Ainsworth, B. E., Haskell, W. L., Herrmann, S. D., Meckes, N., Bassett Jr, D. R., Tudor-Locke, C., Greer, J. L., Vezina, J., Whitt-Glover, M. C. and Leon, A. S. 2011. 2011 Compendium of Physical Activities: a second update of codes and MET values. *Medicine & Science in Sports & Exercise*, 43 (8): 1575-1581.

Amini, N., Sarrafzadeh, M., Vahdatpour, A. and Xu, W. 2011. Accelerometer-based on-body sensor localization for health and medical monitoring applications. *Pervasive and mobile computing*, 7 (6): 746-760.

Arem, H., Moore, S. C., Patel, A., Hartge, P., De Gonzalez, A. B., Visvanathan, K., Campbell, P. T., Freedman, M., Weiderpass, E. and Adami, H. O. 2015a. Leisure time physical activity and mortality: a detailed pooled analysis of the dose-response relationship. *JAMA Internal Medicine*, 175 (6): 959-967.

Arem, H., Pfeiffer, R. M., Engels, E. A., Alfano, C. M., Hollenbeck, A., Park, Y. and Matthews, C. E. 2015b. Pre- and Postdiagnosis Physical Activity, Television Viewing, and Mortality Among Patients With Colorectal Cancer in the National Institutes of Health–AARP Diet and Health Study. *Journal of Clinical Oncology*, 33 (2): 180-188.

Arzu, D., Tuzun, E. H. and Eker, L. 2006. Perceived Barriers to Physical Activity in University Students. *Journal of Sports Science & Medicine*, 5 (4): 615-620.

Awadalla, N., Aboelyazed, A., Hassanein, M., Khalil, S., Aftab, R., Gaballa, I. and Mahfouz, A. 2014. Assessment of physical inactivity and perceived barriers to physical activity among health college students, south-western Saudi Arabia. *Eastern Mediterranean Health Journal*, 20 (10)

Barbieri, E., Agostini, D., Polidori, E., Potenza, L., Guescini, M., Lucertini, F., Annibalini, G., Stocchi, L., De Santi, M. and Stocchi, V. 2015. The pleiotropic effect of physical exercise on mitochondrial dynamics in aging skeletal muscle. *Oxidative medicine and cellular longevity*, 2015

Bauman, A., Ainsworth, B. E., Bull, F., Craig, C. L., Hagströmer, M., Sallis, J. F., Pratt, M. and Sjöström, M. 2009a. Progress and pitfalls in the use of the International Physical Activity Questionnaire (IPAQ) for adult physical activity surveillance. *Journal of Physical Activity and Health*, 6 (s1): S5-S8.

Bauman, A., Bull, F., Chey, T., Craig, C. L., Ainsworth, B. E., Sallis, J. F., Bowles, H. R., Hagstromer, M., Sjostrom, M. and Pratt, M. 2009b. The international prevalence study on physical activity: results from 20 countries. *International Journal of Behavioral Nutrition and Physical Activity*, 6 (1): 21.

Bednarek, J., Pomykała, S., Bigosińska, M. and Szyguła, Z. 2016. Physical activity of Polish and Turkish university students as assessed by IPAQ. *Central European Journal of Sport Sciences and Medicine*, 16 (4): 13-22.

Behrens, T. K. and Dinger, M. K. 2005. Ambulatory Physical Activity Patterns of College Students. *American Journal of Health Education*, 36 (4): 221-227.

Buckworth, J. and Nigg, C. 2004. Physical Activity, Exercise, and Sedentary Behavior in College Students. *Journal of American College Health*, 53 (1): 28-34.

Burnstein, B. D., Steele, R. J. and Shrier, I. 2011a. *Reliability of fitness tests using methods and time periods common in sport and occupational management*: National Athletic Trainers' Association, Inc.

Burnstein, B. D., Steele, R. J. and Shrier, I. 2011b. Reliability of Fitness Tests Using Methods and Time Periods Common in Sport and Occupational Management. *Journal of Athletic Training*, 46 (5): 505-513.

Byrne, N. M., Hills, A. P., Hunter, G. R., Weinsier, R. L. and Schutz, Y. 2005. The metabolic equivalent: One size does not fit all. *Journal of applied physiology*,

Chen, L., Magliano, D. J. and Zimmet, P. Z. 2012. The worldwide epidemiology of type 2 diabetes mellitus—present and future perspectives. *Nature reviews endocrinology*, 8 (4): 228.

Choi, B. C., Pak, A. W. and Choi, J. C. 2007. Daily step goal of 10,000 steps: a literature review. *Clinical & Investigative Medicine*, 30 (3): 146-151.

Chooi, Y. C., Ding, C. and Magkos, F. 2019. The epidemiology of obesity. *Metabolism*, 92: 6-10.

Christensen, K. 2003. Osteoporosis and Spinal Exercise. *AMERICAN CHIROPRACTOR*, 25 (6): 56-58.

Colberg, S. R., Sigal, R. J., Yardley, J. E., Riddell, M. C., Dunstan, D. W., Dempsey, P. C., Horton, E. S., Castorino, K. and Tate, D. F. 2016. Physical Activity/Exercise and Diabetes: A Position Statement of the American Diabetes Association. *Diabetes Care*, 39 (11): 2065-2079.

Cooper, A. J. M., Brage, S., Ekelund, U., Wareham, N. J., Griffin, S. J. and Simmons, R. K. 2014. Association between objectively assessed sedentary time and physical activity with metabolic risk factors among people with recently diagnosed type 2 diabetes. *Diabetologia*, 57 (1): 73-82.

Czernichow, S., Kengne, A.-P., Huxley, R. R., Batty, G. D., De Galan, B., Grobbee, D., Pillai, A., Zoungas, S., Marre, M. and Woodward, M. 2011. Comparison of waist-to-hip ratio and other obesity indices as predictors of cardiovascular disease risk in people with type-2 diabetes: a prospective cohort study from ADVANCE. *European Journal of Cardiovascular Prevention & Rehabilitation*, 18 (2): 312-319.

Dhutia, H. and Sharma, S. 2015. Playing it safe: exercise and cardiovascular health. *The Practitioner*, 259 (1786): 15-20, 12.

Diaz, K. M., Booth, J. N., Seals, S. R., Abdalla, M., Dubbert, P. M., Sims, M., Ladapo, J. A., Redmond, N., Muntner, P. and Shimbo, D. 2017. Physical Activity and Incident Hypertension in African Americans. *The Jackson Heart Study*,

Duclos, M., Dejager, S., Postel-Vinay, N., di Nicola, S., Quéré, S. and Fiquet, B. 2015. Physical activity in patients with type 2 diabetes and hypertension – insights into motivations and barriers from the MOBILE study. *Vascular Health and Risk Management*, 11: 361-371.

El Gilany, A.-H., Badawi, K., El Khawaga, G. and Awadalla, N. 2011. Physical activity profile of students in Mansoura University, Egypt.

Ellapen, T., Essack, F., Thwala, S. and Van Heerden, H. 2014. Coronary Heart Disease Risk Profile among University of Kwa-Zulu Natal Students. *African Journal of Physiotherapy and Rehabilitation Sciences*, 6 (1-2): 21-26.

Ellapen, T., Paul, Y., Swanepoel, M. and Strydom, G. 2018. Do biokineticists transgress on physiotherapists' scope of profession? Evidence-based analysis of two physical rehabilitation disciplines in South Africa. *African Journal for Physical Activity and Health Sciences (AJPHES)*, 24 (3): 316-331.

Ezzati, M., Di Cesare, M. and Bentham, J. 2018. Determining the worldwide prevalence of obesity–Authors' reply. *The Lancet*, 391 (10132): 1774.

Fountaine, C. J., Liguori, G. A., Mozumdar, A. and Schuna Jr, J. M. 2011. Physical activity and screen time sedentary behaviors in college students. *International Journal of Exercise Science*, 4 (2): 3.

Frontera, W. R. and Ochala, J. 2015. Skeletal muscle: a brief review of structure and function. *Calcified tissue international*, 96 (3): 183-195.

Ghaneapur, M., Eftekhar, H., Montazeri, A., Garmarudi, G., Yaseri, M. and Ahvanoei, A. R. 2019. Effectiveness of a Self-Determination Theory (SDT) Based Intervention on Physical Activity, Quality of Life, and Happiness: A Protocol for a Randomized Clinical Trial. *J Biochem Tech*,  (2): 108-117.

Goss, D. L. and Gross, M. T. 2012. *A review of mechanics and injury trends among various running styles*. NORTH CAROLINA UNIV AT CHAPEL HILL.

Hagstromer, M., Ainsworth, B. E., Oja, P. and Sjostrom, M. 2010. Comparison of a subjective and an objective measure of physical activity in a population sample. *Journal of Physical Activity and Health*, 7 (4): 541-550.

Hallal, P. C., Victora, C. G., Azevedo, M. R. and Wells, J. C. K. 2006. Adolescent Physical Activity and Health. *Sports Medicine*, 36 (12): 1019-1030.

Halonen, J. I., Stenholm, S., Kivimäki, M., Pentti, J., Subramanian, S., Kawachi, I. and Vahtera, J. 2015. Is change in availability of sports facilities associated with change in physical activity? A prospective cohort study. *Preventive medicine*, 73: 10-14.

Harrison, F., Atkin, A. J., van Sluijs, E. M. and Jones, A. P. 2017. Seasonality in swimming and cycling: Exploring a limitation of accelerometer based studies. *Preventive medicine reports*, 7: 16-19.

Hatano, Y. 1993. Use of the pedometer for promoting daily walking exercise. *ICHPER*, 29: 4-8.

Healy, G. N., Clark, B. K., Winkler, E. A., Gardiner, P. A., Brown, W. J. and Matthews, C. E. 2011. Measurement of adults' sedentary time in population-based studies. *American journal of preventive medicine*, 41 (2): 216-227.

Heneweer, H., Staes, F., Aufdemkampe, G., van Rijn, M. and Vanhees, L. 2011. Physical activity and low back pain: a systematic review of recent literature. *European Spine Journal*, 20 (6): 826-845.

Hills, A. P., Dengel, D. R. and Lubans, D. R. 2015. Supporting public health priorities: recommendations for physical education and physical activity promotion in schools. *Progress in cardiovascular diseases*, 57 (4): 368-374.

Hjerkind, K. V., Stenehjem, J. S. and Nilsen, T. I. 2017. Adiposity, physical activity and risk of diabetes mellitus: prospective data from the population-based HUNT study, Norway. *BMJ open*, 7 (1): e013142.

Hurwitz, E. L., Morgenstern, H. and Chiao, C. 2005. Effects of Recreational Physical Activity and Back Exercises on Low Back Pain and Psychological Distress: Findings From the UCLA Low Back Pain Study. *American Journal of Public Health*, 95 (10): 1817-1824.

Jackson, E. M. and Howton, A. 2008. Increasing walking in college students using a pedometer intervention: differences according to body mass index. *Journal of American College Health*, 57 (2): 159-164.

Janssen, I. and LeBlanc, A. G. 2010. Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. *International Journal of Behavioral Nutrition and Physical Activity*, 7 (1): 40.

Jones, S. A., Moore, L. V., Moore, K., Zagorski, M., Brines, S. J., Roux, A. V. D. and Evenson, K. R. 2015. Disparities in physical activity resource availability in six US regions. *Preventive medicine*, 78: 17-22.

Joyner, M. J. and Casey, D. P. 2015. Regulation of increased blood flow (hyperemia) to muscles during exercise: a hierarchy of competing physiological needs. *Physiological reviews*, 95 (2): 549-601.

Kader, N. and Haffejee, F. 2018. The prevalence of physical activity among South African Indians residing in Durban. *African Journal for Physical Activity and Health Sciences (AJPHES)*, 24 (4): 525-536.

Keating, X. D., Guan, J., Piñero, J. C. and Bridges, D. M. 2005. A Meta-Analysis of College Students' Physical Activity Behaviors. *Journal of American College Health*, 54 (2): 116-126.

Kim, Y., Park, I. and Kang, M. 2013. Convergent validity of the international physical activity questionnaire (IPAQ): meta-analysis. *Public health nutrition*, 16 (3): 440-452.

Kirchengast, S. 2015. Osteoporosis & Physical Activity.

Koster, A., Caserotti, P., Patel, K. V., Matthews, C. E., Berrigan, D., Van Domelen, D. R., Brychta, R. J., Chen, K. Y. and Harris, T. B. 2012. Association of sedentary time with mortality independent of moderate to vigorous physical activity. *PloS one*, 7 (6): e37696.

Kyu, H. H., Bachman, V. F., Alexander, L. T., Mumford, J. E., Afshin, A., Estep, K., Veerman, J. L., Delwiche, K., Iannarone, M. L., Moyer, M. L., Cercy, K., Vos, T., Murray, C. J. L. and Forouzanfar, M. H. 2016. Physical activity and risk of breast cancer, colon cancer, diabetes, ischemic heart disease, and ischemic stroke events: systematic review and dose-response meta-analysis for the Global Burden of Disease Study 2013. *BMJ*, 354

Larsson, S. C., Burgess, S. and Michaëlsson, K. 2017. Association of genetic variants related to serum calcium levels with coronary artery disease and myocardial infarction. *Jama*, 318 (4): 371-380.

LeCheminant, J. D., Smith, J. D., Covington, N. K., Hardin-Renschen, T. and Heden, T. 2011. Pedometer use in university freshmen: a randomized controlled pilot study. *American journal of health behavior*, 35 (6): 777-784.

Lee, H. T., Roh, H. L. and Kim, Y. S. 2016. Cardiorespiratory endurance evaluation using heart rate analysis during ski simulator exercise and the Harvard step test in elementary school students. *Journal of physical therapy science*, 28 (2): 641-645.

Lukács, A., Simon, N., Demeter, J. S., Kissné Dányi, É. and Kiss-Tóth, E. 2013. Alcohol consumption among university students. *EGÉSZSÉGTUDOMÁNYI KÖZLEMÉNYEK: A MISKOLCI EGYETEM KÖZLEMÉNYE*, 3 (2): 57-61.

Mantovani, A. M., Duncan, S., Codogno, J. S., Lima, M. C. S. and Fernandes, R. A. 2016. Different amounts of physical activity measured by pedometer and the associations with health outcomes in adults. *Journal of Physical Activity and Health*, 13 (11): 1183-1191.

Micklesfield, L. K., Pedro, T. M., Kahn, K., Kinsman, J., Pettifor, J. M., Tollman, S. and Norris, S. A. 2014. Physical activity and sedentary behavior among adolescents in rural South Africa: levels, patterns and correlates. *BMC Public Health*, 14 (1): 40.

Moore, S. C., Lee, I., Weiderpass, E. and et al. 2016. Association of leisure-time physical activity with risk of 26 types of cancer in 1.44 million adults. *JAMA Internal Medicine*, 176 (6): 816-825.

Naidoo, R., Coopoo, Y., Lambert, E. V. and Draper, C. 2009. Impact of a primary school-based nutrition and physical activity intervention on learners in KwaZulu-Natal, South Africa: a pilot study. *South African Journal of Sports Medicine*, 21 (1)

Nyberg, M., Gliemann, L. and Hellsten, Y. 2015. Vascular function in health, hypertension, and diabetes: effect of physical activity on skeletal muscle microcirculation. *Scandinavian journal of medicine & science in sports*, 25: 60-73.

Orendu, A. M., Samaila, C. M., Ishaya, H. B., Paul, A. and Jacob, A. 2016. Measurement of Obesity as Indicated by Body Mass Index Using Waist-Hip Ratio among Apparently Healthy Students in University of Maiduguri, Nigeria. *Nova*, 5 (3): 1-5.

Özgürbüz, C. 2003. Osteoporosis and physical activity. *Turkish Journal of endocrinology and metabolism*, 3: 101-105.

Papathanasiou, G., Georgoudis, G., Papandreou, M., Spyropoulos, P., Georgakopoulos, D., Kalfakakou, V. and Evangelou, A. 2009. Reliability measures of the short International Physical Activity Questionnaire (IPAQ) in Greek young adults. *Hellenic J Cardiol*, 50 (4): 283-294.

Peltzer, K. 2010. Leisure time physical activity and sedentary behavior and substance use among in-school adolescents in eight African countries. *International journal of behavioral medicine*, 17 (4): 271-278.

Phillips, C. M. 2013. Metabolically healthy obesity: definitions, determinants and clinical implications. *Reviews in Endocrine and Metabolic Disorders*, 14 (3): 219-227.

Pillay, J. D., van der Ploeg, H. P., Kolbe-Alexander, T. L., Proper, K. I., van Stralen, M., Tomaz, S. A., van Mechelen, W. and Lambert, E. V. 2015. The association between daily steps and health, and the mediating role of body composition: a pedometer-based, cross-sectional study in an employed South African population. *BMC Public Health*, 15 (1): 174.

Raimundo, R. 2015. Osteoporosis and Physical Activity. *J Osteopor Phys Act*, 3 (139): 2.

Reed, J. A. and Phillips, D. A. 2005. Relationships between physical activity and the proximity of exercise facilities and home exercise equipment used by undergraduate university students. *Journal of American College Health*, 53 (6): 285-290.

Rouse, P. C. and Biddle, S. J. 2010. An ecological momentary assessment of the physical activity and sedentary behaviour patterns of university students. *Health Education Journal*, 69 (1): 116-125.

Rovniak, L. S., Anderson, E. S., Winett, R. A. and Stephens, R. S. 2002. Social cognitive determinants of physical activity in young adults: A prospective structural equation analysis. *Annals of Behavioral Medicine*, 24 (2): 149-156.

Rowe, D. A., Kemble, C. D., Robinson, T. S. and Mahar, M. T. 2007. Daily Walking in Older Adults: Day-to-Day Variability and Criterion-Referenced Validity of Total Daily Step Counts. *Journal of Physical Activity and Health*, 4 (4): 435-447.

Santo, A. S. and Golding, L. A. 2003. Predicting maximum oxygen uptake from a modified 3-minute step test. *Research quarterly for exercise and sport*, 74 (1): 110-115.

Schmid, D. and Leitzmann, M. 2014. Association between physical activity and mortality among breast cancer and colorectal cancer survivors: a systematic review and meta-analysis. *Annals of Oncology*, 25 (7): 1293-1311.

Sisson, S. B., McClain, J. J. and Tudor-Locke, C. 2008. Campus walkability, pedometer-determined steps, and moderate-to-vigorous physical activity: a comparison of 2 university campuses. *Journal of American College Health*, 56 (5): 585-592.

Tanaka, H. 2009. Swimming exercise. *Sports Medicine*, 39 (5): 377-387.

Taylor, J. D., Fletcher, J. P., Mathis, R. A. and Cade, W. T. 2014. Effects of Moderate-Versus High-Intensity Exercise Training on Physical Fitness and Physical Function in People With Type 2 Diabetes: A Randomized Clinical Trial. *Physical Therapy*, 94 (12): 1720-1730.

Thomson, C. A., McCullough, M. L., Wertheim, B. C., Chlebowski, R. T., Martinez, M. E., Stefanick, M. L., Rohan, T. E., Manson, J. E., Tindle, H. A. and Ockene, J. 2014. Nutrition and physical activity cancer prevention guidelines, cancer risk, and mortality in the women's health initiative. *Cancer prevention research*, 7 (1): 42-53.

Tschentscher, M., Niederseer, D. and Niebauer, J. 2013. Health benefits of Nordic walking: a systematic review. *American journal of preventive medicine*, 44 (1): 76-84.

Tudor-Locke, C., Craig, C. L., Brown, W. J., Clemes, S. A., De Cocker, K., Giles-Corti, B., Hatano, Y., Inoue, S., Matsudo, S. M. and Mutrie, N. 2011. How many steps/day are enough? For adults. *International Journal of Behavioral Nutrition and Physical Activity*, 8 (1): 79.

Tudor-Locke, C., Hatano, Y., Pangrazi, R. P. and Kang, M. 2008. Revisiting" how many steps are enough?". *Medicine & Science in Sports & Exercise*, 40 (7): S537-S543.

Tudor-Locke, C. and Lutes, L. 2009. Why do pedometers work? *Sports Medicine*, 39 (12): 981-993.

Vargas-Vázquez, A., Viveros-Ruiz, T. L., Almeda-Valdes, P., Gomez-Velasco, D., Mehta, R., Elias-López, D., Cruz-Bautista, I., Roldán-Valadez, E., Martagón, A. J. and Aguilar-Salinas, C. A. 2019. Metabolic Score for Visceral Fat (METS-VF), a novel estimator of intra-abdominal fat content and cardio-metabolic health.

Vetrovsky, T., Siranec, M., Marencakova, J., Tufano, J. J., Capek, V., Bunc, V. and Belohlavek, J. 2019. Validity of six consumer-level activity monitors for measuring steps in patients with chronic heart failure. *PloS one*, 14 (9)

Wasfi, A., El-Sherbiny, A., Gurashi, E. and Al Sayegh, F. 2008. Sport practice among private secondary-school students in Dubai in 2004. *Eastern Mediterranean Health Journal*, 14 (3)

Williams, P. T. and Thompson, P. D. 2013. Walking versus running for hypertension, cholesterol, and diabetes mellitus risk reduction. *Arteriosclerosis, thrombosis, and vascular biology*, 33 (5): 1085-1091.

Wilmot, E. G., Edwardson, C. L., Achana, F. A., Davies, M. J., Gorely, T., Gray, L. J., Khunti, K., Yates, T. and Biddle, S. J. 2012. *Sedentary time in adults and the association with diabetes, cardiovascular disease and death: systematic review and meta-analysis*: Springer.

Yoshino, M. and Klein, S. 2015. Endurance exercise: More pain, more metabolic gain. *Annals of Internal Medicine*, 162 (5): 385-386.

Zhao, Y., Sigmund, E., Sigmundová, D. and Lu, Y. 2007. Comparison of physical activity between Olomouc and Beijing university students using an International Physical Activity Questionnaire. *Acta Universitatis Palackianae Olomucensis. Gymnica*, 37 (4): 107-114.

**Appendix A: IPAQ questionnaire**

# International Physical Activity Questionnaire

Age: ______________

Gender: ___________

Race: ______________

Faculty: ________________________________________

Department: ____________________________________

## INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous** and **moderate** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal.

### *PART 1: JOB-RELATED PHYSICAL ACTIVITY*

The first section is about your work. This includes paid jobs, farming, volunteer work, course work, and any other unpaid work that you did outside your home. Do not include unpaid work you might do around your home, like housework, yard work, general maintenance, and caring for your family. These are asked in Part 3.

1. Do you currently have a job or do any unpaid work outside your home?

☐ Yes

☐ No → ***Skip to PART 2: TRANSPORTATION***

The next questions are about all the physical activity you did in the **last 7 days** as part of your paid or unpaid work. This does not include traveling to and from work.

2. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, heavy construction, or climbing up stairs **as part of your work**? Think about only those physical activities that you did for at least 10 minutes at a time.

_____ **days per week**

☐ No vigorous job-related physical activity → ***Skip to question 4***

3. How much time did you usually spend on one of those days doing **vigorous** physical activities as part of your work?

_____ **hours per day**
_____ **minutes per day**

4. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads **as part of your work**? Please do not include walking.

_____ **days per week**

☐ No moderate job-related physical activity → ***Skip to question 6***

5. How much time did you usually spend on one of those days doing **moderate** physical activities as part of your work?

_____ **hours per day**
_____ **minutes per day**

6. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time **as part of your work**? Please do not count any walking you did to travel to or from work.

_____ **days per week**

☐ No job-related walking → ***Skip to PART 2: TRANSPORTATION***

7. How much time did you usually spend on one of those days **walking** as part of your work?

_____ **hours per day**
_____ **minutes per day**

***PART 2: TRANSPORTATION PHYSICAL ACTIVITY***

These questions are about how you traveled from place to place, including to places like work, stores, movies, and so on.

8. During the **last 7 days**, on how many days did you **travel in a motor vehicle** like a train, bus, car, or tram?

_____ **days per week**

☐ No traveling in a motor vehicle → ***Skip to question 10***

9. How much time did you usually spend on one of those days **traveling** in a train, bus, car, tram, or other kind of motor vehicle?

_____ **hours per day**
_____ **minutes per day**

Now think only about the **bicycling** and **walking** you might have done to travel to and from work, to do errands, or to go from place to place.

10. During the **last 7 days**, on how many days did you **bicycle** for at least 10 minutes at a time to go **from place to place**?

_____ **days per week**

☐ No bicycling from place to place → ***Skip to question 12***

11. How much time did you usually spend on one of those days to **bicycle** from place to place?

_____ **hours per day**
_____ **minutes per day**

12. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time to go **from place to place**?

_____ **days per week**

☐ No walking from place to place → ***Skip to PART 3: HOUSEWORK, HOUSE MAINTENANCE, AND CARING FOR FAMILY***

13. How much time did you usually spend on one of those days **walking** from place to place?

_____ **hours per day**
_____ **minutes per day**

***PART 3: HOUSEWORK, HOUSE MAINTENANCE, AND CARING FOR FAMILY***

This section is about some of the physical activities you might have done in the **last 7 days** in and around your home, like housework, gardening, yard work, general maintenance work, and caring for your family.

14. Think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, chopping wood, shoveling snow, or digging **in the garden or yard**?

_____ **days per week**

☐ No vigorous activity in garden or yard → ***Skip to question 16***

15. How much time did you usually spend on one of those days doing **vigorous** physical activities in the garden or yard?

_____ **hours per day**
_____ **minutes per day**

16. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** activities like carrying light loads, sweeping, washing windows, and raking **in the garden or yard**?

_____ **days per week**

☐ No moderate activity in garden or yard → ***Skip to question 18***

17. How much time did you usually spend on one of those days doing **moderate** physical activities in the garden or yard?

_____ **hours per day**
_____ **minutes per day**

18. Once again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** activities like carrying light loads, washing windows, scrubbing floors and sweeping **inside your home**?

_____ **days per week**

☐ No moderate activity inside home → ***Skip to PART 4: RECREATION, SPORT AND LEISURE-TIME PHYSICAL ACTIVITY***

19. How much time did you usually spend on one of those days doing **moderate** physical activities inside your home?

_____ **hours per day**
_____ **minutes per day**

***PART 4: RECREATION, SPORT, AND LEISURE-TIME PHYSICAL ACTIVITY***

This section is about all the physical activities that you did in the **last 7 days** solely for recreation, sport, exercise or leisure. Please do not include any activities you have already mentioned.

20. Not counting any walking you have already mentioned, during the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time **in your leisure time**?

_____ **days per week**

☐ No walking in leisure time → ***Skip to question 22***

21. How much time did you usually spend on one of those days **walking** in your leisure time?

_____ **hours per day**
_____ **minutes per day**

22. Think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **vigorous** physical activities like aerobics, running, fast bicycling, or fast swimming **in your leisure time**?

_____ **days per week**

☐ No vigorous activity in leisure time → ***Skip to question 24***

23. How much time did you usually spend on one of those days doing **vigorous** physical activities in your leisure time?

_____ **hours per day**
_____ **minutes per day**

24. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** physical activities like bicycling at a regular pace, swimming at a regular pace, and doubles tennis **in your leisure time**?

_____ **days per week**

☐ No moderate activity in leisure time → ***Skip to PART 5: TIME SPENT SITTING***

25. How much time did you usually spend on one of those days doing **moderate** physical activities in your leisure time?
_____ **hours per day**
_____ **minutes per day**

***PART 5: TIME SPENT SITTING***

The last questions are about the time you spend sitting while at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading or sitting or lying down to watch television. Do not include any time spent sitting in a motor vehicle that you have already told me about.

26. During the **last 7 days**, how much time did you usually spend **sitting** on a **weekday**?

_____ **hours per day**
_____ **minutes per day**

27. During the **last 7 days**, how much time did you usually spend **sitting** on a **weekend day**?

_____ **hours per day**
_____ **minutes per day**

**This is the end of the questionnaire, thank you for participating.**

**Appendix B: IREC clearance**

DUT
DURBAN
UNIVERSITY OF
TECHNOLOGY

*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**

27 July 2018

Mr G D Hewer
120 Valley View Road
Escombe

Dear Mr Hewer

**The physical activity levels of students at a University of Technology in South Africa**

The Institutional Research Ethics Committee acknowledges receipt of your gatekeeper permission letter.

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 Standard Operating Procedures (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

DUT DURBAN UNIVERSITY OF TECHNOLOGY
2018 -07- 27
INSITUTUTIONAL RESEARCH ETHICS COMMITTEE
P O BOX 1334 DURBAN 4000 SOUTH AFRICA

## Appendix C: Permission to use chiropractic clinic

# MEMORANDUM

| | | |
|---|---|---|
| To | : | Prof Ross<br>Chair : RHDC<br><br>Prof Adam<br>Chair : IREC |
| From | : | Dr Charmaine Korporaal<br>Clinic Director : FoHS Clinic |
| Date | : | 25.05.2017 |
| Re | : | Request for permission to use the Chiropractic Day Clinic for research purposes |

Permission is hereby granted to :

**Mr Gareth Hewer (Student Number: 21008167)**

**Research title** : "The physical activity levels of students at a university".

Mr Hewer, is requested to submit a copy of his IREC approved proposal along with the letter of approval as well as proof of his MTech : Chiropractic registration to the Clinic Administrators (Mrs Twiggs) before he starts with his research in order that any special procedures with regards to his research can be implemented prior to the commencement of him beginning his data collection.

Thank you for your time.

Kind regards

Dr Charmaine Korporaal

Clinic Director : FoHS Clinic

Cc: Mrs L Twiggs: Chiropractic Day Clinic

Prof Pillay and Dr F Haffajee : Research supervisors

**Appendix D: Letter to head of department**

Dear Head of Department

My name is Gareth Hewer and I am a Masters Chiropractic student studying at the Durban University of Technology. I am currently conducting research on students to determine their level of physical activity. Students will be required to fill out a questionnaire about physical activity and a few selected students will be given a pedometer to wear for a week. This will monitor their actual level of activity so that this can be compared to the data obtained on the questionnaire. I am seeking permission to speak to one of the classes that your department teaches. I will require approximately ten minutes with the class at the end of their lecture so that I can hand out the questionnaires and pedometers. I will do this at the end of the lecture so that I do not interrupt the lecture. I shall contact the lecturers for that class to find the most suitable lecture and time to do so.

Kind Regards,

______________________ 09/10/2018

Gareth Hewer (MTech Chiropractic) Date

9/10/2018

Supervisor: Prof. F. Haffejee Date

09/10/2018

Co-supervisor: Prof. J.D. Pillay Date

**Appendix E: Letter of information and informed consent for questionnaire**

DUT DURBAN UNIVERSITY OF TECHNOLOGY

FACULTY OF HEALTH SCIENCES

DEPARTMENT OF CHIROPRACTIC AND SOMATOLOGY

**Department of Chiropractic and Somatology: Chiropractic Clinic**
Faculty of Health Sciences
Ritson Campus
Durban University of Technology

11 Ritson Road, Berea, Durban 4001

P O Box 1334, Durban, 4000, South Africa

Tel: (031)373 2511

**www.dut.ac.za**

**Appendix D**

## LETTER OF INFORMATION

**Title of the Research study:** The physical activity levels of students at a University of Technology in South Africa

**Researcher:** Gareth Hewer (BTech Chiropractic)

**Supervisors:** Prof. F. Haffejee (PhD)
Prof. J. Pillay (PhD)

**Brief introduction of the study:** This study is a questionnaire based study to determine the physical activity levels of the students at the Durban University of Technology. If you wish to also participate in the pedometer and fitness assessment you may enquire about this from the researcher.

**Outline of the Procedure:** You are required to complete the questionnaire on physical activity. Participation is voluntary and does not require any fee. There will be no identifying details on the questionnaire and you will remain anonymous. The researcher will be present to answer any questions that may arise. Once the questionnaire is completed it will be placed in a box that only the researcher will have access to. There will be no follow up consultation unless you also wish to participate in the pedometer study and fitness assessment. You must be a registered student at the Durban University of Technology over the age of 18 years. A total of 400 questionnaires will be handed out to various students.

**Risks or Discomforts to the Participant:** There are no risks involved in the study and you will not come to any harm.

**Benefits:** The questionnaire may help you to see how physically active you are and create awareness about physical activity at the university. The study may also be published.

**Reasons why the Participant May Be Withdrawn from the Study:** You will be withdrawn from the study if you fail to complete the questionnaire. You may withdraw from the study at any point if you wish to do so and there will be no penalties for doing so.

**Remuneration:** There will be no form of remuneration.

**Costs of the Study:** You will not be expected to cover any costs towards the study.

**Confidentiality:** The questionnaire will be completely confidential and there will be no identifying details. Once completed the questionnaire will be placed in a box using the ballot method. Only the researcher will have access to the data and will capture the data onto a computerized system to be interpreted.

**Persons to Contact in the Event of Any Problems or Queries:** You can contact me the researcher, Gareth Hewer, on 0724120146 as well as my supervisor on 031 373 2395. You can also contact the Institutional Research Ethics Administrator on 031 373 2375.

Thank you for your participation in the study.

**Department of Chiropractic and Somatology: Chiropractic Clinic**
Faculty of Health Sciences
Ritson Campus
Durban University of Technology

11 Ritson Road, Berea, Durban 4001

P O Box 1334, Durban, 4000, South Africa

Tel: (031)373 2511

**www.dut.ac.za**

## CONSENT

**Statement of Agreement to Participate in the Research Study:**

- I hereby confirm that I have been informed by the researcher, Gareth Hewer, about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: __,
- 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** **Signature**

I, Gareth Hewer (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**

____________________ ____________ ______________

**Full Name of Witness (If applicable)** **Date** **Signature**

____________________ ____________ ______________

**Full Name of Legal Guardian (If applicable) Date** **Signature**

**Appendix F:Letter of information and informed consent for pedometer study and aerobic fitness assessment**

DUT DURBAN UNIVERSITY OF TECHNOLOGY

FACULTY OF HEALTH SCIENCES

DEPARTMENT OF CHIROPRACTIC AND SOMATOLOGY

**Department of Chiropractic and Somatology: Chiropractic Clinic**
Faculty of Health Sciences
Ritson Campus
Durban University of Technology

11 Ritson Road, Berea, Durban 4001

P O Box 1334, Durban, 4000, South Africa

Tel: (031)373 2511

**www.dut.ac.za**

**Appendix E**

**LETTER OF INFORMATION**

**Title of the Research study:** The physical activity levels of students at a University of Technology in South Africa

**Researcher:**Gareth Hewer (BTech Chiropractic)

**Supervisors:** Prof. F. Haffejee (PhD)
Prof. J. Pillay (PhD)

**Brief introduction of the study:** This study is a pedometer and fitness assessment based study to determine the fitness levels of the students at the Durban University of Technology.

**Outline of the Procedure:** You are required to complete the questionnaire on ypur physical activity levels. You will then be issued with a pedometer to wear for a total of seven days. The pedometer will measure the number of steps taken while wearing it. Participation is voluntary and does not require any fee. There will be no identifying details and you will remain anonymous. The researcher will be present to answer any questions that may arise and may also be contacted over the phone to address any queries about the pedometer. Once the pedometer has been worn for seven days you will be required to go to the Chiropractic Day Clinic at DUT to return the pedometer for results to be captured and to take part in the fitness assessment test which requires walking up and down a step for five minutes with heart rate readings being taken afterwards. Measurements such as waist and hip circumference, height and weight will also be taken. There will be no follow up consultation after this. You must be a registered student at the Durban University of Technology over the age of 18 years. A total of 60 students will be required to do the pedometer study and fitness assessment.

**Risks or Discomforts to the Participant:** There are no risks involved in the study and you will not be harmed by participating in the study.

**Benefits:** The study may help you to see how physically active you are and create awareness about physical activity at the university. The study may also be published.

**Reasons why the Participant May Be Withdrawn from the Study:** You will be withdrawn from the study if you fail to complete the questionnaire.

You may withdraw from the study at any point if you wish to do so and there will be no penalties for doing so.

**Remuneration:** There will be no form of remuneration.

**Costs of the Study:** You will not be expected to cover any costs towards the study.

**Confidentiality:** The questionnaire will be completely confidential and there will be no identifying details. Once completed the questionnaire will be placed in a box using the ballot method. Only the researcher will have access to the data from the questionnaire, pedometer and fitness assessment and will capture the data onto a computerized system to be interpreted.

**Persons to Contact in the Event of Any Problems or Queries:** You can contact me the researcher, Gareth Hewer, on 0724120146 as well as my supervisor on 031 373 2395. You can also contact the Institutional Research Ethics Administrator on 031 373 2375.

Thank you for your participation in the study.

**Department of Chiropractic and Somatology: Chiropractic Clinic**
Faculty of Health Sciences
Ritson Campus
Durban University of Technology

11 Ritson Road, Berea, Durban 4001

P O Box 1334, Durban, 4000, South Africa

Tel: (031)373 2511

**www.dut.ac.za**

## CONSENT

**Statement of Agreement to Participate in the Research Study:**

- I hereby confirm that I have been informed by the researcher, Gareth Hewer, about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: __,
- 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** **Signature**

I, Gareth Hewer (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**

______________________ ___________ ________________

**Full Name of Witness (If applicable)** **Date** **Signature**

______________________ ___________ ________________

**Full Name of Legal Guardian (If applicable) Date** **Signature**

**Appendix G: Fitness assessment form**

# Data collection sheet: Fitness assessment

Date:________________________

Participant: ______________________________

Time of stepping:___________minutes

Table One: Heart rate and seconds

| Seconds | Heart rate |
|---|---|
| 0-30 s | |
| 30s-60s | |
| 60s-90s | |
| 90s-120s | |
| 120s-150s | |
| 150-180s | |
| 180s-210s | |
| 210s-240s | |
| 240s-270s | |
| 270s-300s | |
| 300s | |

Table Two: Body Mass Index (kg/$m^2$)

| | |
|---|---|
| Height (metres) | |
| Weight (kilograms) | |
| Body Mass Index (kg/$m^2$) | |

Waist Circumference (cm):____________________

Hip Circumference (cm):______________________

Body fat percentage (%):_____________________

**Appendix H: Letter from Prof. Napier**

*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*

27th June 2018

Mr Gareth Dennis Hewer
c/o Department of Chiropractic and Somatology
Faculty of Health Sciences
Durban University of Technology

Dear Mr Hewer

**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 "The physical activity levels of students at a University of Technology in South Africa" 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 CARIN NAPIER
DIRECTOR (ACTING): RESEARCH AND POSTGRADUATE SUPPORT DIRECORATE