Occupational exposure to flour dust and the associated respiratory outcomes among workers at a selected flour mill in KwaZulu-Natal

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DECLARATION

The author hereby declares the content of this research project is the author's own unaided original work, except where specific indication is given to the contrary (by reference). This work has not been previously submitted to the Durban University of Technology (DUT) or any other University.

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DEDICATION

I dedicate this thesis to:

My late grandfather (Mr Roy Hurripersadh)

My Parents (Mr Anoopchand Hoopdeo and Mrs Meera Devi Hoopdeo)

My brother (Jared Hoopdeo)

Thank you for your continuous support, encouragement, and love. this would not have been possible without you.

“Matha, Pitha, Guru, Deivam.”

(*Sanskrit adage*)

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My first appreciation goes to Lord Shiva for guiding me and giving me the strength to persevere.

To my parents (Mr Anoopchand Hoopdeo and Mrs Meera Devi Hoopdeo): Thank you for all your love, support, and encouragement. I could not have asked for a better support system. To my brother (Jared Hoopdeo): Sincere thanks for ensuring that I always had all that I needed. Thank you to my partner (Neven Naicker) for standing by me and offering constant words of encouragement.

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ABSTRACT

Flour dust is a hazardous substance and refers to the particles that are created when cereals or non-cereal grains are milled finely. Research shows that excessive inhalation of flour dust is linked to various adverse respiratory health effects – however, most of this research has been conducted internationally. This study aims to determine the associated respiratory outcomes with occupational exposure to flour dust, further adding to the limited South African literature in this field. The focus of this study is at a flour mill located in the Phoenix Industrial Park, Durban, KwaZulu-Natal. This is a descriptive cross-sectional study conducted at one point in time. The study sourced quantitative data. A sample size of 63 employees was selected from a total population size of 70 using the simple random sampling strategy, in which the margin of error was set at 5%.

This study sought to determine the respiratory health of employees in a flour mill, to analyse retrospective spirometry data from medical records of employees at the flour mill, to identify factors contributing to increased exposure to flour dust and to determine the relationship between occupational exposure to flour dust and the associated respiratory outcomes, using retrospective spirometry data and occupational hygiene reports.

This study has established a strong relationship between site of work (which determines the level of exposure to flour dust) and the prevalence of respiratory issues. Retrospective environmental monitoring reports have highlighted the departments which presented consistently high flour dust levels, namely, the milling, packing and maintenance departments. Unsurprisingly, these departments also reported a higher prevalence of breathing complications, chest tightness, rhinitis, dry cough, and conjunctivitis as well as reduced mean Forced Expiratory Value per 1 second/ Forced Vital Capacity (FEV_1/FVC) values - highlighting that the department played a role in adverse respiratory effects. The Coronavirus pandemic increased mask usage, therefore, FEV_1/FVC values were slightly better in 2020 when compared to those of 2019. Evidence has revealed that apart from the level of exposure to flour dust, other factors are shown to have influenced results, such as, age, Personal Protective Equipment (PPE) awareness and training, novel Coronavirus pandemic, duration of employment, smoking habits, mixing departments and a lack of a flour dust Occupational Exposure Limit (OEL).

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DEFINITIONS

OEL : The upper limit on an acceptable concentration of a hazardous substance in worksplace air for a particular material or class of materials.

Personal Protective Equipment: Protective clothing, helmets, goggles, or other garments designed to protect the wearer's body from injury or infection.

Respirator: An apparatus worn over the mouth and nose or the entire face to prevent the inhalation of dust, smoke, or other noxious substances.

Hazard: A potential source of harm.

Dust: fine, dry powder consisting of tiny particles of earth or waste matter lying on the ground or on surfaces or carried in the air.

Occupational exposure: Contact with a potentially harmful physical, chemical, or biological agent because of one's place of work.

ABBREVIATIONS

FEV_1 : Forced Expiratory Volume in one second

FVC : Forced Vital Capacity

OEL : Occupational Exposure Limit

PPE : Personal Protective Equipment

TLV : Threshold Limit Value

ACGIH : American Conference of Governmental Industrial Hygienists

CHAPTER ONE
INTRODUCTION

1.1 INTRODUCTION

Grain milling has existed for several years and is considered one of the oldest industries in South Africa (Mncube 2014: 489). Grain milling began with the first European settlements in the Western Cape province and has since boomed into a trade so large that it resulted in migration to other provinces (Mncube 2014: 489). However, as with many industries, the grain and flour milling industry were also linked to adverse health effects among employees due to dust inhalation (Hosseinabadi, Krozhdeh, Khanjani, Zamani, Ranjbar and Mohammadian 2013: 139). During grain handling and milling activities, two main types of dusts are generated, namely grain dust and flour dust. Grain dust can be described as the dust generated by the harvesting, drying, handling, storage or processing of barley, wheat, oats, maize, and rye (South African Department of Labour 1993: 207) and may comprise of broken grain kernels, weed seeds, chaff, storage mites, insects, bacteria, moulds, inorganic matter and even chemicals (Chan-Yeung, Enarson and Kennedy 1992: 477). Flour dust, on the other hand, refers to the fine particles produced whilst milling grains or non-grains and may comprise of enzymes, additives, flavourings, spices, chemical ingredients and storage microbes and mites (Stobnicka and Górny 2015: 241)

1.2 ADVERSE HEALTH EFFECTS ASSOCIATED WITH FLOUR DUST EXPOSURE

In the 18th century, Bernardino Ramazzini was the first person to discover and report illnesses relating to milling and baking, symptoms of which included coughing, breathlessness, hoarseness, asthma, and eye problems (Hosseinabadi *et al.* 2013: 139). Since then, several studies have concluded that grain and flour dust exposure among flour mill workers results in a vast array of respiratory and dermatological issues (Gholami, Sajedifar, Tatari, Teimori, Tazeroudi and Abbaspour 2018: S779; Ahire, Kulkarni, Desai and Chavan 2017: 71; Mohammadien, Hussein and El-Sokkary 2013: 3 and Meo 2004: 187). Studies conducted by Kakooei and Marioryad (2005: 50) and Meo (2004: 187) found that flour dust contains respiratory sensitizing properties. A sensitizer, as described by the South African Department of Labour (1993: 191), is a substance that sensitizers the skin or lungs after exposure, inducing allergic reactions. Once an individual becomes sensitized to a substance, they can experience severe reactions from their exposures, even if the dose is below the regulated OEL. Respiratory sensitizers can cause asthma, rhinitis, or extrinsic alveolitis. Skin sensitizers, on the other hand cause allergic contact dermatitis (South African Department of Labour 1993: 190).

1.2.1 RESPIRATORY-RELATED HEALTH EFFECTS

According to Plog and Quinlan (2002: 36), the respiratory system is responsible for gaseous exchange, the process of which begins with the inhalation of air. Since many of the health effects associated with flour dust exposure is respiratory related, inhalation is considered the primary route of intake; therefore, prominent health effects experienced by flour mill workers is respiratory-related, with asthma and occupational airway diseases commonly listed. A study conducted in Iran reported that employees showed a significant reduction in lung function when exposed to flour above the acceptable Threshold Limit Value (TLV) of 0.5mg/m^3 (Kakooei and Marioryad 2005: 50). It must be noted that studies conducted in other parts of the world such as the East of Iran (Gholami *et al.* 2018: S782), Southern Egypt (Mohammadien *et al.* 2013: 5) and Pakistan (Meo 2004:190) confirmed this finding. From a South African perspective, a Cape Town -based study conducted among 582 grain millers and 153 controls (not exposed to grain dust) sought to assess the prevalence of respiratory symptoms, atopic status and lung function changes (Yach, Meyers, Bradshaw and Benatar 2008: 505). The study revealed that grain workers had the highest prevalence of symptoms including regular expectoration and cough, wheezing, chronic runny nose and eye irritation. The study went on to report that grain mill workers showed significant differences for Forced Expiratory Vital Capacity (FEVC) and Forced Expiratory Flow$_{25-75}$ (FEF$_{25-75}$) within a one-week timeframe (Yach *et al.* 2008: 507). Additionally, a study conducted by Bachmann and Myers (1991: 662) concluded that grain dust causes a range of respiratory symptoms such as wheeze, chest tightness, dyspnoea, chronic sputum production and chronic airflow limitation as well as acute airway obstruction in a few workers (Bachmann and Myers 1991: 662).

Occupational asthma is another respiratory issue of major concern. Asthma caused by workplace exposure to flour is termed Baker's asthma and has been identified as one of the most common types of asthma (Baatjies, Meijster, Heederik, Sander and Jeebhay 2014: 811; Mohammadien *et al.* 2013: 2; Nieuwenhuijsen, Sandiford, Lowson, Tee, Venables, McDonald and Newman Taylor 1994: 584). As described by Hosseinabadi *et al.* (2013: 139), the albumin of flour is the main cause of allergies known as Baker's asthma. It is stated that inhalation of it results in a chain reaction beginning with stimulation of specific antibodies, increased allergies, respiratory disorders and eventually asthma. Research has also highlighted other respiratory-related issues which include but not limited to wheezing, lung fibrosis, allergic alveolitis, febrile reactions and chronic obstructive pulmonary disease (Gholami *et al.* 2018: S779; Ahire *et al.*

2017: 67; Hosseinabadi et al. 2013: 139; Mohammadien *et al.* 2013: 2; Meo 2004: 188). In addition to being a sensitizer, flour dust is also considered an irritant. In a study by Ahire *et al.* (2017: 67), it was stated that this irritant nature may result in short term respiratory, nasal and eye symptoms such as coughing, sneezing, breathlessness, rhinitis, itchy eyes, and conjunctivitis.

1.2.2 DERMATOLOGICALLY RELATED HEALTH EFFECTS

Skin is a known route of entry and is considered a vital route of exposure for allergens, resulting in sensitization, potentially causing allergic skin symptoms (Chongo-Faruk 2017: 256). According to Plog and Quinlan (2002: 56), dermatosis refers to any cutaneous anomaly ranging from redness, itching, and scaling to more serious eczema-like, ulcerative, acneiform, pigmentation, granulomatous or neoplastic conditions. Occupational dermatoses, therefore, directly relate to the cutaneous anomalies directly induced or aggravated by the work environment (Plog and Quinlan 2002: 56). Plog and Quinlan (2002: 56), further add that the term dermatitis is regarded as a more limited term referring to any inflammation of the skin such as contact dermatitis.

Contact dermatitis is regarded as being the most common cause of occupational skin diseases (Plog and Quinlan 2002: 64). There are many different types of dermatitis, however, irritant contact dermatitis and allergic contact dermatitis are among the more recognized (Stobnicka and Górny 2015: 243; Plog and Quinlan 2002: 64). However, research has established that between these two types of contact dermatitis, one is more prevalent than the other – with more cases of an irritant nature reported as compared to allergic (Steenkamp 2013: 27; Sasseville 2008: 59; Plog and Quinlan 2002: 64). Research has yielded some studies linking flour dust exposure to contact dermatitis – with emphasis placed on bakers (Steenkamp 2013: 27; Brisman, Meding and Järvholm 1998: 751). In Sweden, the Swedish Information System on Occupational Injuries showed that bakers appear to report occupational skin disease up to four times more often than the average (Brisman *et al.* 1998: 751), whilst a German study published the highest Irritant contact dermatitis annual incidence rates lay among hairdressers, bakers, and pastry cooks, ranked in order from highest to lowest (Steenkamp 2013: 27).

1.2.3 ADDITIONAL ADVERSE HEALTH EFFECTS

Apart from the more known and studied health effects, a recent study conducted by Carton, Menvielle, Cyr, Sanchez, Pilorget, Guizard, Stücker, and Luce (2018: 871*)* confirms that an association between exposure to flour dust and head and neck squamous cell cancer has been found – reporting stronger and more consistent links among women than in men, despite the higher levels of exposure in men (Carton *et al.* 2018: 872). This association, however, remains sparsely researched as there are limited studies in support of this statement (Carton *et al.* 2018: 869). Stobnicka and Górny (2015: 243) state that while earlier research hinted that bakery workers may be exposed to increased risks of developing nasal and other respiratory tract cancers, the biological evidence required to draw an association between nasal cancer and flour dust inhalation remained inconclusive and Carton *et al.* (2018: 872) concurs with this association. Additionally, Stobnicka and Górny (2015: 243), reveal that flour dust exposure may also lead to dental difficulties, explaining that the dust can adhere to the teeth's surface and gum edge resulting in a very specific coating, resulting in hard tooth tissue abrasion.

1.3 RATIONALE OF THE STUDY

On a global scale, multiple studies have intensely explored the impact of grain and flour dust exposure on employee respiratory health. However, from a South African perspective, literature research has yielded minimal studies. This is further supported by an article by Yach *et al.* (2008: 505) which states that in South Africa, there is limited research exploring the prevalence of respiratory disease among grain workers. It was found that while studies assessing employee exposure to grain and flour dust exists – it remains sparse. Research indicates that within the past decade, published academic work dedicated to examining respiratory health among grain workers is minimal (Yach *et al.* 2008: 505; Baatjies, Meijster, Lopata, Heederik and Jeebhay 2007: 210; Fonn, Groeneweld, De Beer and Becklake 1993: 401; Bachmann and Myers 1991: 656). Additionally, it was discovered that while South Africa has an OEL for grain dust, it lacks a specific OEL for flour dust. This gap identified in South African literature prompted further research. This study seeks to explore occupational exposure to flour dust and the associated respiratory outcomes among employees in a selected flour mill in the KwaZulu-Natal region.

1.4 PROBLEM STATEMENT

The American Conference of Governmental Industrial Hygienists (ACGIH) defines 'flour' as a complex organic dust used in baking and comprises of cereals such as wheat (*Triticum aestivum*), rye (*Secale cereal*), sorghum (*Panicum miliaceum*), barley (*Hordeum vulgare*), oats (*Avena sativa*), rice (*Oryza sativa*) or corn (maize) (*Zea mays*), or a combination of these, which have been processed by milling (Mohammadien *et al.* 2018: 2; Stobnicka and Górny 2015: 241). Flour may also contain contaminants such as silica, fungi, aflatoxins, insects, mites, pesticides, and herbicides (Mohammadien *et al.* 2018: 2). Flour dust refers to the particles that are created when cereals or non-cereal grains are milled finely (Stobnicka and Górny 2015: 241). Flour dust is a hazardous substance and is known to cause various adverse health effects

(Gholami *et al.* 2018: S779) especially among bakers and grain and flour millers. Globally, various studies have intensely explored the negative effects between flour dust and employee health. However, from a South African perspective research has yielded minimal studies making this study timeous in exploring employee occupational exposure to flour dust and the associated respiratory health risks.

1.5 PURPOSE OF THE STUDY

The aim of this study is to determine the associated respiratory outcomes with occupational exposure to flour dust.

1.6 OBJECTIVES

The study's objectives are to:

- Determine the respiratory health of employees in a flour mill.
- Analyze retrospective spirometry data from the medical records of employees at the flour mill.
- Identify factors contributing to increased occupational exposure to flour dust.
- Determine the relationship between occupational exposure to flour dust and the associated respiratory outcomes using retrospective spirometry data and occupational hygiene reports.

1.7 SIGNIFICANCE OF STUDY

The findings of this study will potentially help the flour milling industry improve working conditions and better manage the output of flour dust into the atmosphere. It further seeks to promote increased employee health and safety awareness. Additionally, the outcomes of this study can help enforce health and safety regulations and policies within flour mills. The study will add to the minimal research exploring occupational health, with emphasis on respiratory health among flour mill workers in South Africa.

1.8 OUTLINE OF DISSERTATION

Table 1: Structure of Dissertation

CHAPTER	TITLE	OUTLINE
Chapter one	Introduction to the study	Introduce and give an overview of the study by identifying the topic of inquiry, rationale, problem statement, study aims and objectives and the significance of study. Background information on occupational exposure to flour dust and the associated adverse health effects are provided to highlight the importance of the topic and justify this study.
Chapter two	Literature review	This is an analysis of the existing literature and evidence serves to inform the study's focus and design. The literature reviewed also highlights and compares the occupational exposure to flour dust from different context, such as from a Global, African context and South African context.
Chapter three	Research Methodology	Provides detailed description of the study methodology with the rationale for the research design and methodological selection, implementation strategies and ethical consideration. The study population, sample, data analysis methods are described for the reader to appreciate the intricacies of the study designed and research findings.
Chapter four	Presentation of the results	Statistical analysis packages present the quantitative results. Findings are captured using statistical packages and further analysed to determine relationship between flour dust exposure and the associated respiratory outcomes.
Chapter five	Discussion	Findings are discussed in detail and conclusions are reached.
Chapter six	Recommendations	Conclusions are presented. Limitations of the study are identified. Recommendations are made in relation to the key findings of the study.

1.9 CONCLUSION

In a flour mill, workers are continuously exposed to grain and flour dust via milling transfer operations, mixing and baking processes, packing activities and general housekeeping. Previous research conducted in the field has helped identify factors responsible for exposing employees to excessive dust and identified its correlation to adverse health effects, however, there is limited South African literature in this field of study.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This is an analysis of the existing literature and evidence which serves to inform the study's focus and design. The literature review also highlights and compares the occupational exposure to flour dust from different contexts, from global, african and South African context.

2.2 STRUCTURE OF A WHEAT KERNEL

Wheat is an oval-shaped cereal crop comprising of three main layers namely germ, bran, and endosperm. Specifically, the wheat kernel comprises of 2-3% germ, 13-17% bran and 80-85% endosperm. It is approximated that the typical wheat kernel ranges between 5-9 mm in length with a weight between 35–50 mg (Kanojia, Kushwaha, Reshi, Rouf and Muzaffar 2018: 990). Each layer of the wheat kernel has a specific function; simply, the germ is responsible for storage, digestion, and absorption whilst the endosperm acts as the nutritional storage unit of the germinating plant, it is also rich in starch, of which flour is produced (Kanojia *et al.* 2018: 990). The bran, is the outermost layer and encapsulates the germ and endosperm, forming a protective shield against damage (Kanojia *et al.* 2018: 990; Campbell 2007: 393). To access the endosperm and eventually produce flour, the wheat kernel must undergo several vigorous processes, thereafter, additives are introduced to further refine and enhance the quality of the final product (Kanojia *et al.* 2018: 992).

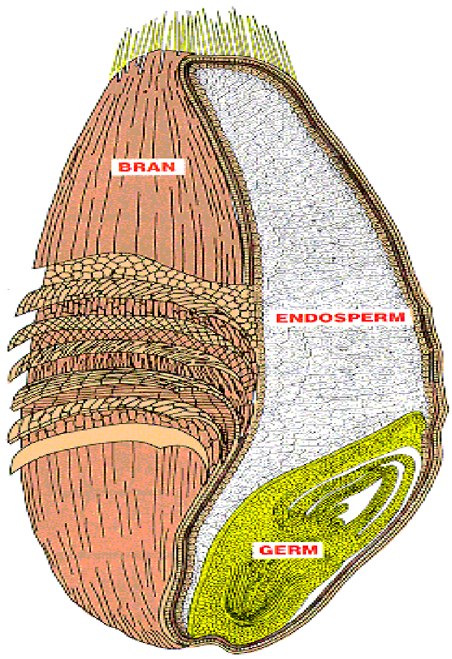

Figure 1: Structure of a wheat kernel (Nebraska Wheat Board 2009: 20)

2.3 FLOUR

The ACGIH defines flour as a complex organic dust used in baking and comprises of cereals such as wheat (*Triticum aestivum*), rye (*Secale cereal*), sorghum (*Panicum miliaceum*), barley (*Hordeum vulgare*), oats (*Avena sativa*), rice (*Oryza sativa*) or corn (maize) (*Zea mays*), or a combination of these, which have been processed by milling (Mohammadien *et al.* 2018: 2; Stobnicka and Górny 2015: 241). Flour may also contain contaminants such as silica, fungi, aflatoxins, insects, mites, pesticides, and herbicides (Mohammadien *et al.* 2018: 2). Although flour can be made from a variety of plants, majority is derived from wheat (Muvhali, Ratshikhopha, Kootbodien, Naicker and Singh 2020: 30) - specifically from the endosperm layer (Kanojia *et al.* 2018: 990). To access the endosperm, the wheat kernel must be broken down via milling operations to effectively separate the three layers into bran, germ, and endosperm (Cappelli, Oliva and Cini 2020: 147). After the endosperm layer is accessed, it is then pulverized further, into fine particles to produce flour (Cappelli *et al.* 2020: 147).

2.4 FLOUR MILLING

Flour milling is regarded as an art (Posner and Hibbs 2011: iii) which involves the process of extracting flour from a grain, typically wheat (Fistes and Rakić 2015: 4661). Flour milling is considered as one of the oldest practicing industries worldwide with reports of flour milling dating back to the Ancient Egyptians (Samuel 2010: 456). There are predominantly two methods of producing flour namely, stone milling and roller milling (Carcea, Turfani, Narducci, Melloni, Galli and Tullio 2020: 1).

2.4.1 STONE MILLING

A study by Albala (2018: 1) identified some of the earliest methods of flour milling which involved beating grains into the hollow spaces of stones. That method was used until the arrival of the saddle quern – a curved stone with a rough surface. With time came the idea of using a mortar and pestle which was essentially a bowl and stick and then much later - the rotary quern (Albala 2018: 2). Atwell (2001: 15) however, argues that the mortar and pestle was some of the earliest milling equipment dating as far back as 8000 B.C. Atwell (2001: 15) asserts that the initial mechanical mills used two horizontally mounted stone disks which allowed the introduction of wheat between them. The disks were rotated manually to facilitate grinding. Over time, the querns evolved into enhanced rotary mills. These modest methods of flour milling existed for many decades with continual improvements being made either to the materials used or the sources used to operate the equipment which alternated between natural resources (such as wind and water) (Williams and Rosentrator 2007: 1), animals and man.

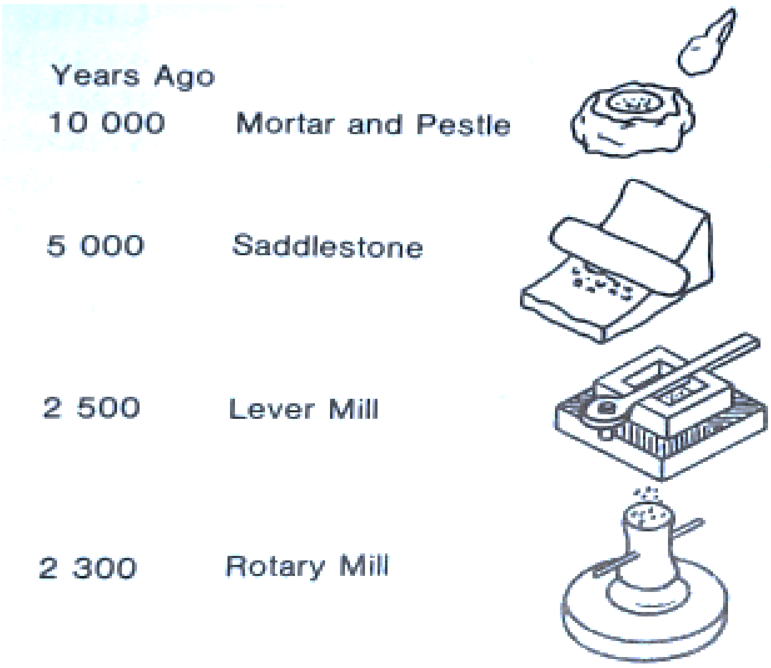

Figure 2: Early grain mills and their time of introduction
(Atwell 2001: 15)

Today, the more progressive flour mills make use of the modern mill, which comprise of metal plates attached to composition stones (Doblado-Maldonado, Pike, Sweley and Rose 2012: 120). Wheat is ground between these stones resulting in a whole wheat flour containing all kernel fractions (Cappelli *et al.* 2020: 149). Cappelli *et al.* (2020: 149) explain that depending on the desired product, the whole wheat flour can still go on to produce refined white flour by going through a centrifugal sifter or plansifter.

Figure 3: Illustration of a millstone (Campbell 2007: 397)

2.4.2 ROLLER MILLING

The change in milling occurred around the middle of the 19th century, as the industrial revolution dawned, when more efficient methods of flour milling came to the fore and the concept of roller milling was introduced (Tann and Jones 1996: 38; Sharrer 1982: 146). Roller milling is a process of passing wheat through two metal rollers moving in rotation (Stefan 2018: 361; Doblado-Maldonado *et al.* 2012: 121). The grinding action is achieved via compression and frictional forces exerted by the rolls on the wheat. The surfaces of the rolls consist of varying degrees of corrugation and smoothness to allow for gradual particle size reduction (Stefan 2018: 361; Doblado-Maldonado *et al.* 2012: 121). The texture of the rolls has more specific functions as the corrugated surfaces are used to crack the wheat, thereby releasing the endosperm, whilst the smoother rolls are used to slowly pulverize the endosperm, in turn, producing flour (Stefan 2018: 361). Along each stage of roller milling, sifting occurs, separating the particles according to the different particle sizes (Fistes and Rakić 2015: 4661).

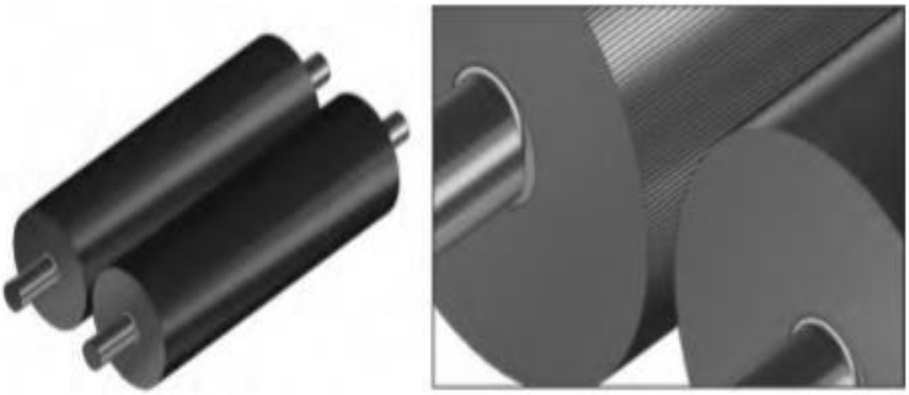

Figure 4: Roller mills (Campbell 2007: 401)

2.5 FLOUR MILLING PROCESS

The flour milling process begins with first receiving and storing the wheat grain (Williams and Rosentrator 2007: 1). According to Bianchini, Harsley, Jack, Kobielush, Ryu, Tittlemier, Wilson, Abbas, Abel, Harrison, Miller, Thomas Shier and Weaver (2015: 43), converting wheat into flour consists of two main processes: cleaning and milling.

2.5.1 THE CLEANING PROCESS

The cleaning system is designed to remove unwanted materials and grains that are deemed unacceptable. The cleaning systems are used to select desirable grain solely based on the kernel's physical properties such as size, shape, specific gravity, relative density, colour, and magnetism (Atwell 2001: 17). This separation occurs via various machines such as separators (used to remove straw and dirt), destoners (to remove stones), magnets (to remove iron particles), aspirators (to remove dust), scourers and other machines (Bianchini *et al*. 2015: 44; Williams and Rosentrator 2007: 2). After cleaning, the grain is temporarily housed in a storage silo for tempering and conditioning. During the wheat conditioning and tempering stage, water is added in specific amounts to toughen the bran outer layer and soften the endosperm inner layer which allows for the different layers of the kernel to separate easily. Tempered wheat is stored for approximately 8 – 20 hours depending on the type of wheat (Nebraska Wheat Board 2009: 24).

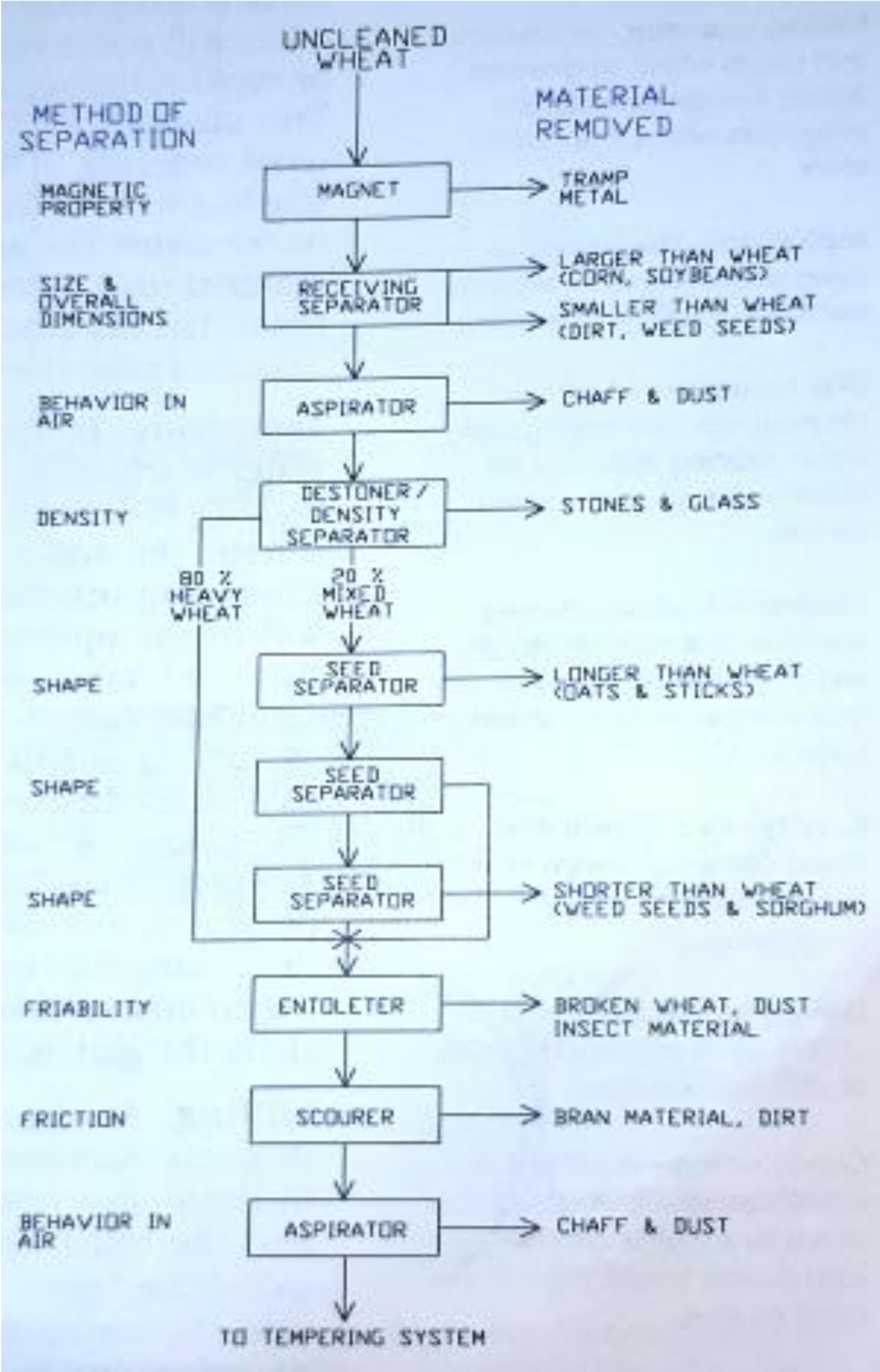

Figure 5: Wheat cleaning process (Atwell 2001: 17)

Atwell (2001: 17) explains some of the cleaning machines and its functions (Figure 5). The wheat first passes through a magnet to remove ferrous metals before it even enters the cleaning system. Thereafter, the wheat passes through a separator to remove sticks, stones, corn and stems. The wheat then undergoes the aspiration step in which lighter, less-dense components of the wheat are detached. Aspiration works by circulating air in an upward direction through the grain as it is entering the separator – effectively stripping away lighter materials from the wheat kernels. Afterwards, the wheat enters a disk separator which separates grain based on shape. Wheat will then go through a scourer which is essentially an abrasive screen used to remove mould or dirt generally found on the wheat's external surface. The destoner is used to remove small stones and pebbles. An entoleter is used to remove broken wheat, remaining dust, and insect remnants. The wheat can now enter the tempering stage prior to being milled (Atwell 2001: 17)

2.5.2 THE MILLING PROCESS

The flour milling process has, over the years, experienced various improvements made to its systems such as James Watt's steam engine invention and its application with American milling in the 1870's. Another improvement involved the replacement of millstones with two corrugated cylindrical steel rolls known as roller milling. Williams and Rosentrator (2007: 2) notes that considering the decades of improvements to the industry's processes, much of its core elements remained essentially unchanged ever since the introduction of the roller mill. According to Cappelli *et al.* (2020: 149) and Williams and Rosentrator (2007: 2), the modern flour milling processes can be categorized into four distinct systems, namely: the break system, the purification/ sizing system, the reduction system and the tailings system.

2.5.2.1 THE BREAK SYSTEM: This stage comprises primarily of roller mills (Williams and Rosentrator 2007: 2) and is the first grinding stage of the wheat. It is responsible for separating the endosperm from the bran and germ (Cappelli *et al.* 2020: 149). Cappelli *et al.* (2020: 149) assert that this is the stage that maximum endosperm separation is achieved. Although some flour is produced, it is not significant at this point of the process as the main purpose is to fracture the endosperm into sizes large enough to progress to the purifiers and reduction system.

2.5.2.2 PURIFICATION/ SIZING SYSTEM: This stage consists of purifiers, roller mills and sifters. The function of a purifier is to sort particles according to its size, air resistance and specific gravity. Interesting to note is that whilst Williams and Rosentrator (2007: 2) asserts that no flour is produced during this stage, as it will either be passed to the reduction stage or back to the break system, Cappelli *et al.* (2020: 149) states that smooth, sizing and reduction rollers pulverize the endosperm into flour. Although they and Williams and Rosentrator (2007: 2) provide differing functions of the purification/ sizing system, both studies found common ground in ascertaining that the main goal of this stage is to separate small bran from the endosperm.

2.5.2.3 REDUCTION SYSTEM: This stage comprises of a series of roller mills interspersed with sifters. The purpose of this system is to crush and shear the grain of which the balance of these two forces is dependent on the smoothness of the rolls surface (Cappelli *et al.* 2020: 149). Williams and Rosentrator (2007: 2) explains that it is during this stage that the endosperm is gradually reduced to flour.

2.5.2.4 THE TAILINGS SYSTEM: Heterogenous materials left over from previous stages are sent to the plansifter for further milling or purification (Cappelli *et al.* 2020: 150). Posner and Hibbs (2011: 219) add that the objective of this stage is to recover minute pieces of endosperm by reducing their size in relation to the bran and germ particles so that it may be effectively separated and obtained during the sifting process.

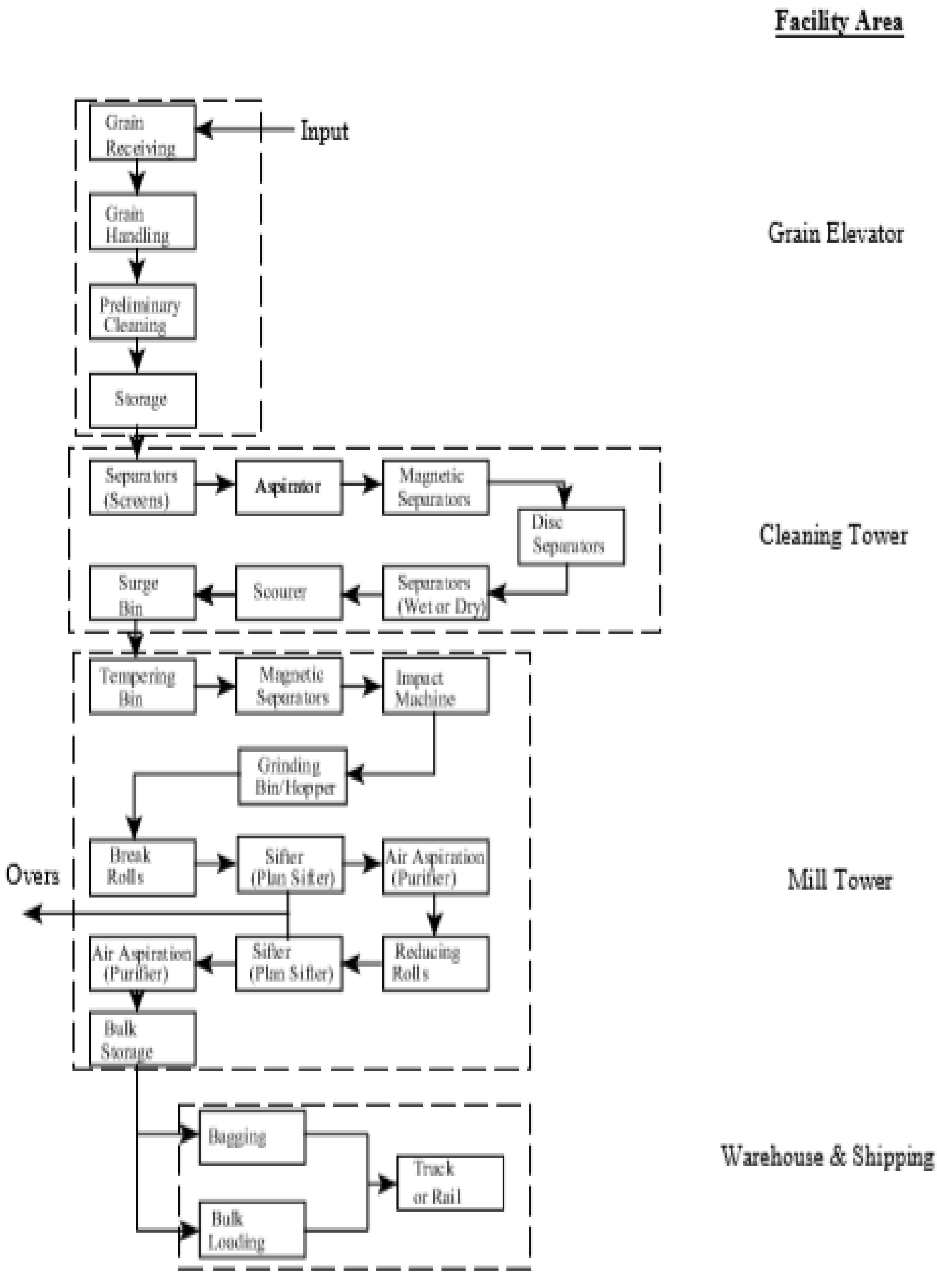

Figure 6: Diagram showing flour milling process flow (Williams and Rosentrator 2007: 3)

2.6 DUSTS GENERATED VIA FLOUR MILLING

There are various types of airborne contaminants, some of which may exist either in the gaseous form or as aerosols. An aerosol may be described as a system of particles that are suspended in a medium – generally air and consist of airborne dusts, sprays, mists, smoke, and fumes. It has been stated by the World Health Organisation (1999: 1), that while all aerosols are hazardous, airborne dusts are particularly concerning due their association with occupational respiratory diseases. According to Plog and Quinlan (2002: 21) dust refers to solid airborne particles that measure between 0.1 to 25 µm in diameter and are typically produced during particle reduction operations that involve grinding, crushing, blasting, impaction of organic and inorganic materials such as rock, ore, coal, wood and, grain.

In the flour milling industry, there are two main types of dusts that workers may be exposed to, namely, grain dust and flour dust (Stobnicka and Górny 2015: 241). According to Stobnicka and Górny (2015: 241), although flour dust and grain dust resemble each other, they are vastly different in composition – this statement has been explored by other studies in which methods of generation, constituents and health effects are discussed in detail (Demeke and Haile 2018: 7; Health Council of the Netherlands 2017: 19; Becklake 2007: 423; Chan-Yeung *et al.* 1991: 477).

2.6.1 GRAIN DUST

Grain dust can be described as the dust generated from the abrasion of the grain kernels during the harvesting, drying, handling, storage or processing of barley, wheat, oats, maize and rye (South African Department of Labour 1993: 209); pulses (soybeans, peas and mustard) and oil seeds (rape seed, flax and sunflower) (Smid 1993: 25). Grain dust is reported to contain fragments of broken grain kernels, weed seeds, chaff, storage mites, insects, bacteria, moulds, inorganic matter and even chemicals (Becklake 2007: 423; Chan-Yeung *et al.* 1991: 477). A study conducted by Chan-Yeung *et al.* (1991: 476) identified various occupations in which workers were at risk of grain dust exposure namely, farmers; grain workers in small country elevators, terminal elevators and transfer elevators; dock workers and; feed, flour and seedmill workers. Several studies have indicated that grain dust may be generated at various points of grain handling and processing stages (Spankie and Cherrie 2011: 26; Becklake 2007: 423 and Chan-Yeung *et al.* 1991: 476), however, Smid (1993: 25) found that exposure to grain dust is most common in farm environments – during the production of grain and when animal feed is used. This statement is further supported by Spankie and Cherrie (2011: 27) who reported that in Britain in the 1990s, the highest average exposure levels to grain dust was in grain terminals where the elevated exposures were attributed to cleaning tasks. The next highest average exposure levels were found in the grain drying on farms. It must be noted that the same study went on to highlight that these results were obtained in the 1990s and developments in the industry may have since changed these outcomes.

2.6.2 FLOUR DUST

Flour dust refers to the particles that are created when cereals or non-cereal grains are milled finely (Stobnicka and Górny 2015: 241) and comprises of enzymes, additives, flavourings, spices, chemical ingredients as well as storage microbes and mites (Demeke and Haile 2018:7). As reported by Mohammadien *et al.* (2013: 2) flour dust may also contain contaminants such as silica, fungi, aflatoxins, insects, pesticides and herbicides. Stobnicka and Górny (2015: 242) have indicated that flour dust has an aerodynamic particle size between ≤4μm and 30μm, adding that in dusty areas, up to 20% of flour dust particles consist of a smaller aerodynamic size (Iyogun, Lateef and Ana 2017: 47).

Exposure to flour dust has been noted in various industries such as confectionaries, malt factories, animal feed manufacturers and the agricultural sector (Stobnicka and Górny 2015: 243; Gholami *et al.* 2018: S779). However, literature suggests that severe exposure to flour dust is generally observed within bakeries and grain and flour mills (Stobnicka and Górny 2015: 243; Hosseinabadi *et al.* 2013: 139). Additionally, research has provided evidence of fluctuating flour dust levels across flour mills - depending on the area of work and on the task being done. A study conducted in Iran assessed occupational exposure to flour dust by collecting respirable and inhalable dust samples across four different job sites: millers, packers, sweepers and operators. The study revealed that sweepers showed the highest levels of exposure whilst operators showed the lowest levels of exposures. However, Ahire *et al.* (2017: 70) and Nieuwenhuijsen *et al.* (1994: 587) argue that the level of dust exposure is highest in the packing and mixing site of flour mills. These results are further supported by a study by Khodadadi, Abdi, Aliabadi and Mirmoeini (2011: 421) which state that workers at the flour packing workstations were exposed to high levels of flour dust as compared to husk packing, flour production and wheat unloading.

Whilst several studies looked at flour dust generation and employee exposures in relation to specific areas or job tasks, the Canadian report by Employment and Social Development Canada (2018: 7) adopts a more holistic approach explaining that, for the most part, there are four sources of flour dust found in a flour mill, namely, via the milling process, chokes / spillages, removal of chokes and packing operations.

- The milling process: Flour is created during the pulverization of wheat grain kernels (Cappelli *et al.* 2020: 147), Employment and Social Development Canada (2018: 7) explains that even though most milling activities operate under negative pressure by way of aspirators and dust collectors, flour dust can escape into the atmosphere and remain in suspension due to its small particle size.
- Chokes/ spillages: Chokes are created when there are blockages in mill equipment. If the blockage goes undetected, the product can overflow, leading to spillages on mill floors (Employment and Social Development Canada 2018: 7; Smith, Parker and Hussain 2000: 27)
- Removal of chokes: This is typically a manual task in which the machine is powered off and the blockage is removed by hand. Additionally, cleaning and maintenance activities are also responsible for dispersal of flour dust with Smith *et al.* (2000: 27) supporting this claim and revealing that dust exposure results were reportedly high whilst performing spillage clean-ups.
- Packing operations: This is owing to semi-automated and automatic gravity and pneumatic bag filling sealing systems. This finding is further supported by studies conducted by Ahire *et al.* (2017: 70); Nieuwenhuijsen *et al.* (1994: 587) and Khodadadi *et al.* (2011: 421) which report that packing and mixing operations are the areas of highest occupational exposure to flour dust.

2.7 UPTAKE AND DEPOSITION OF FLOUR DUST

According to Plog and Quinlan (2002: 36), the respiratory system is responsible for gaseous exchange and begins with the inhalation of air. Since many of the health effects associated with flour dust exposure is respiratory related, inhalation is considered the primary route of intake.

2.7.1 UPTAKE OF FLOUR DUST

Different types of dust have different particle size, therefore, the point of deposition in the respiratory tract greatly depends on the particle size as well as density, shape and aerodynamic properties (Scientific Committee on Occupational Exposure Limits 2008: 3). Classification of dusts is explained by Brown, Gordon, Price and Asgharian, (2013: 2) according to the European Committee for Standardization as,

- Inhalable fraction: refers to a mass fraction of total airborne particles inhaled through the nose and mouth comprising of dusts with an aerodynamic diameter ≥ 10 µm (Scientific

Committee on Occupational Exposure Limits 2008: 3; Boac, Maghirang, Casada, Wilson and Jung S2009: 533)

- Thoracic fraction: refers to mass fraction of inhaled particles penetrating beyond the larynx and refers to dusts with an aerodynamic diameter between 4 – 10 µm (Scientific Committee on Occupational Exposure Limits 2008: 3; Boac *et al.* 2009: 533)
- Respirable fraction: mass fraction of inhaled particles penetrating to unciliated airways. This fraction refers to dusts with aerodynamic diameter ≤ 4 µm (Scientific Committee on Occupational Exposure Limits 2008: 3; Boac *et al.* 2009: 533).

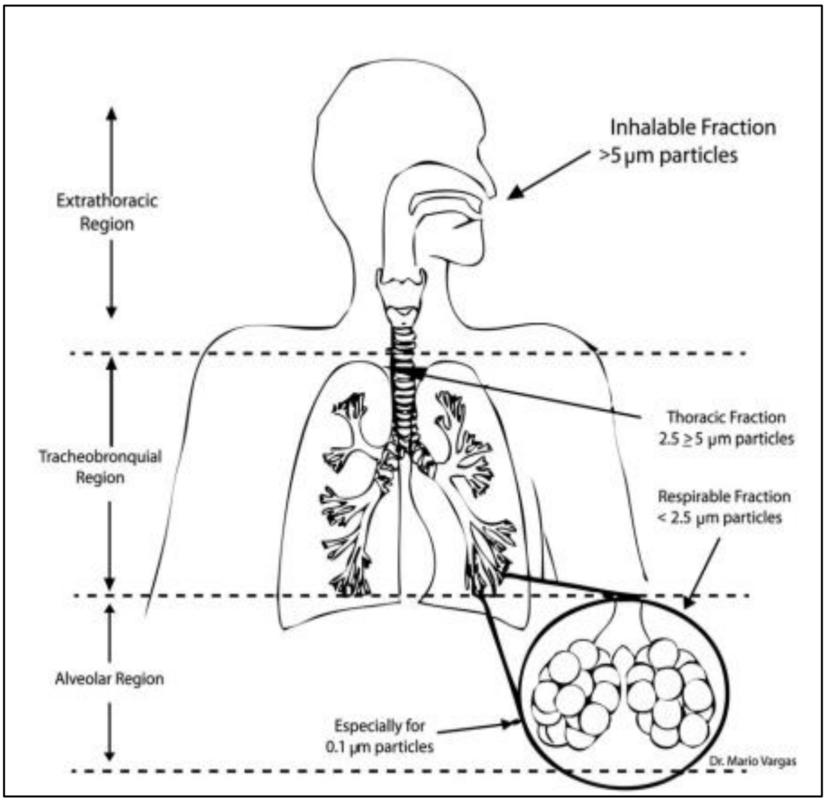

Figure 7: Particle deposition in the human respiratory tract (Sierra-Vargas and Teran 2012: 1032).

Studies conducted by Stobnicka and Górny (2015: 242), Iyogun *et al.* (2019: 47) and Scientific Committee on Occupational Exposure Limits (2008: 2) have indicated that flour dust has an aerodynamic particle size ranging between ≤4µm and 30 µm, with the smallest particles approximately 5µm and the larger particles approximately 15 – 30 µm. According to the Scientific Committee on Occupational Exposure Limits (2008: 2), results obtained from a bimodal distribution of aerodynamic diameters of flour dust showed that more than 50% of the particle mass presented with an aerodynamic diameter greater than 15um. Notably, from the total mass of Inhalable dust, 39% belonged to the thoracic fraction whilst 19% belonged to the respirable fraction. The study further reveals that a considerable amount of flour dust particles is more than 10 µm in diameter, hence they deposit in the upper respiratory tract. In dusty areas, at least 20% of the airborne flour particles are of a diameter small enough to either deposit in the bronchial airways or penetrate the alveoli regions of the respiratory tract. This is further supported by Iyogun *et al.* (2019: 47).

2.7.2 DEPOSITON OF FLOUR DUST

In addition to particle size, another factor influencing particle deposition is the deposition mechanism itself. The particle deposition mechanism refers to the particles ability to adhere or stick to a surface (Hussain, Madl and Khan 2011: 52). For airborne particles, there are three crucial methods of deposition namely, diffusion, sedimentation, and impaction; each of which rely largely on particle size.

6.2.1 Impaction (Inertial Impaction): as particles move within an aerosol, they build momentum that is proportional to their mass. Therefore, particles with considerable mass and inertia will follow Newton's First Law of Motion which declares that a mass in motion tends to remain in uniform motion unless acted upon by an external force (Hussain *et al.* 2011: 53). Impaction relates to this law since large particles (large mass) with increased momentum do not follow the air streams curvature, eventually depositing in the airway (Hussain *et al.* 2011: 53). This deposition mechanism is used by particles ranging between 5–100 µm and due to the large particle size, they deposit in the nasopharyngeal regions (Demeke 2017: 8; Plog and Quinlan 2002: 182)

6.2.2 Sedimentation: This mechanism relies on the force of gravity. Gravitational forces are said to dominate an inhaled particle's air resistance, causing the particles to deposit on the lower surfaces on an airway (Hussain *et al.* 2011: 53). This mechanism is common among particles larger than 0.5 µm and is said to deposit in the thoracic and bronchial regions (Demeke 2017: 8; Hussain *et al.* 2011: 53; Plog and Quinlan 2002: 182).

6.2.3 Diffusion: This involves collisions between air particles and is common among particles less than 0.5 µm in size. Diffusion may cause particles to travel across the streamline and deposit onto the airway walls when the contact is made (Hussain *et al.* 2011: 53). Due to its relatively small particle size, deposition can occur in the alveolar region- the region responsible for gaseous exchange (Hussain *et al.* 2011: 53).

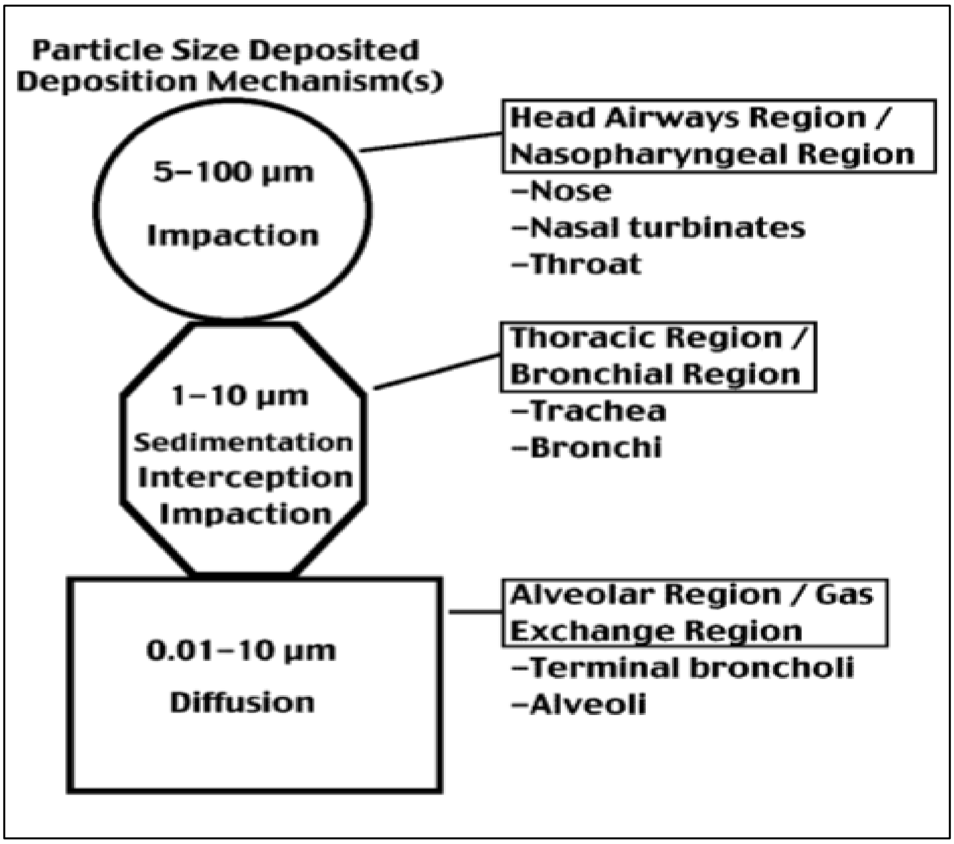

Figure 8: Diagram showing deposition mechanism based on particle size (Plog and Quinlan 2002: 182)

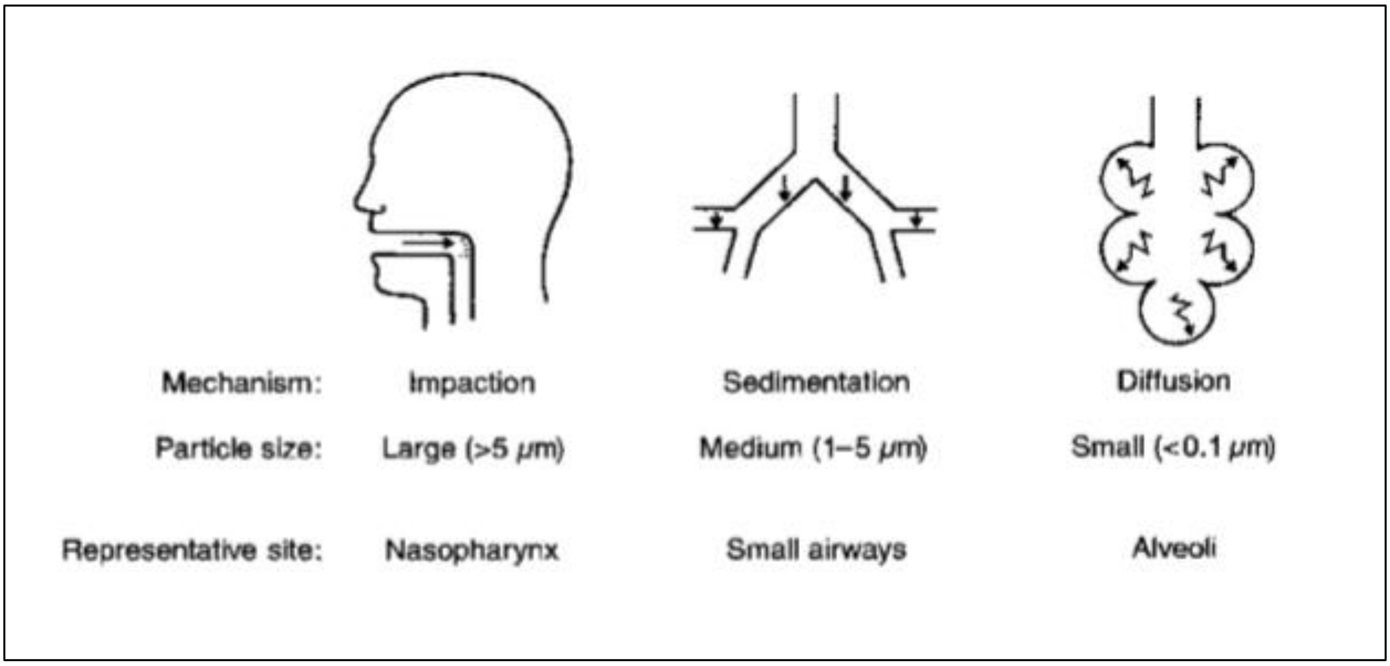

Figure 9: Penetration and deposition mechanism of dust particles in the human respiratory tract (Demeke 2017: 8)

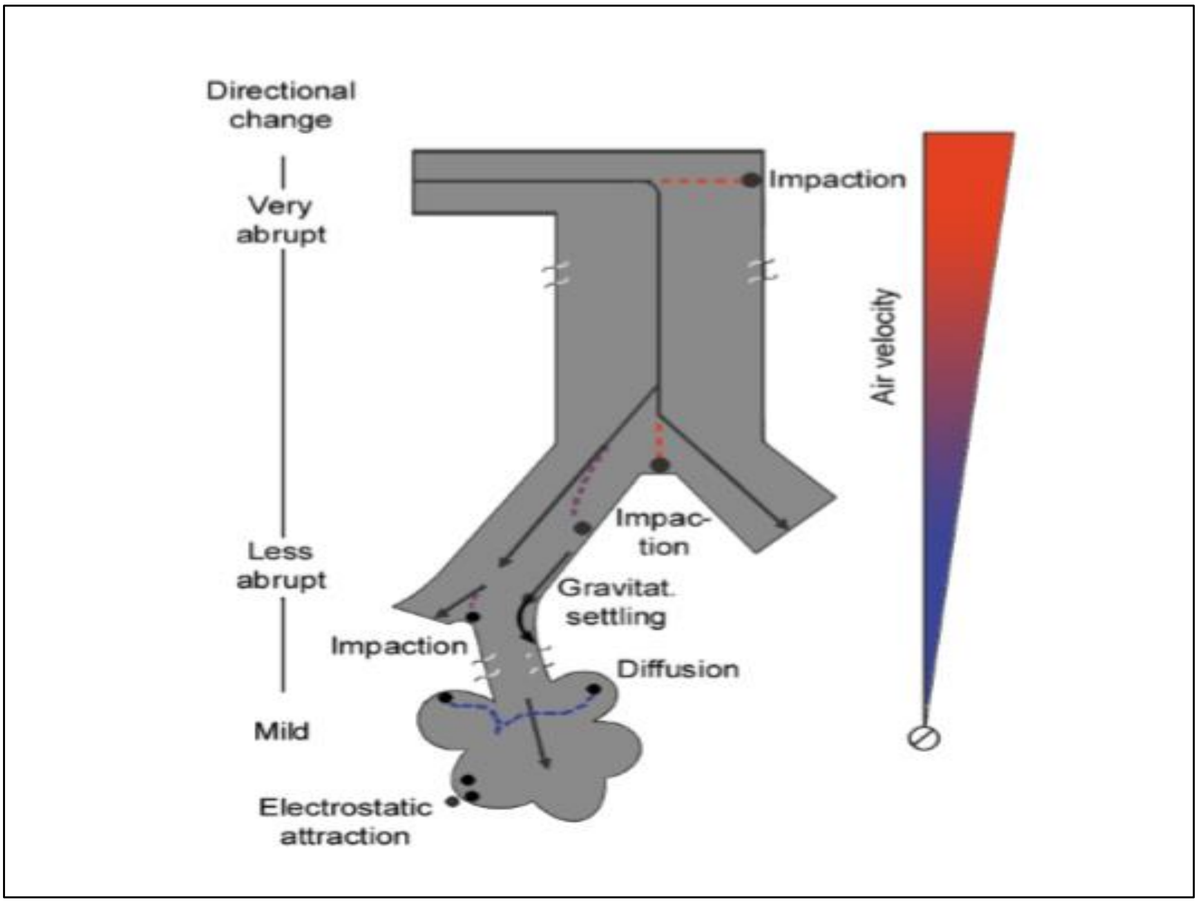

Figure 10: Diagram, showing different particle deposition mechanisms (Hussain *et al.* 2011: 53)

2.8 SPIROMETRY

Spirometry, also referred to as a basic lung function test, is the measurement of air volumes and airflow rates of the lung (Koegelenberg *et al.* 2013: 52). It assesses the parameters of Lung Function and is used to detect abnormalities and respiratory-related issues, evaluate lung impairment, and examines the impact of occupational and environmental exposures (Moore 2012: 233). During a spirometry test, data is collected using a spirometer, an instrument capable of displaying expiratory and inspiratory information in real-time (Koegelenberg *et al.* 2013: 52). The collected measurements are then graphically displayed in the form of a spirogram. Spirograms are known to include volume-time curves and flow-volume curves.

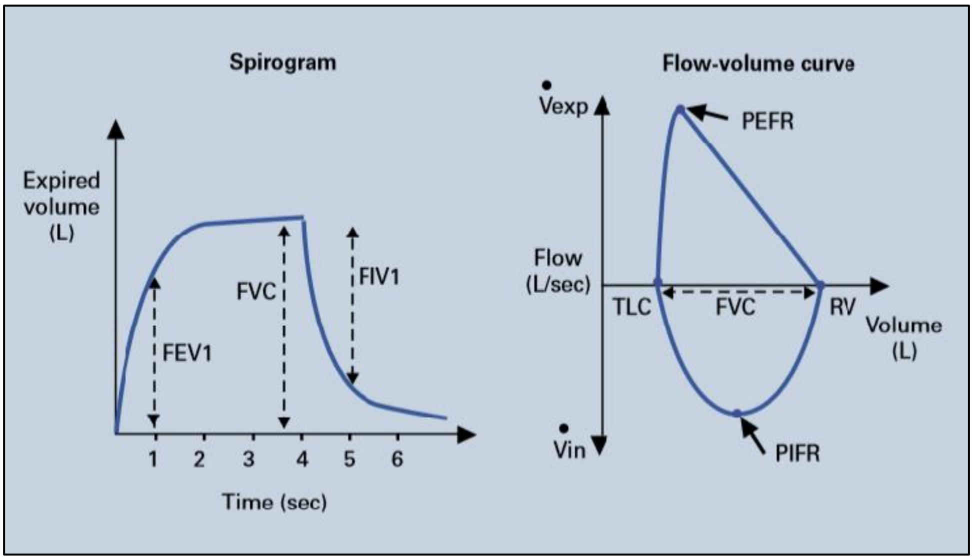

Figure 11: Picture showing normal spirogram with volume-time graph and flow-volume graph (Pierce 2005: 536).

2.8.1 PARAMETERS

Spirometry tests use a wide range of parameters to assess lung function, however the Forced Vital Capacity (FVC); Forced Expiratory Volume in 1 second (FEV_1) and ratio of FEV_1/FVC are considered the minimum values required for diagnostic purposes (van Schalkwyk, Schultz, Joubert and White 2004: 577). These values are also considered highly sensitive and are specific to identifying airflow obstructions.

- **Forced Vital Capacity (FVC):** Measures lung size (in Liters) and indicates the amount of air that can be exhaled from the lungs following deep inhalation.
- **Forced Expiratory Volume – One Second (FEV_1):** Measures the amount of air that can be exhaled in one second following deep inhalation.
- **FEV_1/ FVC Ratio:** Represents the percent of the lung size that can be exhaled in one second (United Steelworkers 2013).

2.8.2 PERFORMING A SPIROMETRY TEST

A spirometry test is considered easy and non-invasive (Moore 2012: 233). To carry out a spirometry test, the patient is required to follow one of two test procedures namely expiratory-only method (open-circuit) and inspiratory-expiratory method (closed-circuit) (van Schalkwyk *et al.* 2004: 581).

1. Expiratory-only method: also referred to as an open-circuit method, consists of a FVC test with or without a slow VC test. A FVC test involves the patient inhaling deeply before

inserting a mouthpiece and expelling the inhaled air forcefully for a duration of six seconds. Should results from this test indicate significant obstruction, then a slow VC test is called for. During a slow VC test, the patient is required to inhale deeply, afterwards, the mouthpiece is inserted, and the patient breathes out in a relaxed manner for as long as possible or for at least 15 seconds. In this test, only the VC values are recorded. Van Schalkwyk *et al.* (2004: 581) explains that the slow VC test aims to shed light on the nature of the obstructive abnormality, adding credibility and clarity to a diagnosis.

2. Inspiratory-expiratory method: Also referred to as a closed-circuit method. This method records both inspiratory and expiratory values via a flow-type spirometer, in turn developing a flow-volume curve. This method involves a series of inspirations and expirations. Once the mouthpiece is inserted, the patient experiences a period of quiet breathing. This is then followed by complete expiration. Afterwards, the patient is required to inhale quickly, forcefully and completely before finally exhaling quickly, forcefully, and completely (van Schalkwyk *et al.* 2004: 581).

A minimum of three acceptable FVC manoeuvres is required. To achieve acceptable repeatability, the difference between the two largest FVC and FEV_1 values must be ≤ 0.150. If this cannot be achieved after three attempts, the test should either be conducted to a maximum of eight manoeuvres; until the patient is unable to continue, or until it is evident that continuous testing is still producing the same result. Tests can be performed whether the patient is seated or standing; however, the seated position is most common as it prevents further injuries should a patient expel air so forcefully that it could render them faint, lightheaded or unconscious (Koegelenberg *et al.* 2013: 55; Ranu, Wilde and Madden 2011: 85). It must be noted that different postures have been found to influence test results as described Reidlich, Tarlo, Hankinson, Townsend, Eschenbacher, von Essen, Sigsgaard and Weissman (2014: 986), which indicates that standing values of the FEV_1 and/ or FVC exceeded sitting values by 0.04 – 0.07 L. It is, however, notable that these results were derived from tests that were not performed in an occupational setting.

2.8.3 INTERPRETATION OF A SPIROMETRY TEST

After an individual's results are captured, it is interpreted and assessed for abnormalities against predicted results obtained from a normal reference population (van Schalkwyk *et al.* 2004: 583). The reference values are based on healthy individuals with normal lung function (van Schalkwyk *et al.* 2004: 582). According to van Schalkwyk *et al.* (2004: 583) Predicted values for FEV_1 and FVC are derived from equations based on age, height and gender and ethnicity as these are the most critical factors influencing lung and airway size in healthy individuals (Ranu *et al.* 2011: 85; van Schalkwyk *et al.* 2004: 583)

Table 2: Guide for Grading Pulmonary Impairment According to Percent of Predicted Spirometry (South Africa, Department of Minerals and Energy 2003: 9)

Parameter	Normal	Mildly Impaired	Moderately Impaired	Severely Impaired
% pred FVC	≥80	60 – 79	51-59	≤50
% pred FEV_1	≥80	60 – 79	41-59	≤40
FEV_1/FVC%	≥75	60-74	41-59	≤40

Results from a spirometry test can be classified as either normal or abnormal. If abnormal, it is then further classified into the specific type of abnormality namely obstructive, restrictive or a mixed obstructive and restrictive abnormality (Brazzale, Hall and Swanney 2016: 1204; South Africa, Department of Minerals and Energy 2003: 7).

2.8.3.1 NORMAL OR ACCEPTABLE SPIROMETRY RESULTS:

A spirometric test is deemed normal or acceptable if the best FEV_1/ best FVC value is ≥ 75 and if the following is true:

- best FVC ≥ 80% predicted value
- < 200ml averaged annual decline in FEV_1 or FVC
- < 10% decline in FEV_1 or FVC from the baseline spirometric test.

2.8.3.2 ABNORMAL SPIROMETRY RESULTS:

A. OBSTRUCTIVE ABNORMALITIES:

An obstructive abnormality as defined by van Schalkwyk *et. al* (2004: 585) is "the disproportionate reduction in the maximal volume that can be displaced from the lung". It is identified when the FEV_1/FVC ratio is < 70% and the FEV_1 value is lower than the FVC value (Ranu *et al.* 2011: 85). To further diagnose an obstructive abnormality, a reversibility test must be conducted to determine the nature of the obstruction (van Schalkwyk *et. al* 2004: 585; Morris 1976: 115). To ascertain the degree of a reversible airway obstruction, it is imperative that an aerosolized bronchodilator, such as 2.5mg of nebulized salbutamol, be administered (Ranu *et al.* 2011: 87; Morris 1976: 115). After the bronchodilator, patients are required to wait for five to ten minutes, after which, another spirometry test is conducted (Morris 1976: 115). If results from the spirometry test post-bronchodilator show a 15% increase in the FEV_1 values, it is deemed reversible (South Africa, Department of Minerals and Energy 2003: 7). Similarly, Ranu *et al.* (2011: 87) reports that a positive response in adults is categorized by a 12% increase in baseline FEV_1 with an increase of 200ml or more (Pierce 2005: 537). However, Ranu *et al.* (2011: 87) purports that a negative response does not dismiss the potential benefits from a trial of bronchodilator therapy. This statement is also supported by Morris (1976: 115).

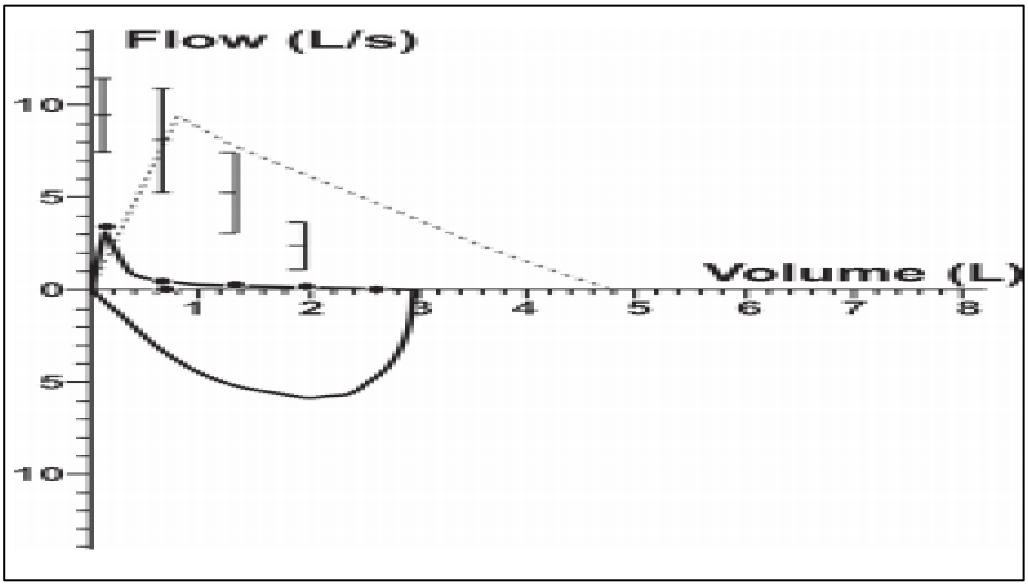

Figure 12: flow-volume curve showing typical obstructive abnormality (Koegelenberg Swart and Irusen 2013: 60).

B. RESTRICTIVE ABNORMALITIES

A restrictive defect or abnormality is defined as a reduction in Total Lung Capacity (van Schalkwyk *et. al* 2004: 585), or simply, loss in lung volume (Moore 2012: 238). This abnormality is characterized by an FEV_1/FVC ratio that is normal or high (>80) whereby the FVC value is reduced more so than the FEV_1 value (Koegelenberg *et al.* 2013: 60; Pierce 2005: 537). According to Koegelenberg *et al.* (2013: 60), there are many conditions that can reduce FVC values, such as interstitial fibrosis, chest wall and pleural disease, neuromuscular diseases, and respiratory muscle weakness (Pierce 2005: 537; van Schalkwyk *et. al* 2004: 585).

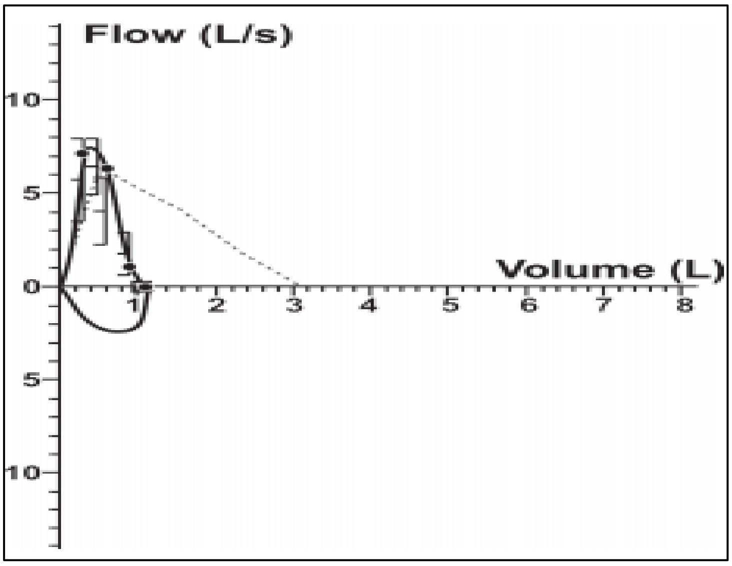

Figure 13: Flow-volume curve showing typical restrictive abnormality (Koegelenberg *et al.* 2013: 60)

C. MIXED OBSTRUCTIVE AND RESTRICTIVE ABNORMALITIES

A mixed abnormality is when both the obstructive and restrictive defect types coexist (Pierce 2005: 537) and is typically characterized by a reduction in both the FEV_1/FVC ratio and the FVC value (Pierce 2005: 537; South Africa, Department of Minerals and Energy 2003: 7). As purported by Koegelenberg *et al.* (2013: 60), it may be difficult to diagnose a patient with a mixed abnormality based solely on the results from a spirometry test, and as such, will need to be referred to a specialist for further investigation.

2.8.4 ETHNIC CORRECTIONS IN SPIROMETRY

Interpretation of lung function tests are conducted by comparing results against reference value of healthy individuals with normal lung function. Predicted values for FEV_1 and FVC are presented as percentages and are derived from equations based on age, height, and gender as these are considered critical characteristics known to influence lung and airway size in healthy individuals (Schalkwyk *et al.* 2004: 583). Another key determinant to consider is an individual's race. It has been reported that when compared to other ethnic populations, Caucasians presented higher FEV_1 and FVC values but similar or lower FEV_1/FVC% (up to 10%) (Koegelenberg *et al.* 2013: 58; van Schwalkwyk *et al.* 2004: 583).

Research by Koegelenberg *et al.* (2013: 58) and van Schalkwyk *et al.* (2004: 583) assert that office spirometers are typically programmed with prediction formulae based on Europeans, citing the European Community for Steel and Coal (ECSC) as the most used. According to van Schalkwyk *et al.* (2004: 583) and Koegelenberg *et al.* (2013: 58), the use of inappropriate predicted values can lead to an increase of abnormal results amongst clinically normal individuals.

Previously, the FEV_1 and FVC predicted values were occasionally adjusted by 0.9 for individuals of African and Asian descent (Koegelenberg *et al.* 2013: 58). However, due to a lack of an all-inclusive study of the South African population, most local institutions currently use the ECSC equations – without racial correction (Koegelenberg *et al.* 2013: 58). On the contrary, in 2003, the South African Department of Minerals and Energy published a document titled "Guidance note for Occupational Medical Practitioners: Lung Function Testing" in which it describes options available to determine reference values for individuals of European and African origin (South Africa, Department of Minerals and Energy 2003: 6).

The document showcases reference values from the ECSC advising that the following equations are acceptable for persons of European descent (South Africa, Department of Minerals and Energy 2003: 6):

- FEV_1 (litres) : 0.058 x height (cm) – 0.026 x age (years) – 4.34
- FVC (litres) : 0.043 x height (cm) – 0.029 x age (years) – 2.49

For ethnically specific reference values, for persons of African descent, the following equations are acceptable (South Africa, Department of Minerals and Energy 2003: 6):

- FEV_1 (litres) : 0.029 x height (cm) – 0.027 x age (years) – 0.535
- FVC (litres) : 0.048 x height (cm) – 0.024 x age (years) – 3.08

For persons of race or Indian origin, any of the above equations are acceptable (South Africa, Department of Minerals and Energy 2003: 6).

Although calculations accommodating ethnically diverse populations are provided, its application is optional. The clinician responsible for interpreting results should be aware of these considerations and must use informed judgement regarding the use of the most appropriate reference values and whether ethnic correction is necessary (Koegelenberg *et al.* 2013: 58;

van Schwalkwyk *et al.* 2004: 583 and South Africa, Department of Minerals and Energy 2003: 6).

2.9 ADVERSE HEALTH EFFECTS ASSOCIATED WITH FLOUR DUST EXPOSURE

Through the years, several studies have found that grain and flour dust exposure among flour mill workers leads to a respiratory and dermatological issues (Gholami *et al.* 2018: S779; Ahire *et al.* 2017: 71; Mohammadien *et al.* 2013: 3; Meo 2004: 187). Some studies have even linked atopy to flour dust exposure, such as Muvhali *et al.* (2020: 18), which states that atopy is an important risk factor for developing Baker's allergy while Marraccini, Brass, Hollingsworth, Marouka, Garantziotis and Schwartz (2008: 2) suggests that bakery flour dust has been identified as a contributor to the severity of atopy and allergic asthma.

2.9.1 FLOUR DUST AS A SENSITIZER AND ALLERGEN

The South African Department of Labour (1993: 191), defines a sensitizer as a substance that sensitizes the skin or lungs after exposure, inducing allergic reactions. Once an individual becomes sensitized to a substance, they can experience severe reactions from their exposures, even if the dose is below the regulated OEL. Respiratory sensitizers can cause asthma, rhinitis, or extrinsic alveolitis, while, skin sensitizers, can cause allergic contact dermatitis (South African Department of Labour 1993: 190).

An allergy, on the other hand, is described as a hypersensitivity reaction induced by immunological mechanisms characterised by clinical symptoms in response to an environmental stimulus (Mamone, Picariello, Addeo and Ferranti 2011: 95). To trigger an allergic response, an allergen, such as flour dust, must be present. This will give rise to inflammatory reactions; tissue damage and the formation of Immunoglobin E (IgE) antibody responses towards the offending allergen. According to Mamone *et al.* (2011: 98) the most recognized allergic reactions are IgE-mediated.

Sensitization, as described by Scientific Committee on Occupational Exposure Limits (2008: 20), is the development of specific Immunoglobin E antibodies to any of the various flour dust allergens. This may also be characterised as atopy which is described as an increase in sensitivity of IgE towards a specific antigen, resulting in a hypersensitive response when exposed to the allergen in question (Schellack and Schellack 2017: 18). It is critical to note that wheat flour itself is a complex organic dust which boasts a vast array of antigenic and allergenic components. The antigenic components may include flour parasites, silica, fungi, insects, enzymes and more importantly wheat flour proteins (Mohammadien *et al.* 2013: 2). Attention must be drawn to wheat flour proteins as studies by Mamone *et al.* (2011: 96) and Amano, Ogawa, Kojima, Kamidaira, Suetsugu, Yoshihama, Satoh, Samejima and Matsumoto (1998: 1229) have both linked the protein fraction in wheat as being one of the most common causes of allergies and intolerance. According to Mamone *et al.* (2011: 95), the wheat flour protein may be categorized into either water/salt-soluble albumins and globulins or water/salt-insoluble gliadins and glutenins.

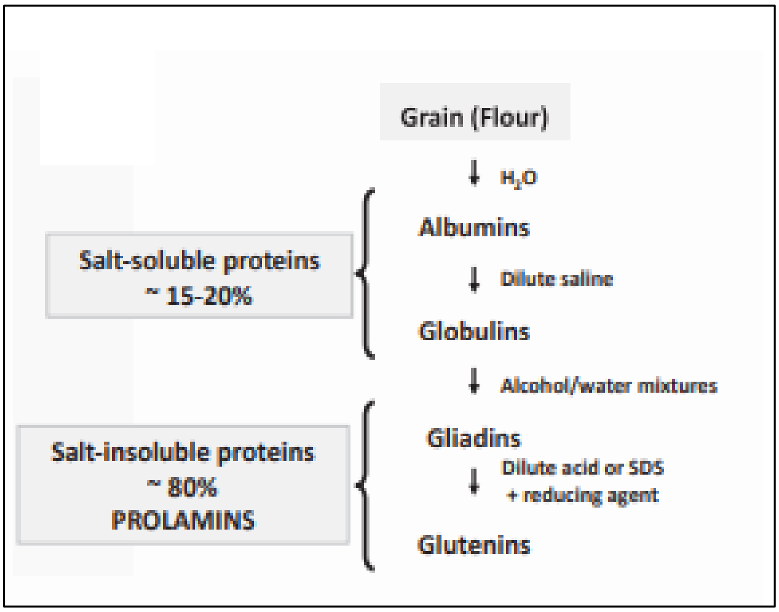

Figure 14: Diagram showing composition of wheat flour protein
(Salcedo, Quirce and Diaz-Perales 2011: 83)

As described by Mohammadien *et al.* (2013: 2), globulins and albumins are major proteins contributing to immediate sensitivity, contrary to Mohammadien *et al.* (2013: 2) together with Khodadadi *et al* (2011: 418), also revealed that approximately 80% of wheat proteins are comprised of gliadin and glutenin - the two proteins whose presence has been positively linked to wheat flour-related diseases based on immunological responses among bakers and mill workers, derived from elevated levels of IgE, IgG and IgA antibodies.

There is a vast body of literature linking flour dust exposure to the onset of allergic symptoms. Research conducted by Ajeel and Al-Yassen (2007: 29), sought to examine the prevalence of occupational allergic disorders among flour mill workers. The study found that, overall, 51.9% of flour mill workers reported having at least one or more symptoms of respiratory, nasal or eye allergy. Ajeel and Al-Yassen (2007: 30) went on to report that up to 90.6% of workers stated that the allergic symptoms were triggered at the start of work and during work hours but improved after leaving the workplace and on weekends and holidays - concluding that flour mill workers had definite work-related allergic symptoms. Interesting to note was that workers with a longer duration of employment reported higher prevalence of symptoms (62%) as compared to those with a shorter term of employment (10.5%). Similarly, a study conducted in Kohlarpur, India (Ahire *et al.* 2017: 70) reported significant respiratory, nasal and eye problems among flour mill workers – stating that approximately 83.33% of respondents suffered from sneezing and coughing whilst 8.89% suffered from eye irritation and itching.

2.9.2 FLOUR DUST AND SKIN CONDITIONS

Skin is a known route of entry and is considered a vital route of exposure for allergens, resulting in sensitization, potentially causing allergic skin symptoms (Chongo-Faruk 2017: 256). According to Plog and Quinlan (2002: 56), dermatosis refers to any cutaneous anomaly ranging from redness, itching and scaling to more serious eczema-like, ulcerative, acneiform, pigmentation, granulomatous or neoplastic conditions. Occupational dermatoses, therefore, directly relate to the cutaneous anomalies directly induced or aggravated by the work environment (Plog and Quinlan 2002: 56). Plog and Quinlan (2002: 56), further add that the term dermatitis is regarded as a more limited term referring to any inflammation of the skin such as contact dermatitis.

Contact dermatitis is regarded as being the most common cause of occupational skin diseases (Plog and Quinlan (2002: 64). There are many different types of dermatitis, but irritant contact dermatitis and allergic contact dermatitis are among the more recognized (Stobnicka and Górny 2015: 243; Plog and Quinlan 2002: 64). It has established that between these two types of contact dermatitis, one is more prevalent than the other – more cases of an irritant nature are reported as compared to allergies (Steenkamp 2013: 27; Sasseville 2008: 59; Plog and Quinlan 2002: 64). Research has yielded some studies linking flour dust exposure to contact dermatitis – with emphasis placed on bakers. In Sweden, the Swedish Information System on Occupational Injuries showed that bakers appear to report occupational skin disease up to four times more often than the average (Brisman *et al.* 1998: 751), whilst a German study published the highest Irritant contact dermatitis annual incidence rates lay among hairdressers, bakers, and pastry cooks, ranked in order from highest to lowest (Steenkamp 2013: 27).

2.9.2.1 IRRITANT CONTACT DERMATITIS (ICD)

Irritant Contact Dermatitis (ICD) is generally defined as a non-immunological local inflammatory response which presents with erythema, oedema, vesicles, and blisters (Steenkamp 2013: 27) and is reported as the making up 80% of occupational contact dermatitis cases (Steenkamp 2013: 27; Sasseville 2008: 59; Plog and Quinlan 2002: 64). It may arise after singular or continuous exposure of a chemical substance at a cutaneous site (Steenkamp 2013: 27). Irritants, according to Plog and Quinlan (2002: 64), may be divided into two groups as either strong or weak. Strong irritants include strong acids, alkalis, ethylene oxide and metallic salts among others and are said to elicit a visible reaction within minutes. On the contrary, weak irritants such as soap and water, detergents, solvents, oils and flour (particularly wet dough) require more time, before changes are seen.

Steenkamp (2013: 27) notes that among bakers, most cases of dermatitis are due to irritation. The study explains that a baker's hands are highly exposed to wet work as their job role requires constant handwashing to maintain food safety standards. According to Steenkamp (2013: 27), the constant handwashing combined with the use of cleaning agents alters the skin's pH, leading to increased risks of bacterial infection as well as compromising the skin's protective function in turn exposing bakers to an increased risk of developing ICD. Although, it must be noted that in addition to the job role, several other factors play a role in the development of ICD such as demographics and more importantly – pre-existing skin conditions (Steenkamp 2013: 27; Plog and Quinlan 2013: 64). Pre-existing atopic eczema is known to increase the susceptibility to irritants and is also considered a risk modifier for hand eczema, a disease caused by exposure to irritants or allergens (Levine 1980: 37). Brisman *et al.* (1998: 752) state that up to 34% respondents with hand eczema also reported hand eczema in childhood. According to Sasseville (2008: 59), while itchiness is a common complaint, main symptoms include pain or a burning sensation.

2.9.2.2 ALLERGIC CONTACT DERMATITIS (ACD)

Allergic Contact Dermatitis, or ACD, is an immunological response that occurs in genetically susceptible individuals who have already been sensitized to an allergen (Steenkamp 2013: 27). Sasseville (2008: 59) explains that this form of contact dermatitis is not reported as frequently as ICD and contributes to 20% of all occupational skin disorders reported. According to Burdzik (2009: 85), it is challenging to differentiate between ICD and ACD, however a distinguishing feature of ACD is that it corresponds to the site of contact and develops within 12 – 48 hours of minimal exposure. Another notable difference between ICD and ACD is that while an irritant affects worker, a sensitizer only affects a few workers (Plog and Quinlan 2002: 64). Some common allergens include nickel sulphate, thiuram mix found in rubber gloves and formaldehyde; while some specific allergens pertaining to flour include ammonium persulphate (flour improver), certain emulsifiers, benzoyl peroxide (bleaching agents) and particularly fungal alpha-amylase (dough improver) (Stobnicka and Górny 2015: 243; Steenkamp 2013: 28).

Burdzik (2009: 86) found that specifically alpha-amylase and benzoyl peroxide cause dermatitis. Stobnicka and Górny (2015: 243) stated that sensitization to fungal alpha-amylase among bakers and millers is usually more common when compared to sensitization to flour dust. A United Kingdom study endeavoured to examine the roles of flour aeroallergens. The study found that a small proportion of cases developed work-related symptoms in relation to specific IgE antibodies for flour and alpha-amylase allergens – aligning with allergic or hypersensitivity responses. The same study further added that specific IgE antibodies to fungal alpha-amylase was slightly higher in comparison to those for flour, suggesting sensitization to this additive may be more concerning as opposed to Baker's asthma (Cullinan, Cook, Nieuwenhuijsen, Sandiford, Tee, Venables, McDonald and Newman Taylor 2001: 102).

2.9.2.3 BAKER'S HAND ECZEMA

A commonly reported dermal reaction caused by flour dust exposure is baker's hand eczema (Steenkamp 2013: 27). Baker's hand eczema is defined as a disease caused by exposure to allergenic and/ or irritating substances in the workplace (Steenkamp 2013: 27; Levine 1980: 37). According to Levine (1980: 37), eczema is characterized by three stages, namely the acute, subacute and chronic stage. It must be made clear that it is not necessary for patients to experience all three stages before the symptoms dissipate. The three stages are briefly described as follows:

- Acute stage: this is characterized by blistering, weeping, oozing, erythema, and oedema.

Figure 15: Figure showing Acute hand eczema (Levine 1980: 38)

- Subacute stage: Characterized by scaling, crusting, cracking, fissuring.

Figure 16: Figure showing subacute hand eczema (Levine 1980: 38)

- Chronic: A key feature of the chronic stage is thickening of the skin (lichenification). Mild erythema and scaling may also be present.

Figure 17: Figure showing chronic eczema (Levine 1980: 38)

2.9.3 FLOUR DUST AND RESPIRATORY CONDITIONS

Flour dust can be classified as either inhalable, thoracic, or respirable since its aerodynamic particle size lies between ≤ 4 μm and 30 μm (Stobnicka and Górny 2015: 242). The different particle sizes mean that the dust may be deposited at any point along the respiratory tract, leading to various respiratory-related issues. In addition, several studies have identified flour dust as a respiratory sensitizer (Stobnicka and Górny 2015: 242; Nieuwenhuijsen *et al.* 1994: 584; Gholami *et al.* 2018: S779) which may lead to respiratory, nasal, and ocular symptoms (Tosho, Adeshina, Salawu and Tope 2015: 55) and have gone on to report increased rates of sensitivity to flour allergens and alpha amylase (Hosseinabadi *et al.* 2013: 139)

According to a study conducted in Nigeria, 202 flour mill workers were investigated to determine their exposure to flour dust and its influence on the onset of respiratory symptoms. The study found that when compared to the controls, the experiments showed significantly higher prevalence of respiratory symptoms, even going on to state that a flour mill worker had a 0.75 higher likelihood of developing respiratory symptoms as compared to the control workers (Tosho *et al.* 2015: 60).

2.9.3.1 BAKER'S ASTHMA

Asthma caused by workplace exposure to flour is termed Baker's asthma and has been identified as one of the most common types of asthma (Baatjies *et al.* 2014: 811; Mohammadien *et al.* 2013: 2; Ajeel and Al-Yassen 2007: 31; Nieuwenhuijsen *et al.* 1994: 584). Baker's asthma is even considered one of the most severe types of occupational allergies (Stobnicka and Górny 2015: 242; Salcedo *et al.* 2011: 81; Brisman 2002: 498). In France, approximately 20% of all occupational asthma cases are specifically Baker's asthma (Stobnicka and Górny 2015: 242; Salcedo *et al.* 2011: 81). In other parts of the world, such as Canada and Finland, Baker's asthma accounts for approximately 20% of insurance compensations, while in the United Kingdom and Norway it is ranked as the second most reported cause of occupational asthma (Salcedo *et al.* 2011: 81).

Baker's asthma, or the concept thereof, has been described as an allergic disease identified by positive skin tests, rhinitis, and respiratory symptoms such as airflow obstruction and bronchial hypersensitivity as well as shortness of breath (Marraccini *et al.* 2008: 2; Brisman 2002: 498). Prominent research by Stobnicka and Górny (2015: 242); Hosseinabadi *et al.* (2013: 139); Galli and Tsai (2013: 693); Salcedo *et al.* (2011: 81); Mamone *et al.* (2011: 98); Nieuwenhuijsen *et al.* (1994: 584) and Ajeel and Al-Yassen (2007: 31) have indicated that the onset of Baker's asthma is linked to the development of allergens. Hosseinabadi *et al.* (2013: 139), describes the albumin of flour as the main cause of allergies known as Baker's asthma, stating that inhalation of it prompts a chain reaction beginning with stimulation of specific antibodies, leading to increased allergies, respiratory disorders and eventually asthma. Likewise, Salcedo *et al.* (2011: 83) reports that wheat allergens and wheat proteins have been linked to Baker's asthma and furthermore a study by Stobnicka and Górny (2015: 242) states that Baker's asthma is a result of immunological sensitization following allergic reactions to specific occupational airborne allergens.

While some studies have drawn a connection between allergens and Baker's asthma, Stobnicka and Górny (2015: 242); Hosseinabadi *et al.* (2013: 139) and Salcedo *et al.* (2011:

81) others have gone on to offer specificity in connecting Baker's asthma to specific antibodies. Amano *et al.* (1998: 1229) explains that Baker's asthma is mainly a Type I allergy in which patients have a specific IgE for the allergen. Explained in further detail, an article published by Galli and Tsai (2013: 693) stated that antigen specific IgE antibodies together with a mast cell are said to lead to the development of acute manifestations such as asthma. This statement is supported by results from a study conducted by Mamone *et al.* (2011: 98) in which it was announced that IgE antibodies specific to wheat albumins and globulins were found in the sera of patients with wheat allergy and with Baker's asthma.

2.9.3.2 REDUCED LUNG FUNCTION

Multiple studies have been conducted worldwide drawing parallels to flour dust exposure and impaired lung function (Iyogun *et al.* 2019: 52; Gholami *et al.* 2018: S782; Tosho *et al.* 2015: 61; Hosseinabadi *et al.* 2013: 145; Mohammadien *et al.* 2013: 3 and Wagh, Pachpande, Patel, Attarde and Ingle 2006: 398), with some citing impaired lung function as one of the most common health issues among flour mill workers.

According to Mohammadien *et al.* (2013: 2), Meo (2004: 187) and Kakooei and Marioryad (2005: 51), the most important diagnostic tool to measure lung function while simultaneously evaluating the health of the lung is the spirometry test. In a study carried out in the East of Iran, spirometry test used to determine lung function among flour mill workers. To effectively assess the outcomes based on employee exposure - the sample size was separated into exposed and non-exposed. Results revealed that the prevalence of respiratory symptoms among exposed employees were much higher in comparison to the non-exposed employees (Gholami *et al.* 2018: S779). Additionally, it was noted that the pulmonary function among the exposed group was lower than the non-exposed group (Hosseinabadi *et al.* 2013: 142; Meo 2004: 188).

In 2004, a study by Meo (2004: 187) determined that flour dust adversely impacted lung function across four parameters namely FVC, FEV_1, PEF and MVV (Meo 2004: 190) – confirming the results found in other studies of its kind. Wagh *et al.* (2006: 398) found that flour mill workers showed a reduction in FVC, FEV_1; PEFR and MVV indices in comparison to controls – adding that the parameters predominantly affected were FVC, FEV_1 and PEFR. Similarly, studies conducted in Nigeria by Iyogun *et al.* (2019: 52) and Tosho *et al.* (2015: 61) reported significantly lower FEV_1 and PEFR values among grain millers and flour mill workers as compared to control groups in the respective studies. Other than reduced lung function parameters, some studies also discovered that lung function is strongly influenced by exposure time to flour dust. Research by Iyogun *et al.* (2019: 52) Wagh *et al.* (2006: 399) and

Hosseinabadi *et al.* (2013: 141) has suggested that stratification of results bears testament to the inverse relationship shared between duration of exposure and the outcome; explaining that as duration of exposure increased - lung function values decreased. Meo (2004: 188) offers clarity by investigating the dose-response effect of flour dust on lung function by dividing duration of exposure to flour dust into three groups of 1-4 years, 5-8 years and >8 years. Results found that among those exposed for 1-4 years, there was no significant difference recorded, however the same cannot be said for the other two groups. Among those exposed for between 5-8 years however, there was a significant reduction in FVC, FEV_1, PEF and MVV values as compared to the controls, with the percentage change in the flour mill worker's data in relation to the controls was being slightly decreased for FVC, FEV_1, PEF and MVV. For workers exposed for more than eight years, a significant reduction in FVC, FEV_1, PEF and MVV was noted in comparison to the control group - with the percentage change in flour also significantly reduced for FVC, FEV_1, PEF and MVV values (Meo 2004: 188). The evidence provided by literature support the notion that flour dust impairs lung function, further concluding that duration of exposure to flour dust plays a significant role in its severity.

2.9.4 FLOUR DUST AND CONJUNCTIVITIS

Conjunctivitis is defined as inflammation of the conjunctiva and is characterised by symptoms such as itching, red eyes or discharge (Kathrada 2019: 6; Valley and Irhuma 2017: 5). It is regarded as a frequently reported, yet less severe allergy brought on by flour dust exposure (Stobnicka and Górny 2015: 243). Symptoms may be induced either immunologically via na allergic reaction or by means of non-specific irritation (Stobnicka and Górny 2015: 243). Whilst symptoms induced by irritation are described as being reversible, with immunologically induced sensitization, symptoms are said to persist even after exposure to flour dust is restricted (Stobnicka and Górny 2015: 243). Sufficient evidence linking flour dust exposure to conjunctivitis is available (Ahire *et al.* 2017: 70; Stobnicka and Górny 2015: 243; Meo 2004: 46; Ijadunola, Erhabor, Onayade, Ijadunola, Fatusi and Asuzu 2004: 254). According to Ijadunola *et al.* (2004: 253), production staff at a flour mill in Nigeria showed a significantly higher prevalence of several non-pulmonary symptoms in relation to external controls – symptoms of which included eye irritation, eye discharge and conjunctivitis among others. When the same study compared production staff to internal controls, it again found a significant difference in prevalence for eye irritation as well. However, Ijadunola *et al.* (2004: 254) go on to state that whilst the difference in prevalence of eye discharge and conjunctivitis between the two occupational groups were higher among production workers than that of internal controls – it was not statistically significant. Another study carried out in India reported similar findings, showing that eye irritation and itching were some of the major symptoms experienced during cleaning, grinding, and packing activities in the flour mill. Results showed that during cleaning activities, up to 44.44% of respondents stated that they experienced eye irritation and itching. This was found to be most common symptom reported for that specific activity. Interestingly, during the grinding and packing activities, results were significantly lower with only 17.78% and 8.89% respectively – suggesting that the process itself may also contribute to exposure (Ahire *et al.* 2017: 70).

2.9.5 FLOUR DUST AND ALLERGIC RHINITIS

Allergic rhinitis, alternatively referred to as hay fever, is clinically defined as the symptomatic disorder of the nose. It is brought on by exposure to allergens, resulting in an IgE – mediated inflammation of the nasal membrane. Symptoms of allergic rhinitis include rhinorrhea, nasal obstruction, nasal itching and sneezing as well as the less common sinus headaches, itching, red eyes and a runny nose (Bousquet and van Cauwenberge 2001: 5). Bousquet and van Cauwenberge (2001: 5), adds that symptoms are reversible either spontaneously or with aid of treatment. Bousquet and van Cauwenberge (2001: 3) describes allergic rhinitis as being a global health problem, reporting it as a common disease affecting as many as 10 – 25% of the population – further purporting that its prevalence is still on the rise. In South Africa, this figure is equally alarming, as a study conducted by Potter (2004: 11), reported that over the last thirty years, there has been an exponential increase in the prevalence of allergic rhinitis, affecting at least 17 and 28% of the South African population.

Previously, allergic rhinitis was divided into three categories of seasonal, perennial, and occupational based on time of exposure (Bousquet and van Cauwenberge 2001: 5). However, these categories were deemed unsatisfactory and has since been changed. The new categories are based on duration (either intermittent or persistent) and severity (mild, moderate, or severe).

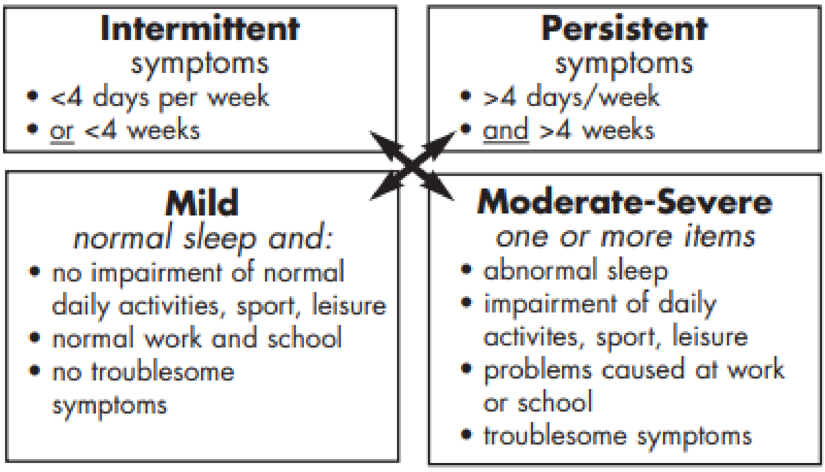

Figure 18: Diagram showing classification of allergic rhinitis (Bousquet and van Cauwenberge 2001: 5)

Flour dust is regarded as an occupational allergen and is described as capable of causing persistent rhinitis (Carton *et al.* 2018: 869; Ahire *et al.* 2017: 70; Potter 2004: 12; Meo 2004: 187). However, some studies have drawn a strong correlation between flour dust and the prevalence of rhinitis in conjunction with asthma. The overwhelming evidence showing the link between allergic rhinitis and asthma led to the formation of an internationally recognized document titled the Allergic Rhinitis and its Impact on Asthma (ARIA), which is endorsed by the World Health Organization (WHO) and currently provides guidelines for diagnosis and treatment of allergic rhinitis (Potter 2004: 11). Bousquet and van Cauwenberge (2001: 7) have described allergic inflammation as not just being limited to nasal airways and goes on to list multiple co-morbidities that have been associated with rhinitis, with one such co-morbidity being asthma. The document goes on to state that epidemiological studies have consistently shown that asthma and rhinitis often co-exist within the same patients, stating that:

- Most patients with allergic and non-allergic asthma have rhinitis.
- Many patients with rhinitis have asthma.
- Allergic rhinitis is associated with and constitutes a risk factor for asthma.
- Many patients with allergic rhinitis have increased non-specific bronchial hyperreactivity.

The above findings have been supported by studies conducted by Mohammadien *et al.* (2013: 2); Hosseinabadi *et al.* (2013: 139), as well as Stobnicka and Górny (2015: 243), in which the researchers found that rhinitis often precedes asthma. This is further supported by Hosseinabadi *et al.* (2013: 139), in which it is reported that asthma caused by flour dust is described with a latent period between first exposure and development of symptoms, which varies from a few weeks to 35 years. However, on average, intense symptoms of allergic rhinitis occur after eight to nine years and asthma after 13 to 16 years of exposure.

2.10 HYGIENIC STANDARDS FOR FLOUR DUST

For almost six decades, numerous organizations have proposed OELs for airborne contaminants, but the most recognized and widely accepted are the exposure limits issued by the ACGIH and are known as TLVs (Paustenbach, Cowan and Sahmel 2011: 865). According to Galer, Leung, Sussman and Trzosi (1992: 292), in 1942, the ACGIH developed the TLVs, as a toolset to assist industrial hygienists and occupational health professionals in controlling workers' exposure to hazardous substances in the workplace – it was originally developed to guide industrial hygienists in exercising their own judgement when applying exposure limits (Paustenbach, Cowan and Sahmel 1992: 871). TLVs are airborne concentrations of substances which represent conditions under which it is believed that nearly all workers may be repeatedly exposed to daily without adverse effects (American Conference of Governmental Industrial Hygienists 1998: 477). The ACGIH purports that even with TLVs in place, it is still possible for a small percentage of individuals to experience discomfort from substances that may measure at or below the threshold limit. Additionally, some individuals may also experience hyper-susceptibility due to genetics, age, medication, and previous exposures (American Conference of Governmental Industrial Hygienists 1998: 477).

TLVs have existed for almost 76 years and are reviewed and updated on an annual basis by a committee of health professionals whose decisions are based on the best available data from industrial experience, experimental human and animal studies and, when possible, a combination of all three (Smith and Perfetti 2018: 2; Paustenbach, Cowan and Sahmel 1992: 870). While the ACGIH TLVs are globally recognized and highly influential – it maintains that its purpose is to provide guidelines and recommendations towards the control of potential workplace health hazards – as such, it cannot be legally enforced (Paustenbach, Cowan and Sahmel 1992: 871). However, Galer *et al.* (1992: 292) states that after publication of the TLVs, governmental agencies such as The United States of America, Occupational Safety and Health Administration (OSHA) and the Safety and Health Branch of Labour Canada adopted the approach of regulating the exposure to toxic workplace substances. Paustenbach, Cowan and Sahmel (1992: 871) are pf the same mind pointing out that when the OSHA was first formed, Congress permitted OSHA, for a period of two years, to adopt national consensus standards or established federal standards. Now, the approach of regulating exposure to hazardous workplace substances has extended across the globe, and while the names of the OELs differ across the regions, the function remains unequivocally the same.

Table 3: Table showing global occupational hygiene standards.

Country	Expansion	Abbreviation	Definition
The United States of America	Permissible Exposure Limits	(OSHA) PEL	TWA concentrations must not be exceeded during any 8 h work shift of a 40-hour work week (National Institute for Occupational Safety and Health 1977: xii)
Australia	Workplace Exposure Standard	WES	Airborne concentrations of a chemical that are not expected to cause adverse health effects on the worker exposed.
Britain	Workplace Exposure Limits	WEL	Concentrations of hazardous substances in the air, averaged over a specified period, known as Time-Weighted Average (TWA). Two time periods are generally used: Long Term: 8 h Short Term: 15 min (Health and Safety Executive 2013: 6)
South Africa	Occupational Exposure Limit	OEL	Concentration of a substance in the workplace that a worker may be exposed to without causing adverse effects (Viljoen 2014: 2)

2.10.1 TYPES OF THRESHOLD LIMITS

According to the American Conference of Governmental Industrial Hygienists (1998: 477), there are three categories of TLVs:

a. Threshold Limit Value – Time-Weighted Average (TLV-TWA): The time-weighted average concentration for a typical eight hour working day and a 40-hour workweek, in which it is believed that nearly all workers may be repeatedly exposed, day after day, without adverse effects.

b. Threshold Limit Value-Short-Term Exposure Limit (TLV-STEL): a 15 min TWA exposure which should not be exceeded at any time during the workday even if the eight-hour TWA ute falls within the TLV-TWA. The ACGIH exclaims that exposure above the TLV-TWA up to the STEL should not be longer than 15 minutes and should not occur more than four times a day.

c. Threshold Limit Value – Ceiling (TLV-C): The concentration that should not be exceeded during any point of the working exposure.

2.10.2 INTERNATIONAL OCCUPATIONAL EXPOSURE LIMITS

Internationally, there are various exposure limits for flour dust, ranging from 0.2 mg/m^3 to 10 mg/m^3. It is important to note that while some countries do not differentiate between grain dust and flour dust – studies have argued that these are two separate dusts (Stobnicka and Górny 2015: 245; Nielson, Larsen, Hansen and Poulsen 2012: 893) and therefore require a specific exposure limit for each (Nielson *et al.* 2012: 896). Based on available research, countries that do identify these dusts as being separate appear to have slightly different exposure limits, commonly showing that the flour dust OEL is lower than the grain dust OEL. For instance, in Canada, grain dust and flour dust each have their own OEL of 4 mg/m^3 and 3 mg/m^3 respectively; whereas in the Netherlands, the OEL for inhalable grain dust is 1.5 mg/m^3 while the OEL for inhalable wheat flour dust is 0.2 mg/m^3. In Great Britain, even though the exposure limits for grain dust and flour dust are both set at 10 mg/m^3 each, they are still viewed as separate dusts. In the United States of America, grain dust is measured in accordance with the ACGIH TLV of 4mg/m^3 for total dust (Nielson *et al.* 2012: 893), but the ACGIH TLV of 0.5 mg/m^3 for flour dust. Countries that only have a flour dust OEL include Germany and Denmark with 4 mg/m^3 and 3 mg/m^3 respectively while in Sweden the recommended value for flour dust is 3 mg/m^3. The Maximum Exposure Limit (MEL) in Greece is 10 mg/m^3 and 5 mg/ ^{3} for inspirable and respirable fractions respectively.

Research has shown that unlike Great Britain, smaller European countries have opted for lower OELs for flour dust, with many falling below the 5 mg/m^3 mark. In 2002, a study published by Brisman, Järvholm and Lillienberg (2002: 335) summarized inhalable dust concentrations at which the risk of developing rhinitis and asthma was prominent. The study found that the risk of developing asthma appeared to increase at inhalable dust concentrations ≥ 3 mg/m^3, whereas the risk of rhinitis increased at concentrations ≤ 1mg/m^3. These results were supported by a United Kingdom paper; in which it was reported that work-related symptoms occurred at dust concentrations of 4.4mg/m^3 – which is substantially lower than the current exposure limit of 10 mg/m^3 (Cullinan *et al.* 2001: 102). In more recent articles published by Nielson *et al.* (2012: 891) and Martinelli *et al.* (2020: 2), it was inferred that sensitization occurred at dust levels as low as 0.5 mg/m^3, with a significant risk introduced at ≥ 1 mg/m^3. In light of the studies conducted by Brisman, Järvholm and Lillienberg (2002: 335) and Cullinan *et al.* (2001: 102) together with a host of historical and recent research, the European Scientific Committee on Occupational Exposure Limits (SCOEL) began questioning the efficacy of current exposure limits – and in 2008, went on the publish a report announcing that the available literature did not provide reliable threshold limits that offered protection against the detrimental health effects caused by flour dust. The report brought to the forefront two key points, namely:

1. Acknowledgement that SCOEL could not recommend health based OELs for sensitizers because no such threshold limit could be identified and
2. SCOEL recognized the findings revealed by Brisman, Järvholm and Lillienberg (2002: 335) by suggesting that an exposure limit of 1mg/m^3 be set. This limit was justified by arguing that a significant number of workers would be safeguarded from the onset of the disease and that the expected symptoms would be mild. This statement was later dismissed as the report went on to state that concentrations <1 mg/m^3 may trigger symptoms in already sensitized workers.

The SCOEL concluded the report by declaring that an OEL capable of protecting all employees could not be identified, therefore it was recommended that good work practices and health surveillance systems be entrenched in bakery and mill settings. However, even with the inability of stating a specific OEL for flour dust, the report gained recognition and went on to influence an amendment to the Netherlands OEL. In 2017, the Health Council of the Netherlands proposed a new flour dust OEL of 0.2 mg/m^3 – a 0.08 mg/m^3 increase from the previous 0.12 mg/m^3. The Health Council of the Netherlands cited the 2008 SCOEL report as a driving factor behind the change. Following the Netherlands, Canada was next to adjust the flour dust OEL, increasing it from the 0.5 mg/m^3 to 3 mg/m3 (Canada, Department of the Environment 2017: 2442) – this change was not influenced by the SCOEL but rather by a 2001 study conducted by the Labour program, concluding that the limit of 0.5 mg/m^3 was impractical as it would require employees to always wear respiratory protection during their work shifts. The gazette justified the amendment by asserting that if certain engineering controls were implemented, worker exposure to flour dust in Canadian flour mills could be reduced to 3 mg/m^3.

2.10.3 NATIONAL OCCUPATIONAL EXPOSURE LIMITS

Countries around the globe have attempted to restrict flour dust exposure by enforcing the appropriate legal compliance standards. However, in South Africa, research points out that even with this growing body of literature, there appears to be a disparity in understanding the difference between flour dust and grain dust and the distinct adverse health effects induced by each.

The Occupational Health and Safety Act (No. 85 of 1993) is the main legislation that governs workplace health and safety in South Africa. Notably, this Act does not stipulate an OEL for flour dust, but it does contain an OEL of 10 mg/m^3 for grain dust. According to the OHS Act, HCS regulations, grain dust is described as the dust generated via harvesting, drying, handling, storage or processing of barley, wheat, oats, maize and rye, including contaminants. Although this is the widely accepted definition in South Africa, Stobnicka and Górny (2015: 241) have argued that not only are flour dust and grain dust two separate dusts due their dissimilar physical and biological characteristics but also due to their mechanisms and areas of generation. This argument is supported by studies conducted by Demeke and Haile (2008: 7); Becklake (2007: 423) and Chan-Yeung *et al.* (1991: 477).

The lack of a specific OEL for flour dust has been raised previously via a South African study by Baatjies *et al.* (2007: 213). The study, which was based at bakeries of various sizes of a large supermarket chain in the Western Cape, reported that there are currently no specific exposure limits for wheat in South Africa; therefore, the widely accepted 'general dust' or 'grain dust' standard of 10 mg/m^3 was applied instead (Baatjies *et al.* 2007: 213). Baatjies *et al.* (2007:213) stated that when compared to the South African legal compliance limits, the obtained inhalable flour dust samples were well below the OEL of 10 mg/m^3, but when compared to the ACGIH TLV of 0.5 mg/m^3, results were up to 3-4 times higher. Additionally, the study compared the same inhalable flour dust samples obtained to the international limit of 0.2mg/m^3 and discovered that approximately 95% of the flour dust sample concentrations exceeded this limit, suggesting that bakery workers were inadequately protected against allergic health risks when the current legal standards for flour dust was applied (Baatjies *et al.* 2007: 213). Another study conducted by Viljoen (2014: 63) declared that when compared to developed countries, South Africa has less stringent OELs highlighting again that workers were inadequately protected against workplace exposure to hazardous substances.

The evidence presented by both Baatjies *et al.* (2007: 213) and Viljoen (2014: 63) indicated that not only did South Africa fail to differentiate between flour dust and grain/general dust but that the current hygienic standards were significantly higher in comparison to international limits, arguing that current South African legal exposure standards were in dire need of revision (Baatjies *et al.* 2007: 213).

2.11 CONCLUSION

The literature review found remarkable evidence linking adverse health effects to flour dust exposure particularly regarding the respiratory system. The studies and research reviewed above show that although much of the adverse effects were identified years ago – it is still prevalent today, indicating that few strides have been made towards improving employee working conditions. The flour milling process and related activities largely contribute to airborne flour dust therefore attention is required to adapt the process whilst keeping employee respiratory health and safety at the forefront.

CHAPTER 3

METHODOLOGY

3.1 RESEARCH DESIGN

This was a descriptive cross-sectional study conducted at one point in time. The study sourced quantitative data. This study sought to determine the occupational exposure to flour dust and the associated respiratory outcomes.

3.2 SETTING FOR THE STUDY

The study site was a flour mill located within the Phoenix Industrial Park, Durban, KwaZulu-Natal. The company produced flour on a large scale with a product range comprising of white flour, cake flour, brown bread flour, whole-wheat meal, semolina, pollard, Khune and an extensive range of specialized and premixed flour products. The study site followed general milling processes, namely wheat purchasing, wheat receiving and storage, main production line activities, packaging, treatment, storage, and despatch.

Figure 19: Location of Phoenix Industrial Park (Google Maps 2017)

3.3 STUDY POPULATION

The organisation consisted of approximately 95 employees of which 70 are permanently employed and the remaining 25 are temporarily employed. The employees formed part of different departments namely: administration, mill, maintenance, packing, laboratory, bakery, warehouse, and despatch. To keep up with demand, the mill operated on a 24-hour basis, seven days a week, therefore it was necessary to have day shift and night shift teams. Day shift employees worked 8-hour shifts whereas night shift employees worked 12-hour shifts five or six days a week.

3.4 SAMPLING POPULATION

A sample size of 56 employees was selected from a total population size of 65. A statistician's report (Appendix A1) and statistician's letter (Appendix A2) are attached to confirm the minimum sample size. During the course of the study, five employees were made permanent after working for one year, which changed the sample population to 70.

Inclusion Criteria:

- Permanent employees 18 years and older
- Participants employed in this company for at least one year
- Employees who agreed to participate in the study and signed the letter of information and consent
- Both males and females were selected

Exclusion criteria:

- Visitors, casual labourers, sub-contractors, and labour-broker staff
- Employees who were employed for less than one year
- Employees who already participated in the pilot study

3.5 SAMPLING STRATEGY

A total of 63 employees were selected from a total population size of 70. The simple random sampling strategy was used. This strategy was chosen as it allowed each member from the study population an equal opportunity of being included in the sample size (Welman, Kruger and Mitchell 2005: 59). The margin of error was set at 5% with a confidence interval set at 95%.

3.6 RECRUITMENT STRATEGY

The researcher created a Microsoft Excel spreadsheet. The spreadsheet was divided into two columns. The researcher assigned a number to each member of the study population, meaning that one column had a number, and the next attached column had an employee's name. This was done for the entire study population. Afterwards, the researcher utilized the Data Analysis 'Add-in' function on Microsoft Excel. This function made use of the sample function which consisted of a random number generator. which was used to generate 56 numbers at random from the 70 numbers. The 56 numbers which make up the sample size, indicated the name of the selected employee. Once the sample size was obtained, the researcher approached the selected employees by requesting them to participate in the study. Employees were informed on what the study entails. Employees were also made aware that participation in the study was completely voluntary and refusal to participate would not result in any consequence or prejudice.

3.7 DATA COLLECTION

3.7.1 DATA COLLECTION INSTRUMENTS

Data was collected using three data collection instruments namely, questionnaires, spirometry test results and occupational hygiene reports.

3.7.1.1 QUESTIONNAIRE:

Data was collected in the form of self-administered questionnaires. Prior to administering the questionnaire, prospective participants were required to complete the letters of information (Appendix F1 and Appendix F3) and letter of consent (Appendix F2 and Appendix F4) which provided the prospective participant with the necessary information regarding the study. The questionnaire was written in English (Appendix G1) and isiZulu (Appendix G2) as the preferred language by the participants. The questionnaire was divided into three sections. Section A focused on demographic and personal data as factors such as age and race affected spirometry test results. Section B looked at work conditions in the flour mill as factors such as duration of employment, department and PPE influenced spirometry results and linked directly to retrospective environmental reports. Section C assessed medical history seeking to eliminate common cold and allergies and identify a link between flour dust and adverse health effects.

Validity and Reliability: Validity relates to the degree of which a concept is accurately measured (Heale and Twycross 2015: 66). Reliability refers to the consistency of a measure. To ensure that validity and reliability of the data collection tool was achieved, a pilot study among 5 employees from the already established population size was conducted. These employees were not included in the final study. During the pilot study, participants were encouraged to write notes on the questionnaire and to ask for clarity to remove confusion about any questions. The questions were validated and checked for level of understanding thereafter.

3.7.1.2 SPIROMETRY TESTS:

Spirometry, also referred to as the basic lung function test, is the measurement of air volumes and airflow rates of the lung (Koegelenberg *et al.* 2013: 52). A spirometry test assesses the parameters of Lung Function and can detect abnormalities and respiratory-related issues. Interpretation of a spirometry test requires understanding of various components such as the lung function parameters which dictate the criteria for interpreting the spirometry results, the accelerated annual decline in FEV_1 and FVC and the grading system used. These components are discussed below:

3.7.1.2.1 Parameters:

The test used three important indicators to measure lung function, namely:

- **Forced Vital Capacity (FVC):** Measures lung size (in Liters) and indicates the amount of air that can be exhaled from the lungs following deep inhalation.
- **Forced Expiratory Volume – One Second (FEV_1):** Measures the amount of air that can be exhaled in one second following deep inhalation.
- **FEV1/ FVC Ratio:** Represents the percent of the lung size that can be exhaled in one second (United Steelworkers 2013).

Afterwards, an individual's results are interpreted and assessed for abnormalities against predicted results obtained from a normal reference population (Van Schalkwyk *et. al* 2004: 583). The results are further displayed in the form of a spirogram.

Table 4: Guide for Grading Pulmonary Impairment According to Percent of Predicted Spirometry (South Africa, Department of Minerals and Energy 2003: 9)

Parameter	Normal	Mildly Impaired	Moderately Impaired	Severely Impaired
% pred FVC	≥80	60 – 79	51-59	≤50
% pred FEV_1	≥80	60 – 79	41-59	≤40
FEV_1/FVC%	≥75	60-74	41-59	≤40

3.7.1.2.2 Criteria for interpreting Spirometry results

- Normal or acceptable results:
    - A spirometric test is deemed normal or acceptable if:

      The Best FEV_1/ Best FVC ≥ 75% and,

        - Best FVC ≥ 80% predicted value
        - < 200ml averaged annual decline in FEV_1 or FVC or
        - < 10% decline in FEV_1 or FVC from the initial/ baseline spirometric test (South Africa, Department of Minerals and Energy 2003: 7).
- Abnormal Spirometric results:
    - Obstructive abnormality:

      When the FEV_1/FVC ratio is below the normal range, an airflow limitation through the airways is indicated. An obstructive abnormality is termed reversible if there is a 15% or greater increase in the FEV_1 following administration of a bronchodilator such as salbutamol. Severity of the abnormality is based on the Best FEV_1 as percentage predicted (South Africa, Department of Minerals and Energy 2003: 7)

    - Restrictive abnormality:

      This is ascertained by a reduction of FVC without a reduction in the FEV_1/FVC ratio. This may indicate lung tissue or chest wall damage. Severity of the abnormality is based on the Best FVC value as a percentage predicted (South Africa, Department of Minerals and Energy 2003: 7).

    - Mixed obstructive and restrictive abnormality:

      This is obtained when there is a reduced FEV_1/FVC ratio as well as a reduced FVC. This may highlight issues in the airways and lung tissue. Severity of abnormality is based upon the Best FEV_1 or FVC as a percentage predicted, thereafter, the worst of the two results will be used to determine the grading (South Africa, Department of Minerals and Energy 2003: 7).

- **Accelerated Annual Decline in FEV_1 or FVC:**

This is interpreted when the decline in an individual's FEV_1 or FVC value exceeds an annual average of 200ml (0.2L) between tests. The normal rate of annual decline in these parameters is approximately 40ml per year (South Africa, Department of Minerals and Energy 2003: 8).

- **Grading the severity of spirometric abnormalities**:

Abnormalities are categorized as mild, moderate, or severe depending on the index (FEV_1, FVC, FEV_1/FVC), each of which shows the most impairment of lung function. The grading system is better explained below:

  - Mild Impairment: Able to meet physical demands of most jobs
  - Moderate Impairment: Diminished ability to meet physical demands of many jobs
  - Severe Impairment: Unable to meet physical demands of most jobs (South Africa, Department of Minerals and Energy 2003: 8)

Spirometry tests form part of the company's annual medical surveillance and is conducted by an Occupational Nurse in accordance with a report released by the South African Department of Minerals and Energy (2003: 4). Prior to conducting the test, the Schiller 260 spirometer was calibrated. This was done daily and in the same room to maintain consistency. This was a modern spirometer; therefore, it was computer-driven and worked in conjunction with a computer software. To calibrate the spirometer, a CRC 3 Liter Volume Calibration Syringe and a wireless weather station was used. The calibration syringe was first connected to the computer, afterwards, the spirometer was connected to the calibration syringe. Once all components were connected to each other and the computer, a pop-up tab appeared on the computer screen requesting for data such as the temperature, relative ambient pressure, and the relative humidity. These measurements were obtained via the wireless weather station. Measurements were inserted into the available fields in the pop-up tab. Thereafter, the Occupational Nurse was required to mimic exhalation by pumping air into the spirometer mechanically using the calibration syringe. According to the pop-up tab on the screen, this action must be completed until the reference value of nine liters is achieved. To ensure reliability, the calibration test was repeated.

To perform the spirometry test, employees were requested to be seated to prevent injury in case of light-headedness and fainting. Once the employee was comfortable, the Occupational Nurse explained the procedure to execute a proper, satisfactory lung function test. The employee was then requested to inhale deeply before exhaling into the spirometer. Employees were encouraged to exhale continuously for at least six seconds. The test was repeated three times to allow for the employee to learn the technique and to choose the best results for assessment. Once the test was completed, a spirogram was printed and analysis of the results ensued to assess the parameters of Lung Function and to detect abnormalities and respiratory-related issues.

3.7.1.3 OCCUPATIONAL HYGIENE REPORTS

To ensure safe work environments in accordance with the Occupational Health and Safety Act (No. 85 of 1993), it is imperative that workplaces conduct environmental monitoring. This is carried out by Registered Approved Inspection Authority (AIA) and is conducted at intervals not exceeding 24 months. The results obtained from the various types of environmental monitoring are then compared to national and international legislation to determine if the work environment is without excessive hazard or risk. Dust sampling is an example of environmental monitoring and is generally conducted in two ways, area sampling or personal sampling.

- **Area sampling**: Measures background concentrations, identifies sources of exposure and tests effectiveness of controls (Plog and Quinlan 2002: 523).
- **Personal Sampling**: Personal sampling relies on portable, battery-operated sampling pumps that are attached within an employees' breathing zone (30cm region between one's head and shoulders) usually during an 8-hour shift or a 15-minute period (Plog and Quinlan 2002: 523)

In South Africa, flour dust is viewed in the same light as grain dust, therefore, it is measured and assessed as grain dust. According to the National Institute for Occupational Safety and Health (2007: 154), the measurement method used for grain dust is the NIOSH 0500 (Total dust) method. Briefly, the NIOSH 0500 uses a 37-mm, closed-face cassette with the gravimetric technique to analyze airborne particulate matter (National Institute for Occupational Safety and Health 1977: 1). Results obtained from the air sampling were then compared to the grain dust Occupational Exposure Limits (OELs) as outlined by the South African Department of Labour (1993: 191).

Table 5: OEL for Grain dust

Substance	Time-Weighted Average Occupational Exposure Limit- Control Limit (TWA OEL-CL)
Grain dust	Before 2021 amendment = 10mg/m^3
	After 2021 amendment = 8mg/m^3

3.8 PILOT STUDY

A pilot study among five employees from the already established sample size was conducted. These employees were not included in the final study. Participants included in the pilot study were required to read the letter of information and sign the letter of consent. The letter of information and letter of consent was written in English (Appendix D1) and (Appendix D2) respectively. The letter of information and letter of consent was also made available in isiZulu (Appendix D3) and (Appendix D4) respectively.

3.9 RESEARCH PROCEDURE

The researcher first contacted a statistician to calculate the appropriate sample size for the study according to the population size and study design. The statistician provided the researcher with a statistician's report (Appendix A1) and a statistician's letter (Appendix A2) which confirmed the minimum sample size. The researcher aimed to collect data using three data collection instruments, namely questionnaires, spirometry tests and occupational hygiene reports. The questionnaire was adapted from a recognised occupational medical practitioner from whom formal permission was sought (Appendix B1). Permission from the occupational medical practitioner was then formally granted (Appendix B2). Prior to the main study, a pilot study was conducted among five employees from the already established sample size. Thereafter, ethical approval was obtained from the Institutional Research Ethics Committee (Appendix C).

Prior to conducting the pilot study, prospective pilot study participants were required to read the letter of information and letter of consent. The pilot study letters of information and letter of consent was available in English (Appendix D1) and (Appendix D2) respectively. The pilot study letter of information and letter of consent was also made available in isiZulu (Appendix D3) and (Appendix D4) respectively. Gatekeeper's permission was sought from the Managing Director of the study site (Appendix E). Once permission was obtained via the Gatekeeper's letter, the study commenced. The letter of information and letter of consent for the main study was written in English (Appendix F1) and (Appendix F2) respectively. The letter of information and letter of consent for the main study was also made available in isiZulu (Appendix F3) and (Appendix F4) respectively.

Once prospective participants read and signed the letter of information and letter of consent, the researcher handed the participant a questionnaire, either English (Appendix G1) or isiZulu (Appendix G2), depending on the participants' preference. Questionnaires were administered at the study site by the researcher, during normal working hours. The researcher requested the use of the board room as a space in which participants could complete the relevant letters and answer the questionnaire. Permission was granted from supervisors and top management to allow time for participants to answer the questionnaire. The participants required at least 45 minutes to complete the questionnaire. The researcher requested that supervisors allowed participants to leave the work area one at a time, so that normal work functions would not be interrupted. Each participant was provided with one questionnaire. After the participants completed the questionnaire, it was handed to the researcher for collection and storage. The participant was then permitted to return to work.

Spirometry tests: The researcher arranged with the Safety, Health, Environment and Quality (SHEQ) Manager to visit the study site. Retrospective spirometry test results were assessed. These were obtained from the company clinic with assistance of the occupational nurse and the SHEQ Manager for only those employees who had provided consent to participate in the study. The researcher compiled a list of employees who had agreed to participate in the study and handed this list to the SHEQ Manager who was the keeper of these documents. The SHEQ Manager provided the researcher with only the requested employees' spirometry tests. The researcher then scanned each employees' spirometry test results for analysis. The scanned files were stored on a password protected memory stick and the memory stick was stored in a locked cupboard. The original spirometry test results were returned to the SHEQ Manager. The researcher aimed to trend individual's lung function on a yearly basis based on the % pred FVC, % pred FEV_1 and FEV_1/FVC% results obtained from the spirometry tests. These results were captured in a Microsoft Excel spreadsheet. Permission to review spirometry test results was sought from the relevant employee in the form of a Letter of information and Letter of consent which details the research procedures and requirements. The SHEQ manager ensured that they maintained confidentiality of the information accessed by signing a Letter of Agreement (Appendix H)

Occupational Hygiene reports: The researcher reviewed retrospective occupational hygiene reports. These were obtained from the company's SHEQ Manager. The researcher made an appointment with the SHEQ Manager to visit the study site to view the *Occupational Hygiene reports*. The researcher perused the reports and extracted the results obtained from the air sampling. The extracted results were captured on a Microsoft Excel spreadsheet. Afterwards, each result was compared to the grain dust TWA OEL-CL value to determine whether employee's personal exposure to dust was within the acceptable limit.

3.10 DATA ANALYSIS

Information was initially captured using Microsoft Excel and later analyzed using the latest SPSS Statistics 27.0 statistical package. The responses from the questionnaire were sorted according to the questions and cleaned to remove irrelevant data and incomplete questionnaires. The data was then identified as either univariate, bivariate or multivariate. Univariate data was categorical data will be represented in the form of frequency. Continuous data was analyzed using summary statistics of mean, median, standard deviation, range and a confidence interval. Bivariate data was categorical data analyzed using the Chi Square tests to show statistical significance. Continuous variables were analyzed using students T-tests, Analysis of Variance (ANOVA) tests and Pearson Correlation tests where necessary. Multivariate data referred to categorical data analyzed using logistic regressions whereas continuous data will be analyzed using linear regression. Pie graphs, bar graphs, tables and other visual tools were used as appropriate.

3.11 ETHICAL CONSIDERATIONS

A letter of permission from the Occupational Medical Practitioner to amend medical questionnaires was sought. The research proposal was submitted to the Durban University of Technology's Institutional Research Ethics Committee to be reviewed and approved and be issued with an ethical clearance number (IREC 150/ 20). Gatekeeper permissions was sought from the Managing Director of the study site. Prior to participating in the study, all prospective participants were provided with a letter of information and a letter of consent. All data will be kept under lock and key for five years in a cupboard accessible only to the researcher or supervisor. Thereafter, it will be disposed of by means of shredding. All electronic copies will be deleted. The name of the study site was not mentioned during any point of the research. All employees involved in the study remain anonymous and the information received was handled in a strictly confidential manner. The SHEQ manager that provided access to the relevant employee information-maintained confidentiality of participants by signing a letter of agreement.

Deception, the act of misleading or withholding the true nature of a situation, was prevented by ensuring that all study participants were made aware of the study and the collection methods.

3.12 CONCLUSION

This study attempted to determine the respiratory health of employees in a flour mill. This study analyzed retrospective spirometry data from the medical records of employees at the flour mill; identified factors contributing to increased occupational exposure to flour dust and determined the relationship between occupational exposure to flour dust and the associated respiratory outcomes using retrospective spirometry data and occupational hygiene reports. To achieve the above, the methods outlined in this chapter was adhered to.

CHAPTER 4

RESULTS

4.1 INTRODUCTION

This chapter presented the findings obtained from the questionnaire, retrospective lung function tests and previous environmental monitoring reports. The questionnaire was the primary tool used to collect data and was distributed amongst 63 respondents. The data collected from the responses were analysed using SPSS version 27.0 and presented using relevant graphs and tables.

4.2 SOCIAL DEMOGRAPHIC CHARACTERISTICS

4.2.1 AGE:

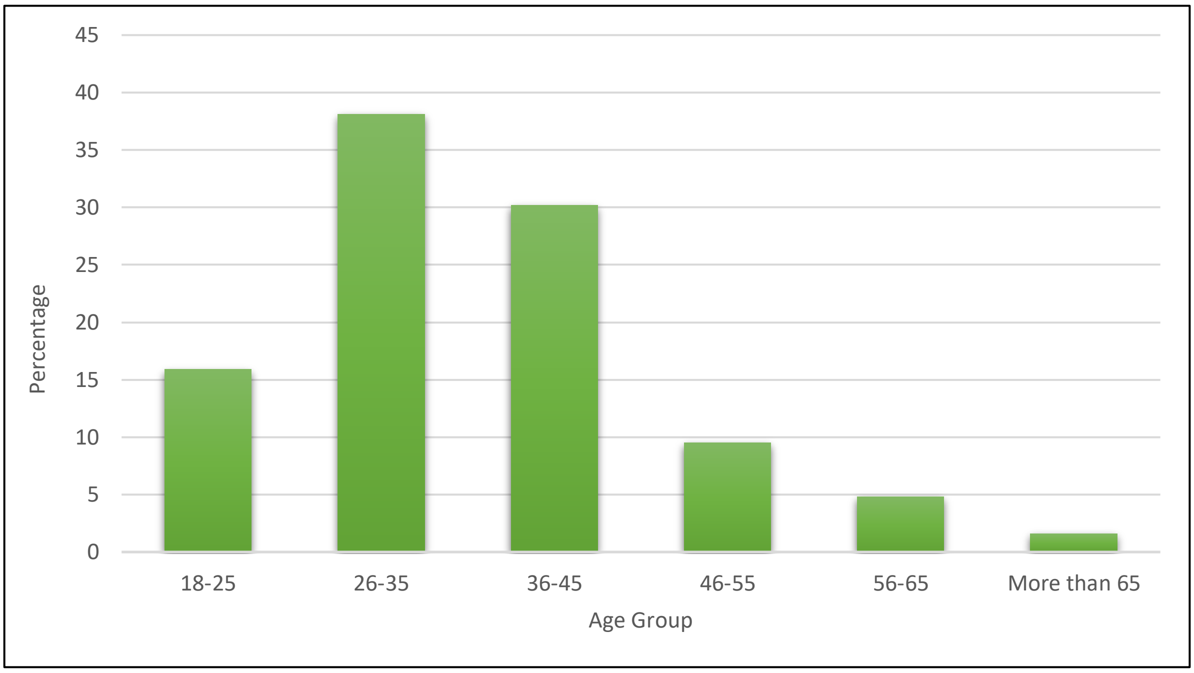

Figure 20: Percentage of respondents per age group

Figure 20 indicates that 24 (38.1%) respondents were within 26-25 years, 19 (30.2%) were within 36-45 years while one (1.6%) respondent was more than 65 years. The analysis indicated that up to 43 (68.3%) respondents were within 26-45 years old.

4.2.2 RACE:

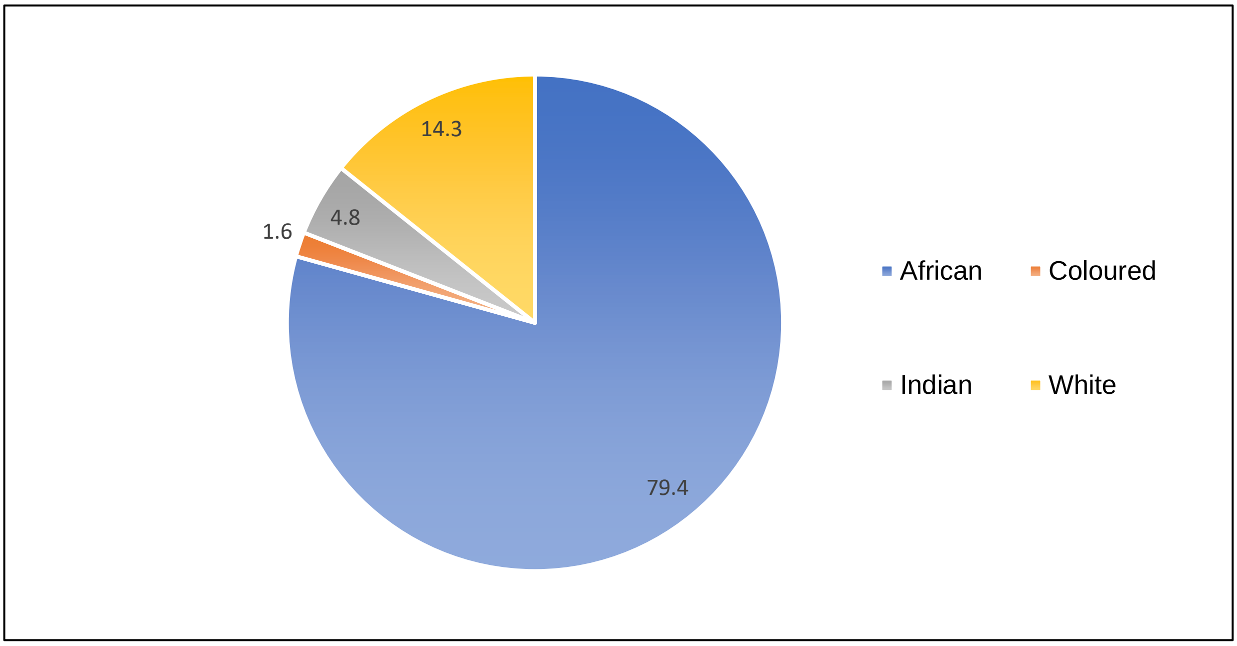

Figure 21: Percentage of respondents per race group

Up to 50 (79.4%) respondents were African, nine (14.3%) were White, three (4.8%) Indian, and only one (1.6%) was Coloured.

4.2.3 GENDER:

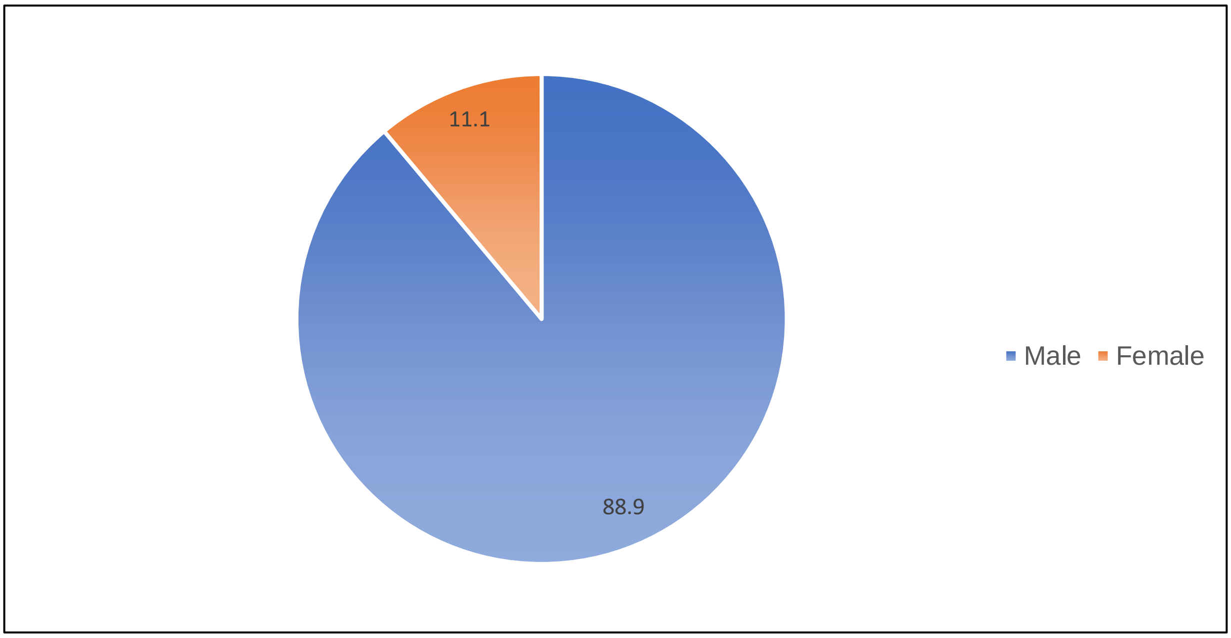

Figure 22: Percentage of respondents per gender

There was 56 (88.9%) males and seven (11.1%) females.

4.2.4 LEVEL OF EDUCATION:

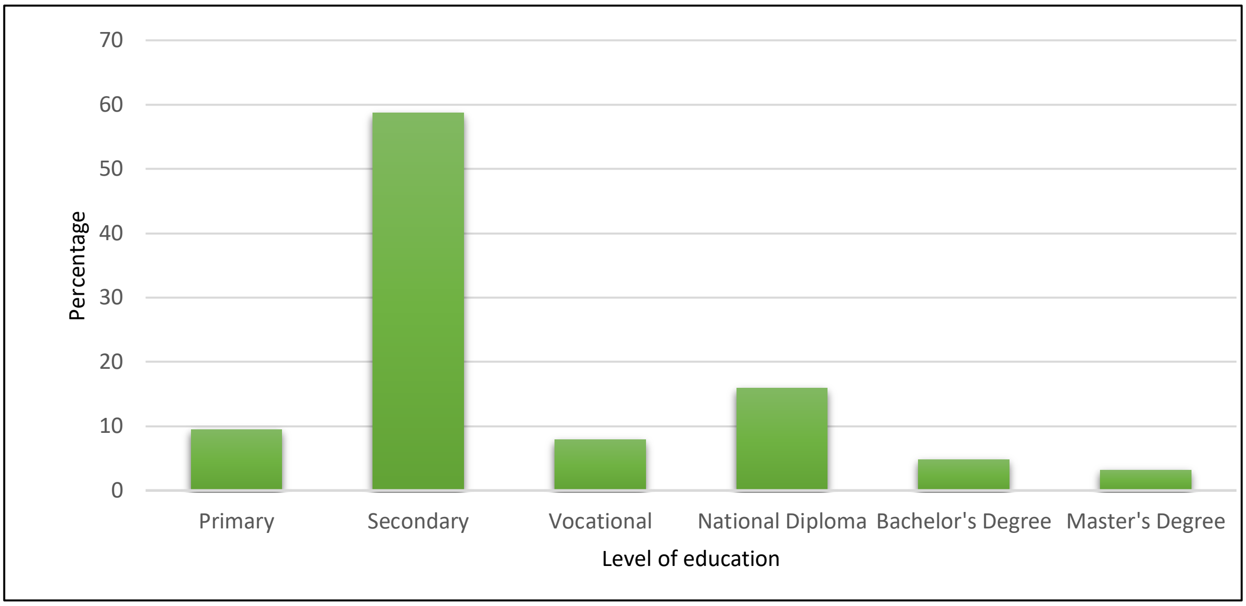

Figure 23: Respondent’s level of education in percentage

Up to 37 (58.7%) respondents possessed Secondary school education (Grade 12 National Senior Certificate), ten (15.9%) were qualified with a National Diploma, 9.5% Primary school education, 5 (7.9%) possessed Vocational training, three (4.8%) held a Bachelors’ degree while only one (2%) was qualified with a Master’s degree (Figure 23).

4.2.5 FREQUENT MODE OF TRANSPORT

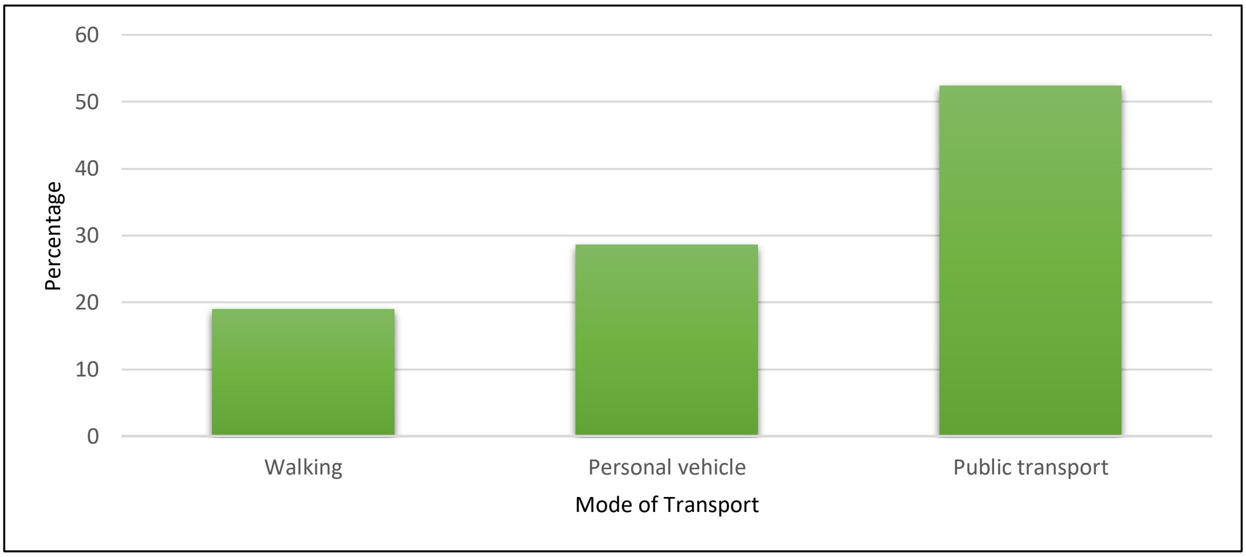

Figure 24: Respondent’s mode of transport

Public transport was the most common mode of transport used by 33 (52.4%) respondents. A personal vehicle was used by 18 (28.6%) respondents while 12 (19%) walked (Figure 24).

4.3 WORK-RELATED INFORMATION

4.3.1 LENGTH OF SERVICE FOR CURRENT EMPLOYMENT AT FLOUR MILL

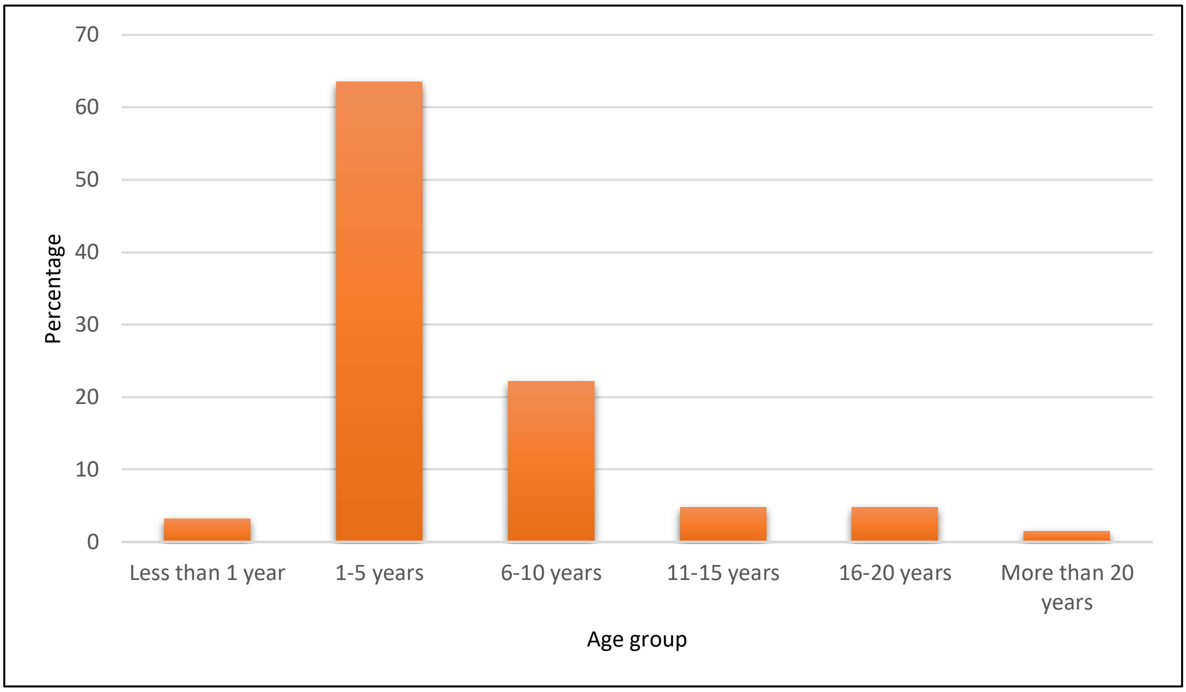

Figure 25: Number of years respondents worked in current flour mill

A sum of 40 (63.5%) respondents had worked in the flour mill between one to five years, 14 (22.2%) between 6-10 years, while only one (1%) worked for more than 20 years.

4.3.2 PREVIOUS EMPLOYMENT IN OTHER FLOUR MILLS

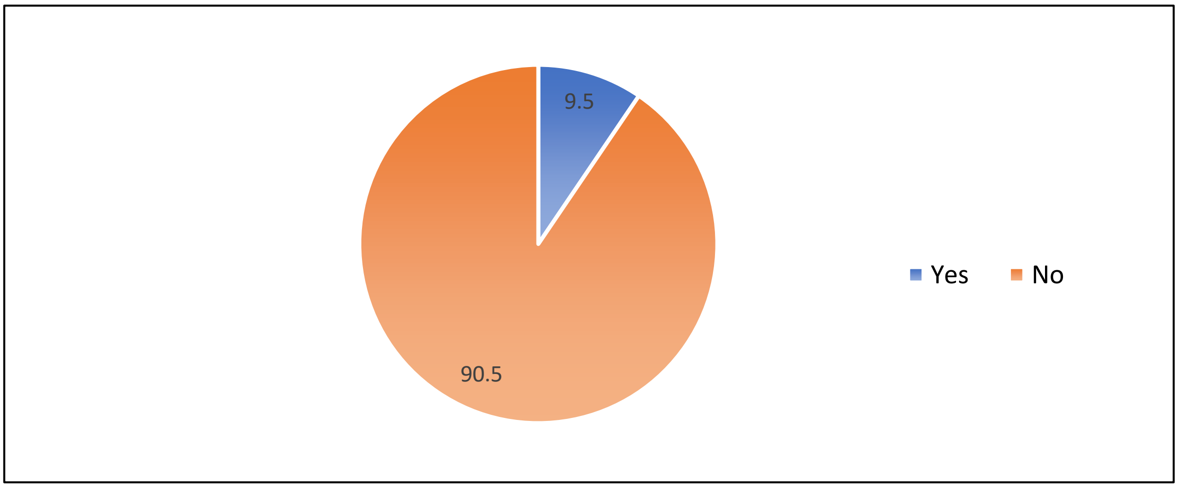

Figure 26: Pie chart showing whether respondents were previously employed in other flour mills

As shown in Figure 26, 57 (90.5%) respondents answered 'no' to the "Have you ever been employed in other flour mills previously" - On the other hand, six (9.5%) respondents indicated 'yes'

Table 6: Frequency of employment in other flour mills

		Frequency	Percent
How long have you worked in the other flour mills?	+ / - 5 years	1	16.7
	1 year	2	33.3
	14 years	1	16.7
	15yrs	1	16.7
	3 years	1	16.7
	Total	6	100.0

According to Table 6, among those (n=6) who indicated 'yes', it was uncovered that two (33.3%) were employed for a year whilst one each indicated that they had worked for three years (16.7%), 14 years 16.7%), 15 years (16.7%), and five years (16.7%), respectively in a previous flour mill.

4.3.3 AREA WORKED IN THE FLOUR MILL

Most of the respondents currently worked in the mill or packing.

4.3.4 TYPE OF SHIFT

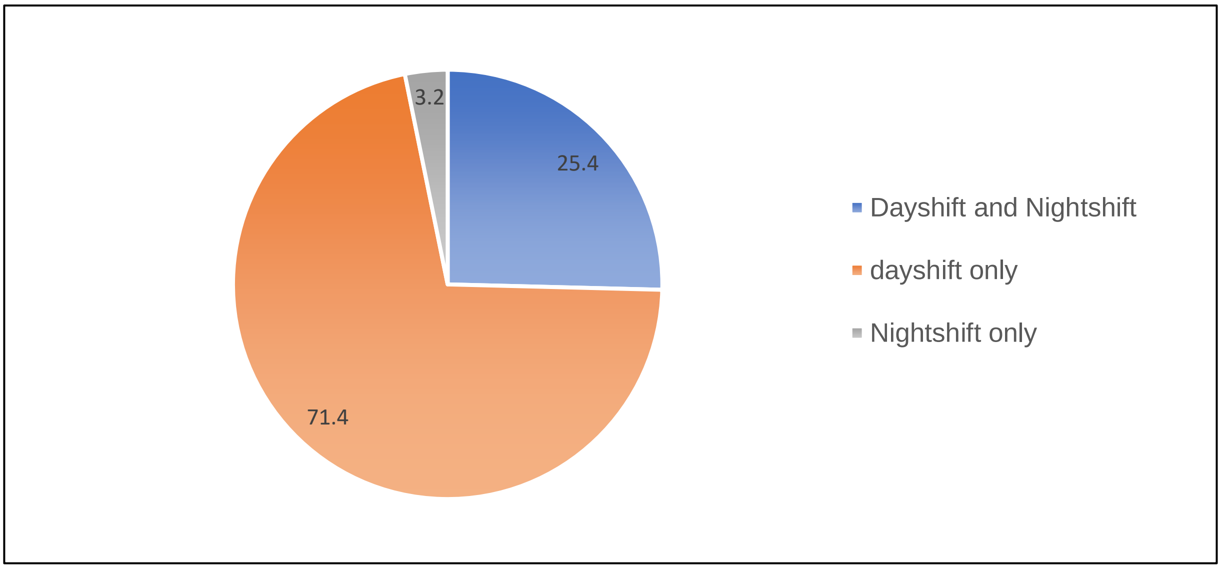

Figure 27: Type of Shifts

Majority of the respondents (71.4%) have day shifts only, 25.4% both day and night shifts, and 3.2% have night shifts.

Table 7: Breakdown of shift structure

		Frequency	Percent
Shifting process	2 days = day shift 7am - 5pm 3 days = nightshift 5pm - 7am	1	6.3
	3 days dayshift and 2 nightshift	1	6.3
	4 nightshift and 1 dayshift	1	6.3
	because they want to balance the hours that i am working.	1	6.3
	dayshift: thursday and friday nightshift: saturday - tuesday	1	6.3
	for a month i work: - 7 night shifts (5pm-7am) - 10 day shifts (7am-5pm) -12 days off a month	1	6.3
	i work 2-day shifts and 3 nightshift	1	6.3
	i work in 2-week cycles, week 1 = 3 days off, 4 night shifts week 2 = 4-day shifts, 3 days off	1	6.3
	i work on a 2-week cycle. 5 dayshift and 3-night shift	1	6.3
	it depends if they need night shift	1	6.3
	on a 2 week rotation 1 week = 2 days, 3 nights 2 week = 3 nights, 1 day	1	6.3
	permanent on day shift and night shift, i gave instruction and go home.	1	6.3
	a shift is in a two-week cycle: first 2 weeks: 1. day shift = 5 days 2. nightshift = 4 days second 2 weeks: 1. 3 days nightshift + 1-day shift 2. 5 days dayshift	1	6.3
	some customers run a night shift in their bakeries and this is the best time to see them and assist them with their issues	1	6.3
	sometimes dayshift and sometimes nightshift	1	6.3
	the first week i do the day shift and the second week i do the night shift, that's how it changes	1	6.3
	total	16	100.0

Among the respondents (n=16) who indicated both day and night shifts, Table 7 summarises the shifting process. A critical point emerging from the shifting process is that each of the respondents had a different type and period of shifts.

4.3.5 NUMBER OF WORKDAYS IN A WEEK

Table 8: Number of workdays in a week

		Frequency	Percent
Number of days in a week	4 days	1	1.6
	5 days	54	85.7
	5 days, depends if there are customers that need flour during the weekend or on public holidays	1	1.6
	5 days when I work dayshift and 4 days night shift	1	1.6
	5-6 days	2	3.2
	6 days	1	1.6
	7 days a week	1	1.6
	I work 3 or 4 days	1	1.6
	I work in a 2 week cycle Week 1 = 2 Dayshift and 3 nightshift Week 2 = 1 dayshift and 4 nightshift	1	1.6
	Total	63	100.0

Majority of the respondents worked five days a week. Nevertheless, one (1.6%) of the respondents stressed that it depended on whether there were customers that needed flour during the weekend or on public holidays. This suggested that working days may extend to weekends. More so, two (3.2%) of the respondents indicated to have worked five-six days while one (1.6%) noted seven days. Others worked three or four days while those involved in both night and day shifts had a different working day schedule

4.3.6 NUMBER OF HOURS WORKED A DAY

Table 9: Number of hours respondents worked in a day

		Frequency	Percent
How many hours a day do you work?	9 hours	23	36.5
	I don't know	2	3.2
	Less than 9 hours	1	1.6
	More than 9 hours	37	58.7
	Total	63	100.0

According to Table 9, 37 (58.7%) of the respondents indicated that they work more than nine hours day, 23 (36.5%) indicated that they work for nine hours, only one (1.6%) was noted to work less than nine hours, and two (3.2%) indicated not to know the number of hours worked in a day. Among those who indicated working more than nine hours a day, it was uncovered that some still checked on drivers at offloading points after five pm. Equally, it was noted that respondents worked longer if there was a lot of work. For those who claimed not to know the number of hours worked a day, it was uncovered that some day's respondents left work early and some days they worked late. This was also supported with another statement that if the day is busy, sometimes, they worked for more than nine hours or below nine hours. Overall, it can be gathered that working nine hours a day was the norm in the flour mill.

Figure 28: Number of hours worked in a day

4.3.7 UNDERSTANDING OF PERSONAL PROTECTIVE EQUIPMENT

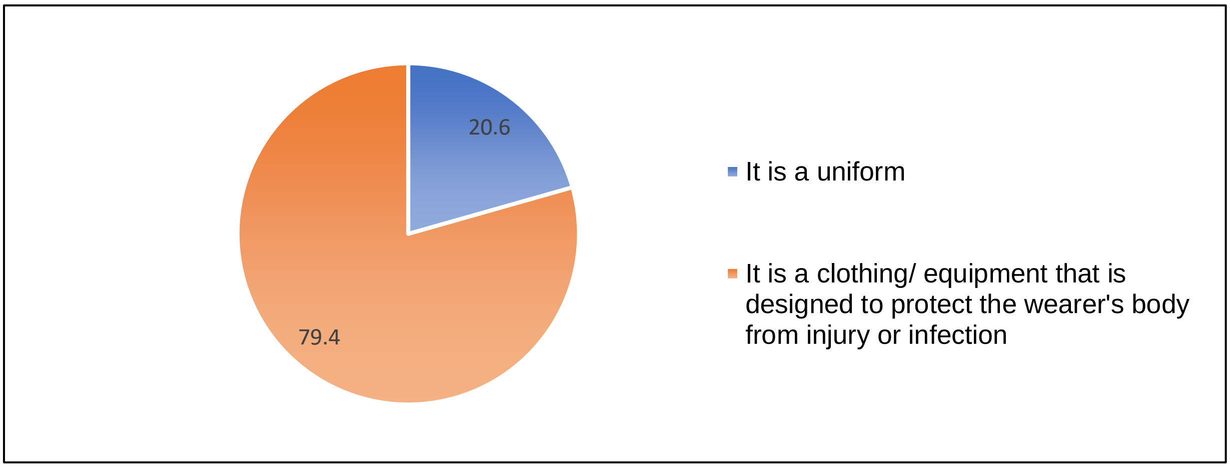

Figure 29: Responses for the understanding of PPE

When asked to indicate their understanding of PPE, 50 (79.4%) respondents indicated that it was the clothing/equipment designed to protect the wearer's body from injury or infection, while 13 (20.6%) indicated that was a uniform (Figure 29).

4.3.8 DOES THE PLACE OF EMPLOYMENT PROVIDE PPE

63 (100%) respondents answered that the place of employment provided PPE.

4.3.9 WEARING OF PPE

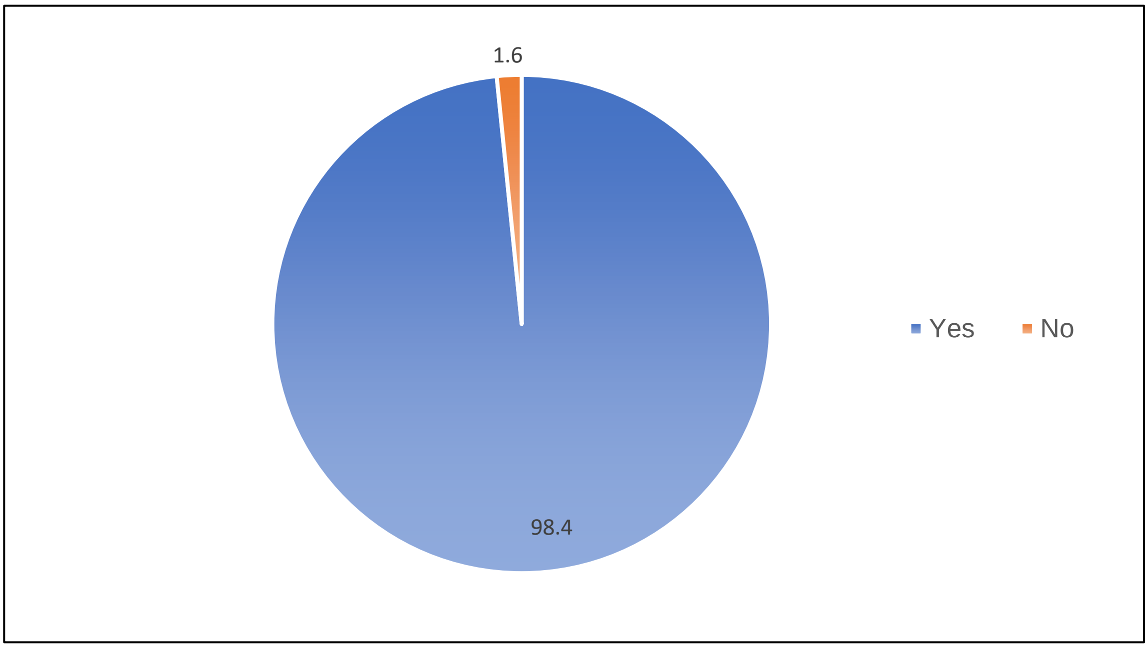

Figure 30: Percentage of respondents that wear PPE

Figure 30 above indicates that 62 (98.4%) of the respondents wear their PPE while only one (1.6%) indicated 'no'

4.3.10 CORRECT USE OF PPE

Amongst 63 respondents, 61 (96%) answered that they wore it correctly while one (1.6%) of the respondents indicated 'no' and one (1.6%) was 'not too sure'.

4.3.11 FREQUENCY OF WEARING PPE

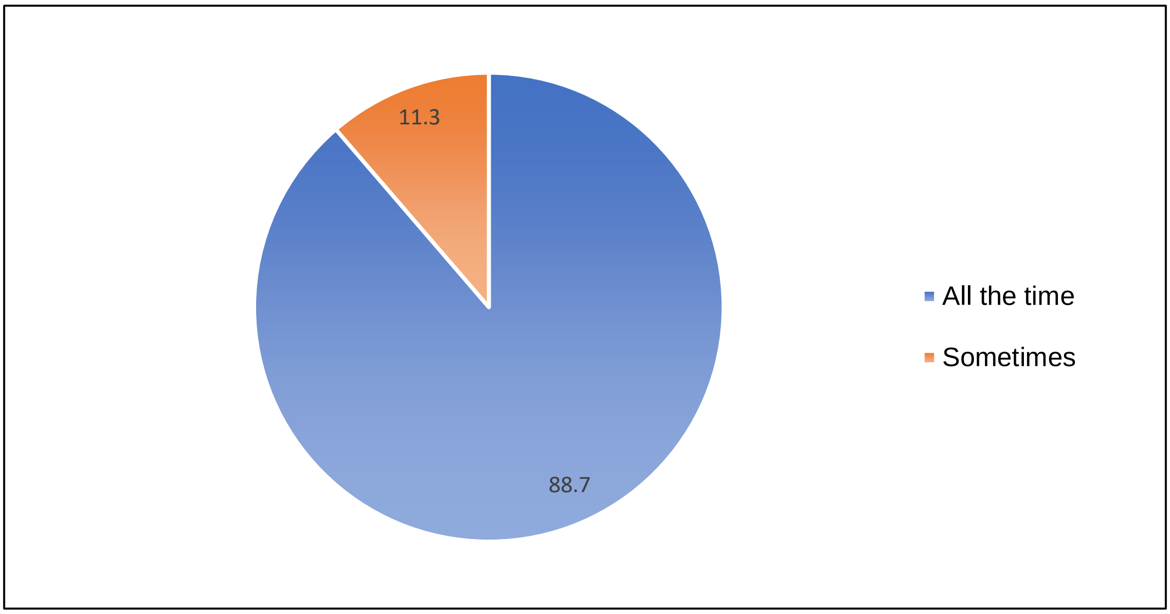

Figure 31: Frequency (in percentage) of respondents wearing PPE

Figure 31 above illustrates that 55 (88.7%) respondents wore their PPE all the time, whereas 7 (11.3%) respondents wore their PPE sometimes. The reasons for wearing the PPE varied among the respondents. Among those who indicated 'all the time', it was uncovered that personal safety and protection was the main reason. Others included safety and health to prevent infection and because it was mandatory for workers to wear one. On the other hand, those who indicated wearing masks 'sometimes' revealed that it was not a requirement in the administrative office

4.3.12 FEELINGS ABOUT WEARING PPE

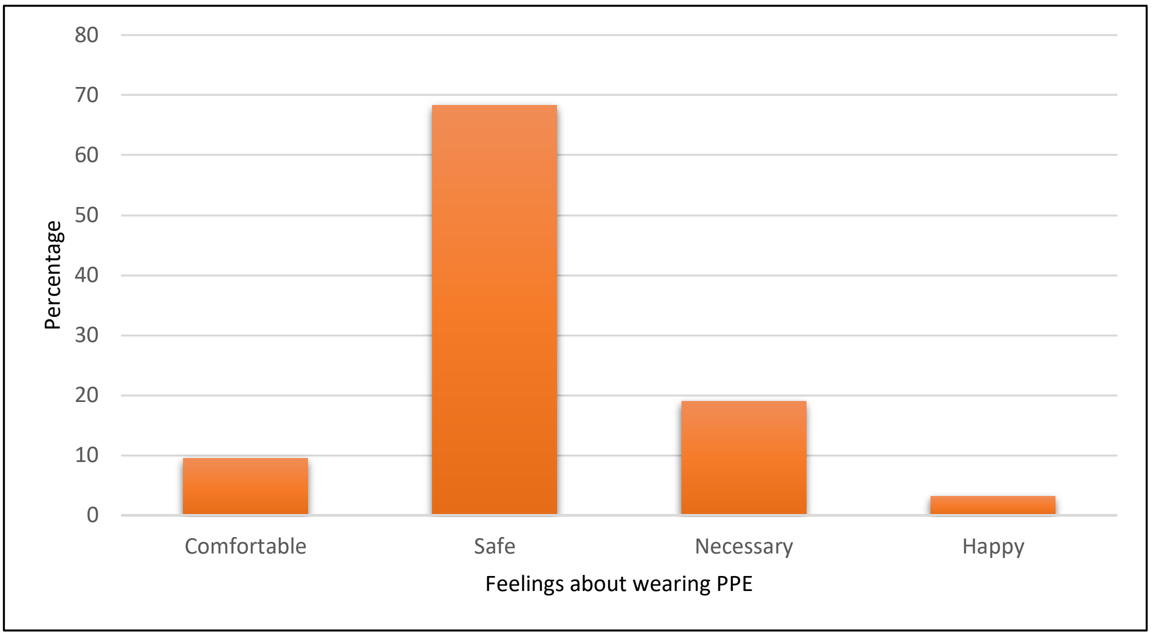

Figure 32: Respondents feelings towards wearing PPE

Respondents feeling towards PPE use was classified into four categories namely comfortable, safe, necessary, and happy. Up to 42 respondents (68%) indicated that wearing PPE made them feel safe whilst working. It was uncovered from 12 (19%) respondents that wearing PPE was necessary and important to carry out their work. Others expressed happiness wearing PPE. According to one statement, they felt that employers cared for them.

4.3.13 UNDERSTANDING OF A RESPIRATOR

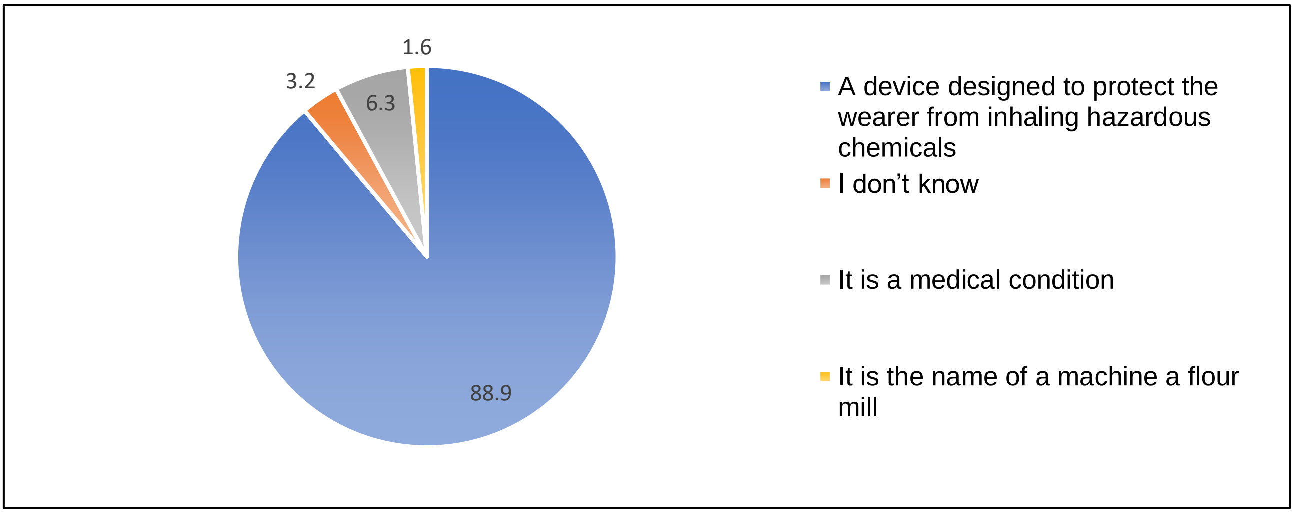

Figure 33: Understanding of a respirator

When asked to indicate their understanding of a respirator, 56 (88%) respondents indicated that it was a device designed to protect the wearer from inhaling hazardous chemicals, 3 (6.3%)

indicated it was a medical condition, two (3.1%) claimed not to know why, one (1.6%) noted that it was the name of a machine in a flour mill (Figure 33). Despite the majority having a good understanding of what a respirator was, some had poor or no understanding of it.

4.3.14 UNDERSTANDING OF A RESPIRATOR ZONE

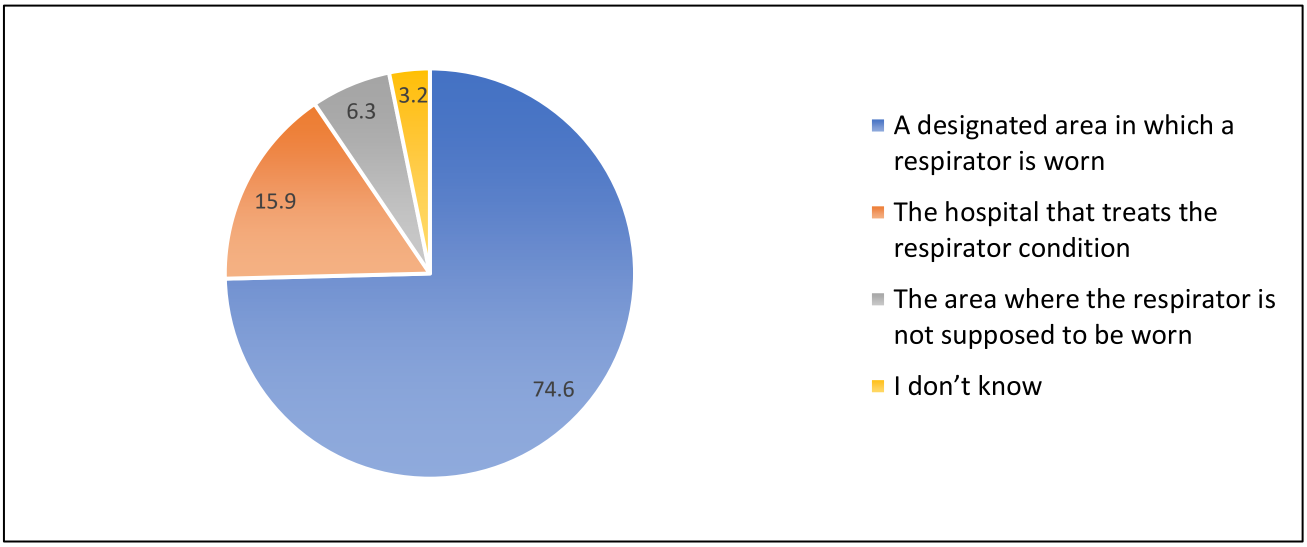

Figure 34: Percentage of understanding a respirator zone

In terms of the respondents' understanding of a respirator zone, 46 (74.6%) respondents correctly indicated that it was a designated area in which a respirator was worn, four (6.3%) incorrectly indicated that it was the area where the respirator was not supposed to be worn. In addition, six (10%) respondents erroneously indicated that it was the hospital that treats the respirator condition while two (3.17%) of the respondents had no understanding of its meaning (Figure 34).

4.3.15 WORKING IN A RESPIRATOR ZONE

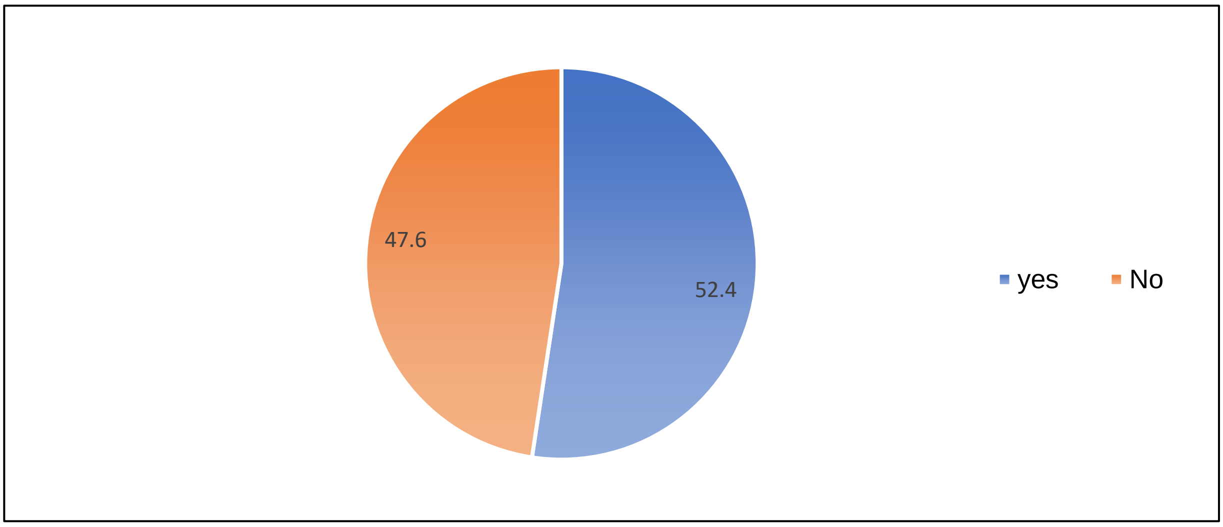

Figure 35: Percentage of respondents that work in a respirator zone

Up to 33 (52.4%) respondents worked in a respirator zone and 30 (47.6%) didnot work in this zone (Figure 35).

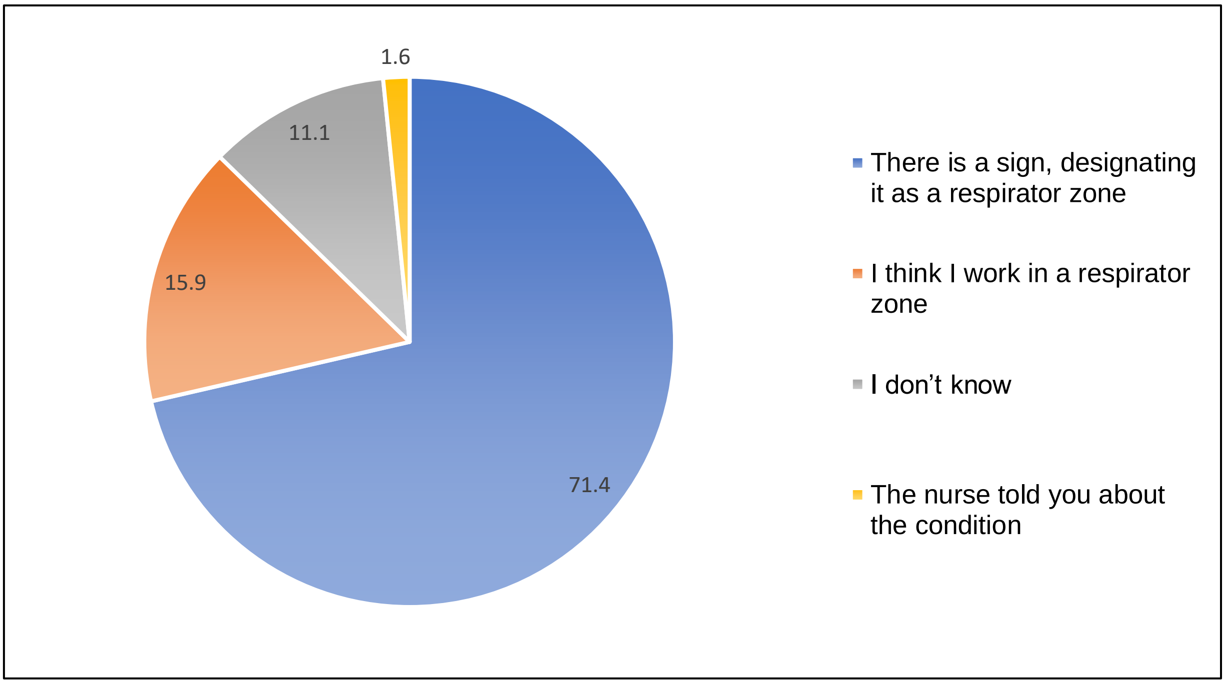

Figure 36: Percentage of respondents able to identify a respirator zone

When asked to explain how the respondents knew they work in a respirator zone, 45 (71.4%) respondents indicated that there was a sign, designating it was a respirator zone, ten (15.9%) assumed they worked in respirator zone, seven (11.1%) claimed not to know, whilst one (1.6%) noted that the nurse told the respondents about the condition (Figure 36).

4.3.16 WEARING A RESPIRATOR

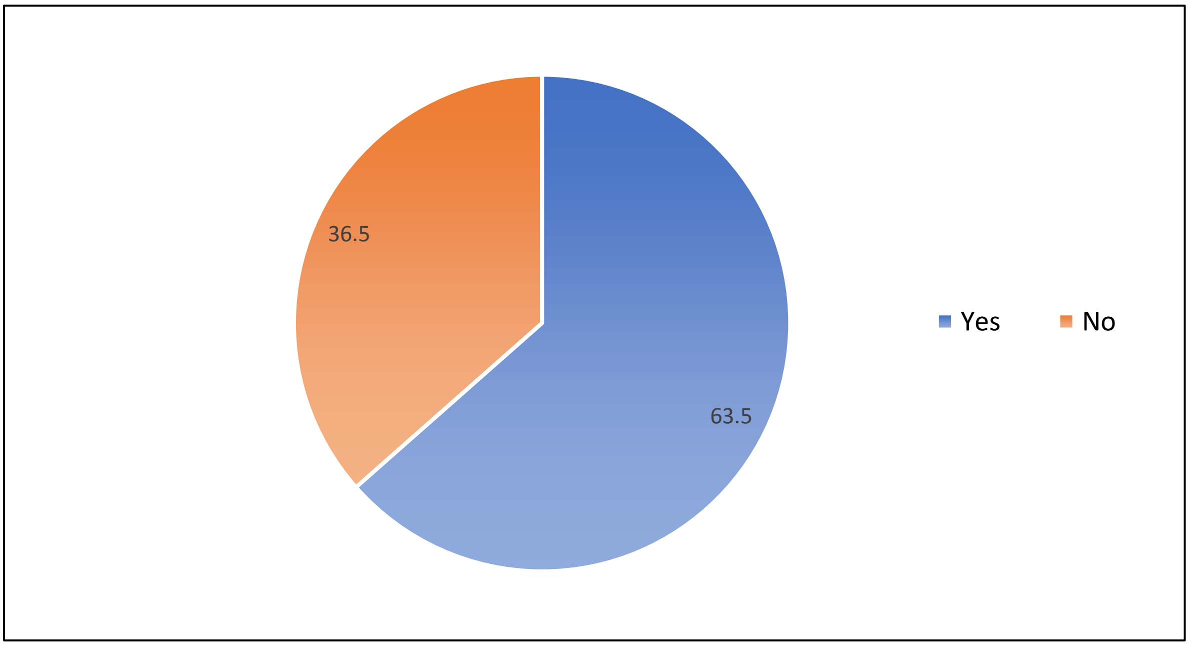

Figure 37: Percentage of respondents that wear a respirator

A large portion of 40 (63.5%) respondents wore a respirator while 23 (36.5%) did not wear one (Figure 37).

When asked to indicate their reasons for not wearing a respirator, it was found that 52 (82.6%) respondents did not work in an area that required a respirator. However, it was uncovered that one (4.3%) respondent wore a mask in place of a respirator, one (4.3%) thought that nothing worn would help with the breathing and one (4.3%) indicated that they don't have breathing problems and only wore a respirator when needed (Table 10).

Table 10: Respondents reasons for not wearing a respirator

Stated reasons (n=23)				
No breathing problem (n=1; 4.3%)	Nothing can help with breathing (n=1; 4.3%)	Do not work in the zone (n=19; 82.6%)	Wore masks (n=1; 4.3%)	Only when needed (n=1; 4.3%)

Given that a few of the respondents did not wear a respirator, it was prudent to know what these respondents used instead. It was found that respondents used either a dusk mask, medical mask or normal cloth masks, while one indicated wearing nothing.

4.4 MEDICAL INFORMATION

4.4.1 SMOKING HABITS

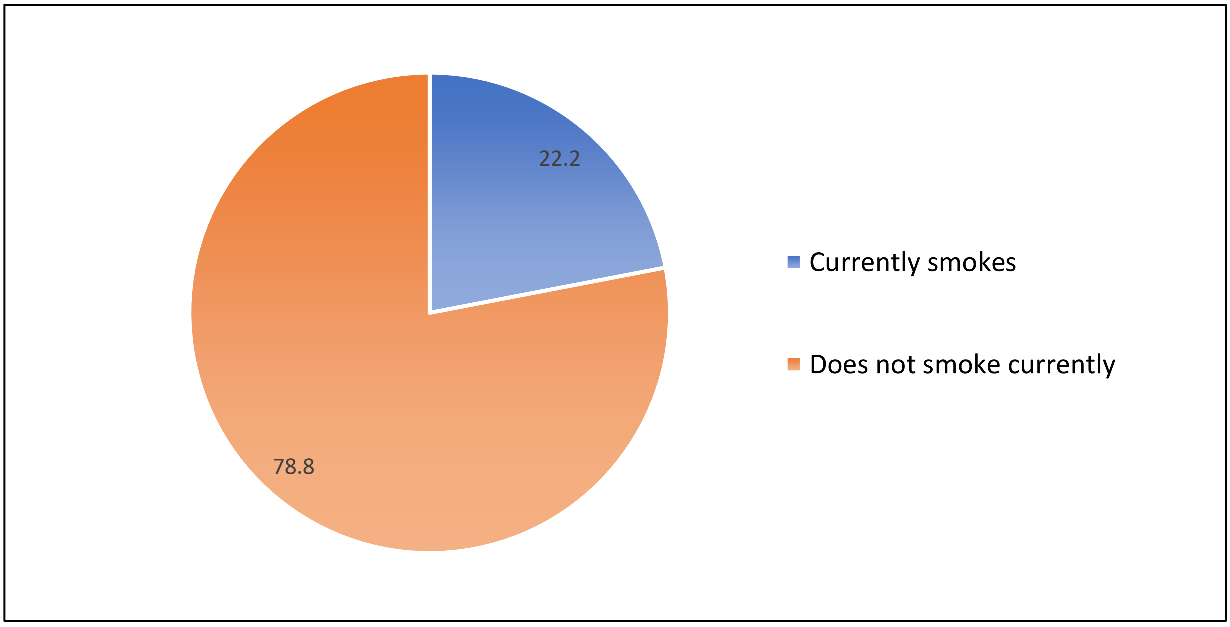

Figure 38: Percentage of employees that smoke vs employees that do not smoke currently

Up to 50 (77.8%) respondents did not currently smoke whilst 13 (22.2%) indicated to have smoked currently.

4.4.2 NUMBER OF YEARS SMOKING

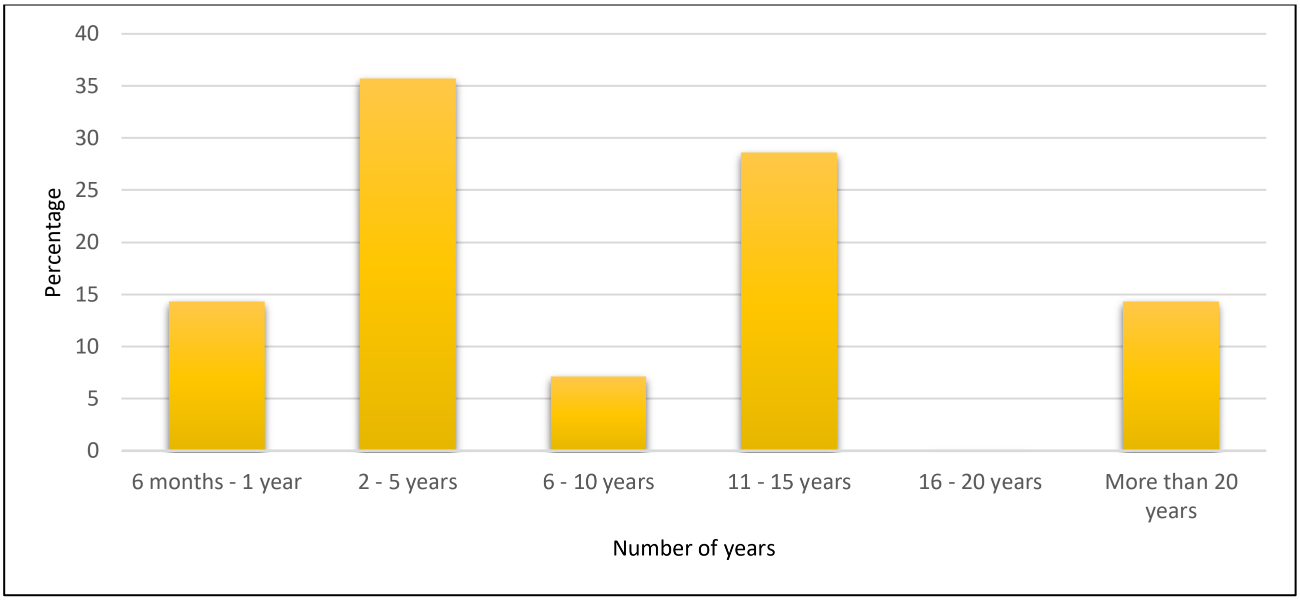

Figure 39: Number of years employees have been smoking expressed in percentage

Results from the number of respondents who smoked (n=14) showed that five (35.7%) have smoked for 2-5 years, four (28.6%) indicated that they have smoked for 11-15 years, one (7%) has smoked for 6-10 years while two (14%) have smoked less than a year and two (14%) have smoked for more than 20 years.

4.4.3 NUMBER OF CIGARETTES SMOKED IN A DAY

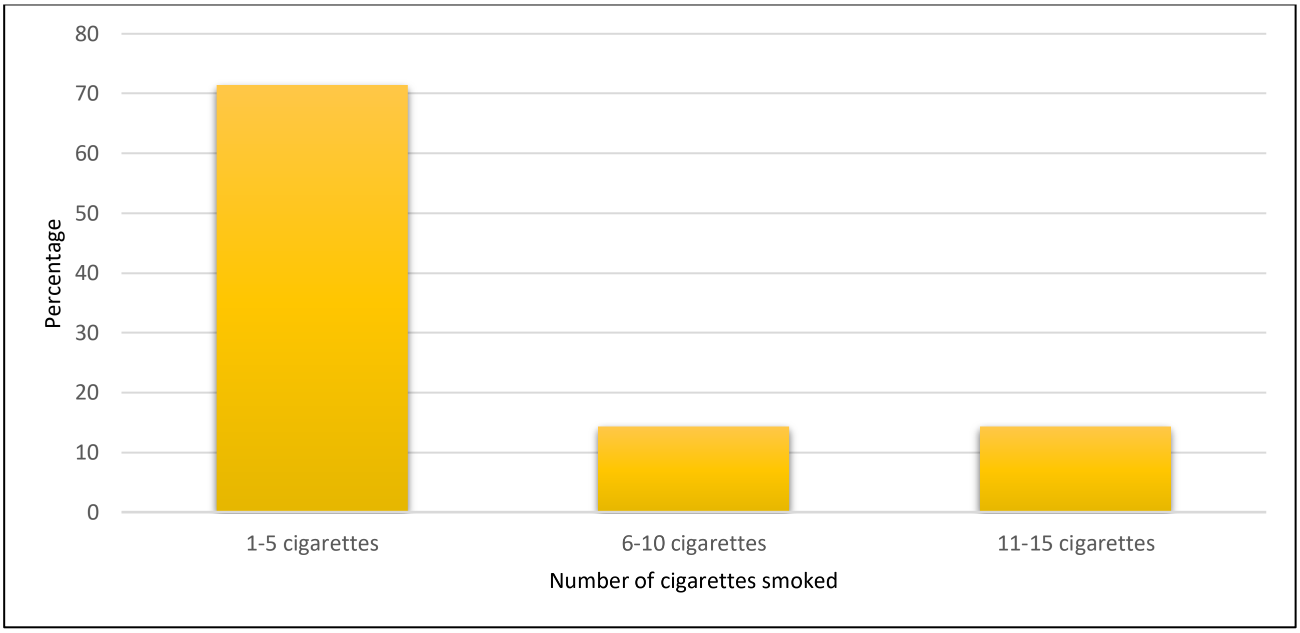

Figure 40: Number of cigarettes employees smoked per day

Among the number of respondents who smoked (n=14), the bar graph above indicates that 10 (71.4%) respondents smoked between 1-5 cigarettes a day while two (14.3%) each smoke 11-15 cigarettes and two (14.3%) smoked 6-10 cigarettes per day.

4.4.5 EXERCISE HABITS

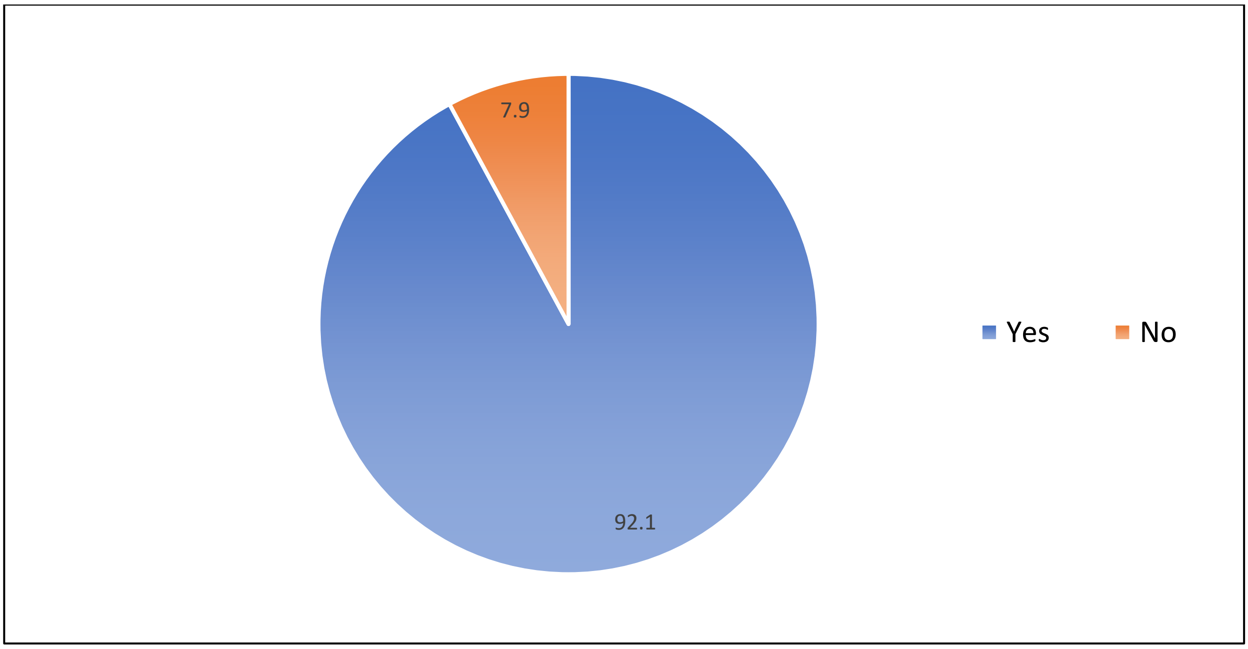

Figure 41: Percentage of employees that exercise

Up to 58 (92.1%) respondents exercised while only five (7.9%) did not exercise (Figure 41).

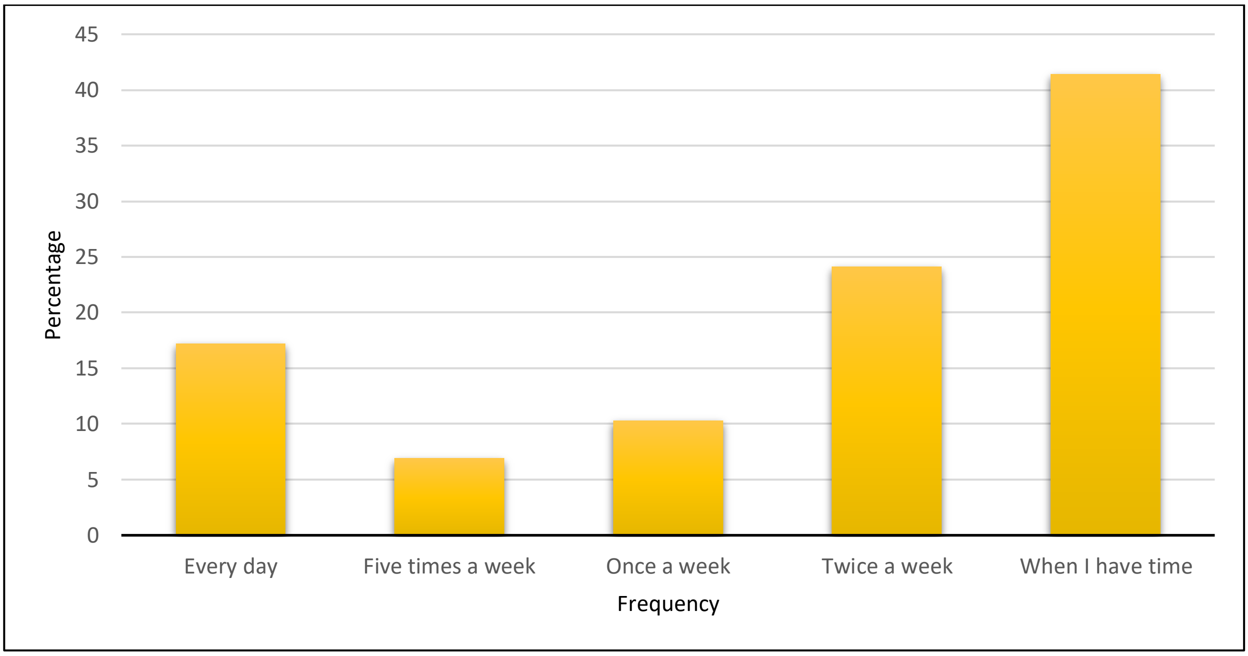

Figure 42: Frequency of respondents exercising habits

Among those who indicated that they exercised, it was found that 25 (41.4%) exercised only when they had time, 13 (24.1%) exercised twice a week, 10 (17.2%) exercised daily, 6 (10.3%) exercised once a week and 4 (6.9%) exercised five times a week.

4.4.6 FAMILY ILLNESS HISTORY

Table 11: Family illness history

Illness	Responses (n=63)			
	Yes n(%)	No n(%)	I don't know n(%)	Total
Do you have a family history of: [Epilepsy]	1(1.6%)	62 (98.4%)	0	63(100%)
Do you have a family history of: [Asthma]	6(9.5%)	56(88.9%)	1 (1.6%)	63(100%)
Do you have a family history of: [Hayfever]	8(12.7%)	53(84.1%)	2(3.2%)	63(100%)
Do you have a family history of: [Sinusitis]	11(17.5%)	50(79.4%)	2(3.2%)	63(100%)
Do you have a family history of: [Skin rashes/ dermatological issues]	6(9.5%)	54(85.7%)	3(4.8%)	63(100%)
Do you have a family history of: [Cancer]	5(7.9%)	52(82.5%)	6(9.5%	63(100%)

It was gathered that one (1.6%) respondent had a history of epilepsy, six (9.5%) respondents had a history of asthma, six (9.5%) had a history of skin rashes, eight (12.7%) had a history of hay fever, 5 (7.9%) had a history of cancer and 11(17.5%) had a history of sinusitis. This suggested that the most common illness was sinusitis.

4.5.7 HISTORY OF ALLERGIES AND DIZZINESS

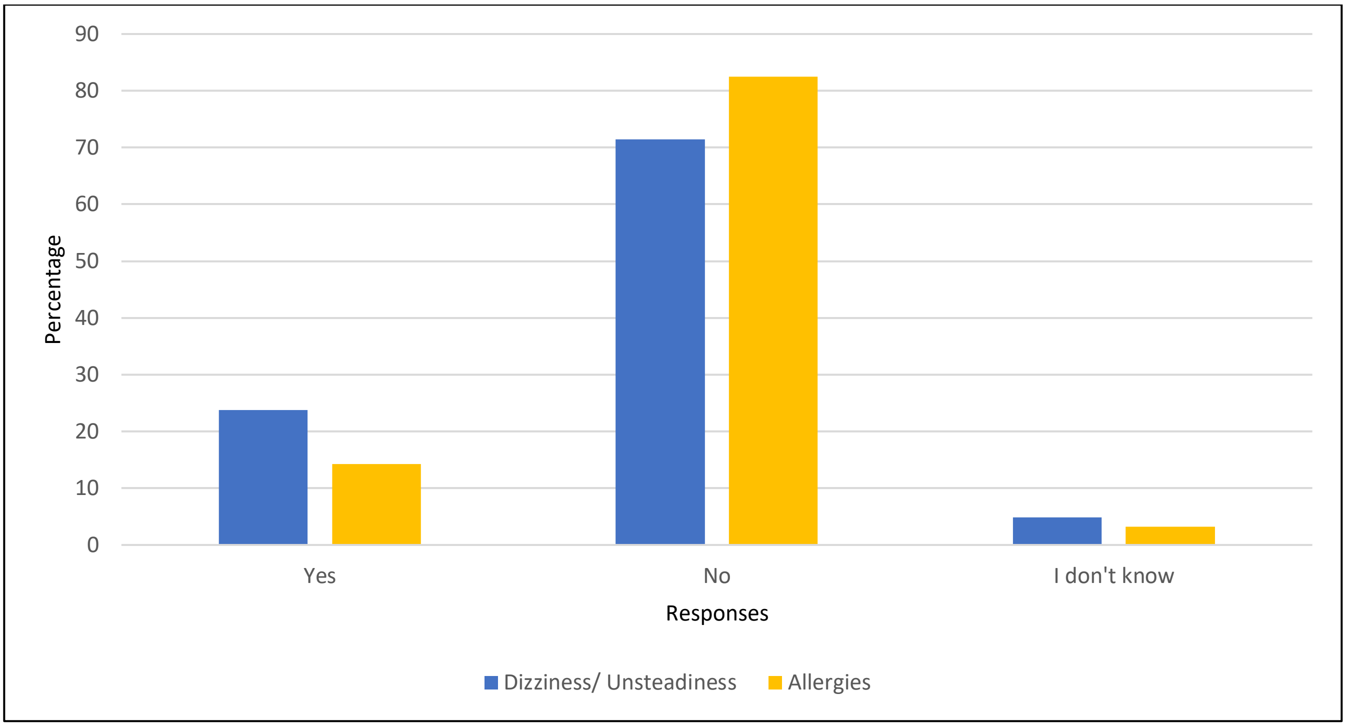

Figure 43: Responses for history of dizziness/ unsteadiness and allergies

The graph above (Figure 43) shows that 45 (71.4%) respondents had no history of dizziness. Figure 43 also shows that 51 (82.5%) respondents did not have allergies. Up to 15 (23.8%) respondents experienced dizziness and or unsteadiness while nine (14.3%) indicated to having a history of allergies. It was revealed that respondents were allergic to onion, seafood, codeine, chlorine, and dust.

4.4.8 HISTORY OF BREATHING DISORDER

This subsection details the respondents' history of breathing disorder.

4.4.8.1 TIGHT CHEST

Table 12: Showing respondents breathing condition

		Frequency	Percent
Does your chest ever feel tight, or your breathing becomes difficult?	Yes	10	15.9
	No	53	84.1
	Total	63	100.0

Table 12 indicates that only ten (15.9%) of the respondents had tight chests and experienced difficulty breathing while 53 (84.1%) respondents had none of these conditions.

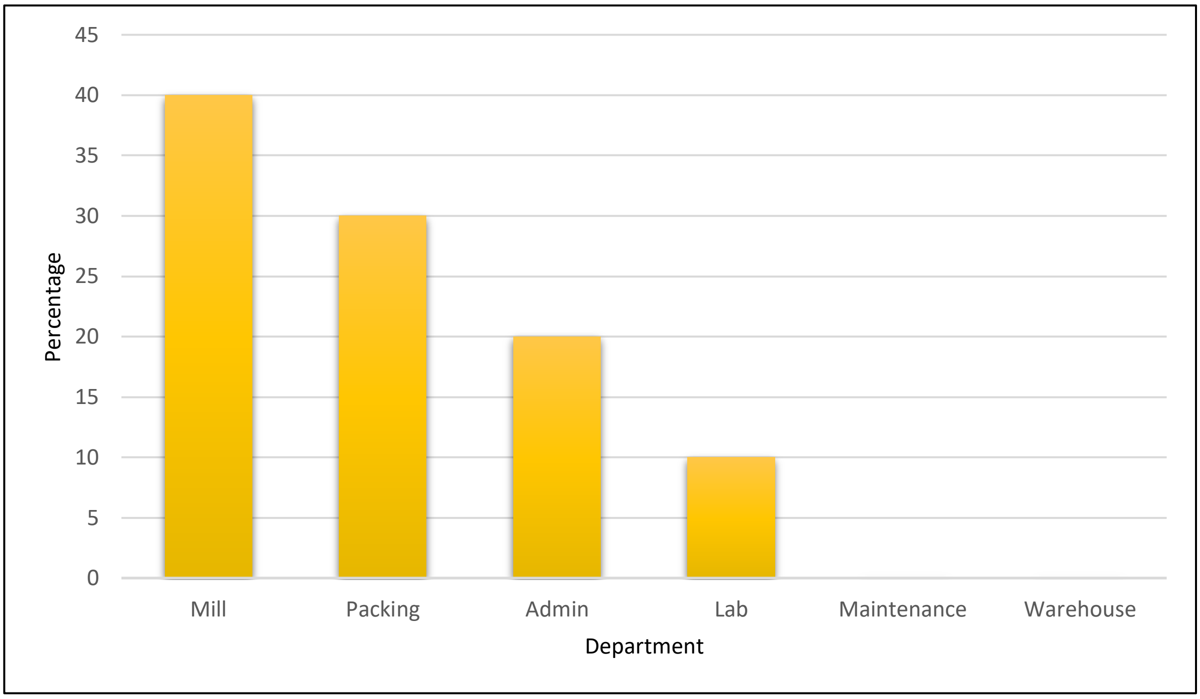

Figure 44: Percentage of respondents experiencing chest tightness and breathing difficulties per department

The number of times in a week the respondents (n=10) had trouble in breathing: It was found that while some experienced these one or two times in a week, others expressed that a breathing problem was not a regular thing. Added to this, it was uncovered that some of the respondent's had trouble breathing or tight chest when they inhaled dust or walked in the mill or up the stairs. To further analyse this information, the responses of the respondents who positively reported experiencing tightness in the chest or difficulty breathing, responses were categorised according to departments. The mill department reported the highest with four (40%) respondents, followed closely by the packing with three (30%) respondents, administration with two (20%) respondents and lab with one (10%) respondent. Warehouse and maintenance departments did not report anything.

4.4.8.2 BREATHING PROBLEM

Table 13: Showing the respondents breathing problem

Breathing problem	Responses (n=63)			
	Yes n (%)	No n (%)	I don't know n (%)	Total
Have you ever had an attack of wheezing or whistling in your chest?	4(6.3%)	59 (93.7%)	0	63(100%)
Have you ever had an attack of shortness of breath that came on during the day when you were not doing anything?	0	63(100%)	0	63(100%)
Have you ever had an attack of shortness of breath that came on suddenly with exercise?]	9(14.3%)	54(85.7%)	0	63(100%)

Results showed that 59 respondents (93.7%) had never had an attack of wheezing or whistling in their chest while four (6.3%) have indicated to have experienced this. The data also indicated that none of the respondents had an attack of shortness of breath that came on during the day when they were not doing anything. In contrast, it can be gathered from the data in Table 13 that only nine (14.3%) respondents had an attack of shortness of breath that came on suddenly with exercise.

Table 14: Showing the respondents description of their breathing problem

		Frequency	Percent
Which of the following statements best describe your breathing?	I get regular trouble with my breathing, but it always gets completely better	8	12.7
	I never or rarely have trouble with my breathing	53	84.1
	My breathing is never quite right	2	3.2
	Total	63	100.0

When asked to indicate the statements that best described their breathing, the 53 (84.1%) respondents noted 'I never or rarely have trouble with my breathing', eight (12.7%) indicated that ‘I get regular trouble with my breathing, but it always gets completely better’ while two indicated ‘my breathing is never quite right’ (Table 14).

4.4.8.3 ASTHMA DIAGNOSIS

Table 15: Showing the respondents' asthma history

Asthma condition	Responses (n=63)			
	Yes n (%)	No n (%)	I don’t know n (%)	Total
Has your doctor ever told you that you have asthma?	1(1.6%)	58 (92.1%)	4 (6.3%)	63(100%)
Have you had an attack of asthma within the past 12 months?	0	63(100%)	0	63(100%)
Have you ever had an attack Were you off-duty or hospitalized as a result of asthma?	0	63(100%)	0	63(100%)

Only one (1.6%) of the respondents had been told by their doctor that they had asthma. The results also indicated that none of the respondents had an attack of asthma within the past 12 months and none have ever had an attack off-duty or were hospitalised because of asthma.

4.4.9 EXPERIENCE WITH SNEEZING, RUNNING OR BLOCKED NOSE

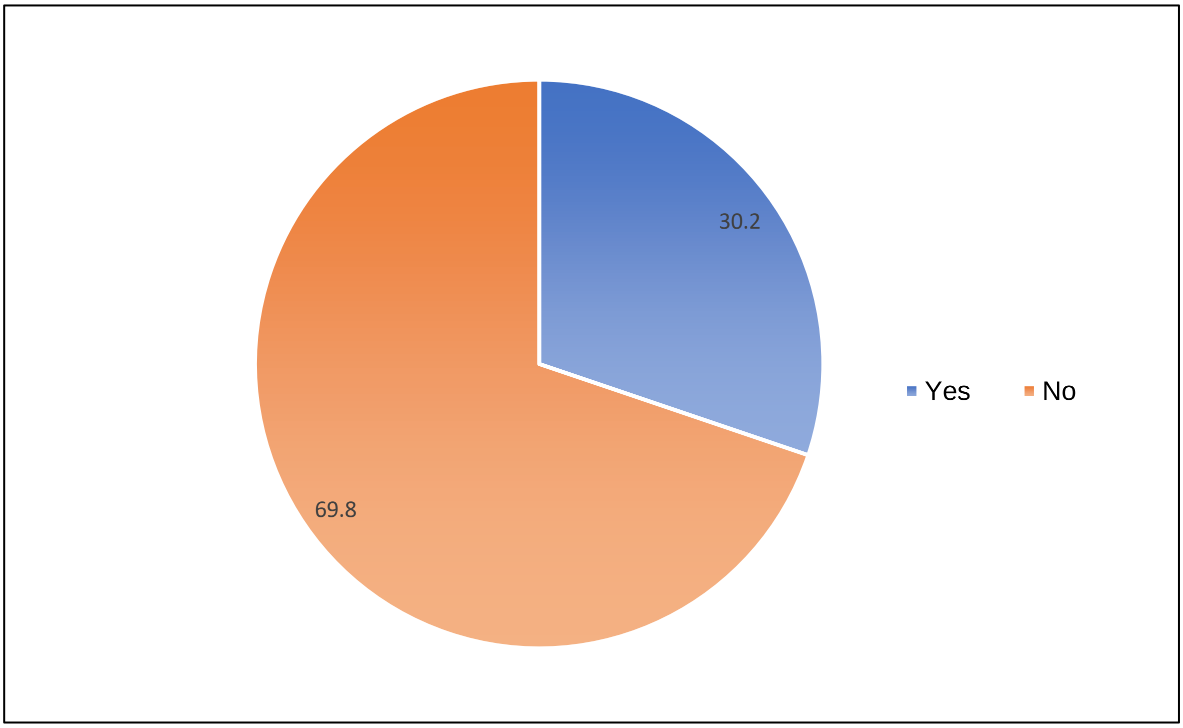

Figure 45: Respondents experienced sneezing, running or blocked nose

Figure 46 indicates that only 19 (30.2%) respondents experienced sneezing, running or blocked nose other than when they had a cold while 43 (69.8%) had never had this condition.

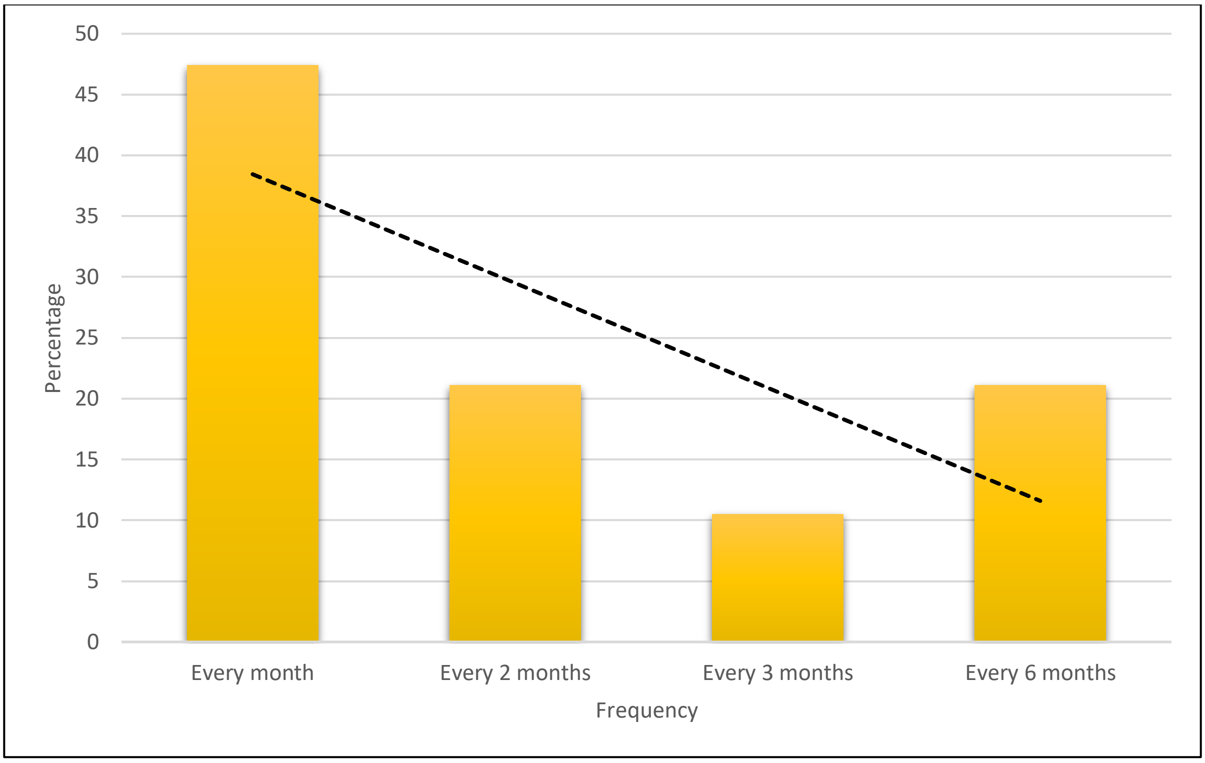

Figure 46: Respondent's frequency of experiencing sneezing, running or blocked nose

Among the respondents (n=19) who had experienced sneezing, running or blocked nose other than when they had had a cold, it was found that nine (47.4%) experienced this every month, four (21.1%) each indicated that they experienced this every six months and or every two months while two (10.5%) experienced this every three months (Figure 47).

Table 16: Showing the number of times a month respondents experienced sneezing, running or blocked nose

		Frequency	Percent
How many times a month have you experienced sneezing, running or a blocked nose?	0 -3	12	63.2
	11 - 14	1	5.3
	4 - 6	4	21.1
	7 - 10	1	5.3
	Not Applicable	1	5.3
	Total	19	100.0

Of the 19 respondents, 12 (63.2%) experienced sneezing, running or blocked nose 0-3 times a month, 4 (21.1%) experienced this 4.6 times. The data also revealed that each one of the respondents' experienced sneezing, running or blocked nose 7-10 times a month and 11-14 times a month.

It further assessed the relationship between area of work and symptoms of sneezing, running or blocked nose, the responses were analysed according to department. The milling department showed the highest response of eight (42.11%) respondents, followed by four (21.05%) from packing, three (15.79%) from Administration, two (10.53%) from Maintenance, one (5.26%) from laboratory and 1 (5.26%) from warehouse.

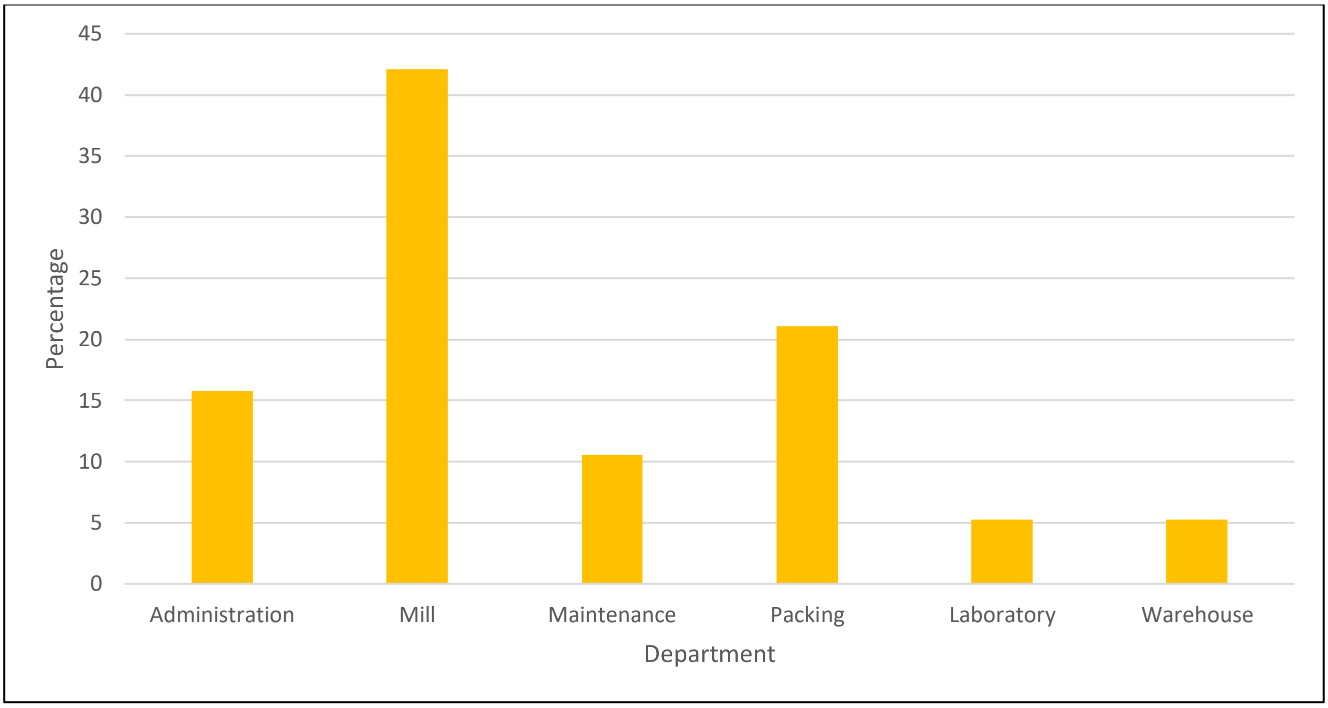

Figure 47: Respondent's frequency of experiencing sneezing, running or blocked nose

4.4.10 EXPERIENCE WITH A DRY COUGH

Table 17: Showing respondents experience with a dry cough within the past 12 months

		Frequency	Percent
Have you had a dry cough within the past 12 months?	Yes	11	17.5
	No	52	82.5
	Total	63	100.0

Table 17 indicates that only 11 (17.5%) respondents had a dry cough within the past 12 months. To better analyse the dry cough experiences, responses were further separated according to departments.

Table 18: Dry cough per department

Department	Yes	
	Count	%
Admin	2	18
Lab	2	18
Mill	2	18
Packing	1	9
Maintenance	4	36
Warehouse	0	0

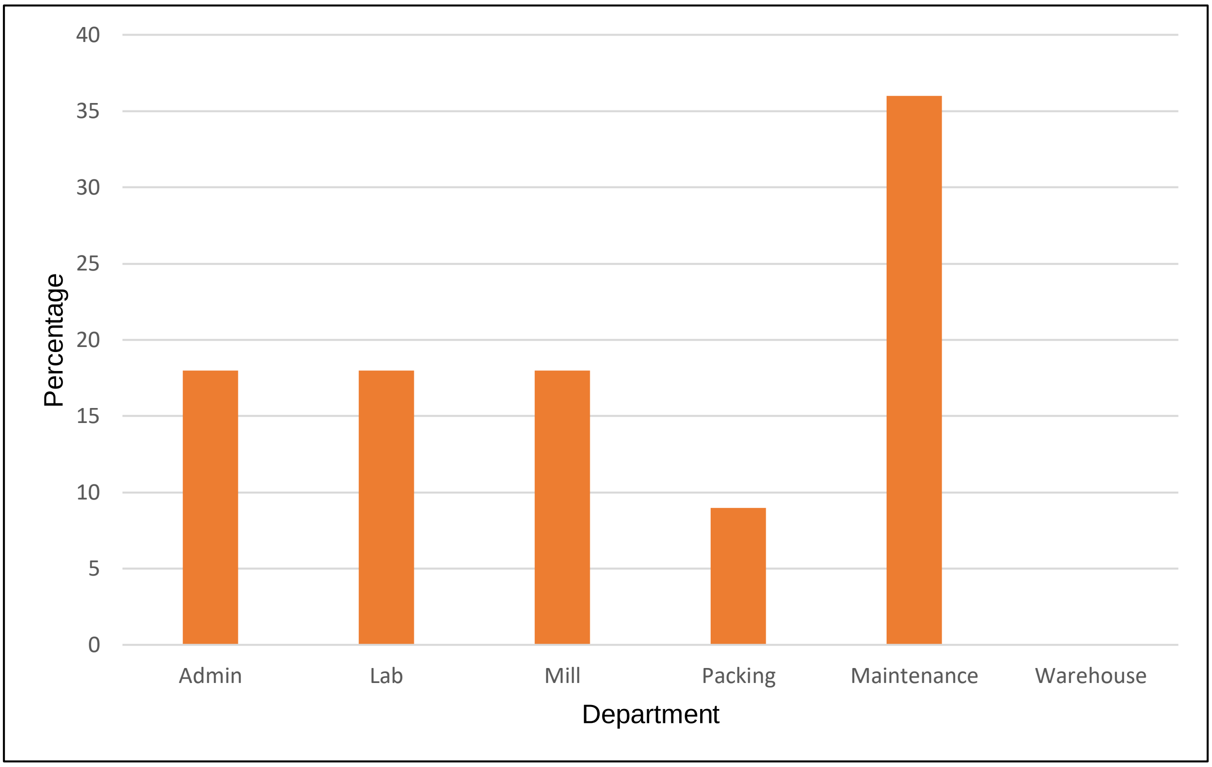

Figure 48: responses for dry cough per department

The data showed that the maintenance department reported the highest response for dry cough of 4 (36%) responses. The mill department was second with two (18%) responses, followed closely by the lab with two (18%) responses, administration with two (18%) responses and packing with one (9%) response. The warehouse department had not experienced dry cough at all.

4.4.11 EXPERIENCE WITH ITCHING OR WATERING OF THE EYES

Table 19: Respondents experience with itching or watering of the eyes within the past 12 months

		Frequency	Percent
Have you experienced itching or watering of the eyes within the past 12 months?	Yes	14	22.2
	No	49	77.8
	Total	63	100.0

Results showed that only 14 (22.2%) respondents had had itching or watering of the eyes within the past 12 months.

Table 20: frequency respondents experience itching or watering of the eyes within the past 12 months

		Frequency	Percent
How often have you experienced the itching or watering of the eyes?	Every month	10	71.4
	Every six months	1	7.1
	Every two months	2	14.3
	Not Applicable	1	7.1
	Total	14	100.0

Furthermore, among the respondents (n=14) who indicated to have had itching or watering of the eyes within the past 12 months, it was found that 71.4% experienced this condition every month, 14.3% every two months while one experienced every six months (Table 20).

Table 21: Showing the number of times a month respondents experience itching or watering of the eyes within the past 12 months

		Frequency	Percent
How many times has this occurred per month?	0 - 3	9	64.3
	11 - 14	1	7.1
	4 - 6	1	7.1
	7 - 10	2	14.3
	More than 15	1	7.1
	Total	14	100.0

Table 21 shows that out of the 14 respondents, 9 (64.3%) experienced itching or watering of the eyes within the past 12 months 0-3 times a month, two (14.3%) experienced this 7-10 times while one each experience this 4-6 times, 11-14 times, and more than 15 times within the past 12 months. To better analyse the itching or watering eyes experiences, responses were further separated according to departments.

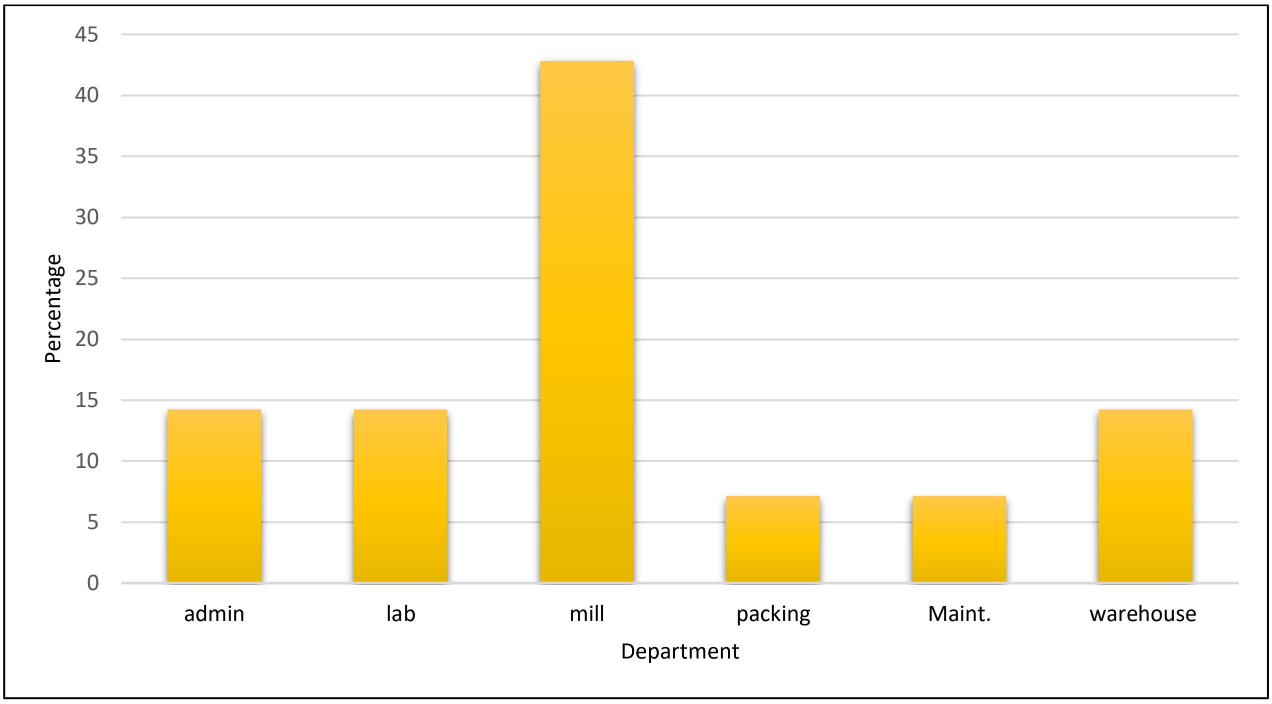

Figure 49: Responses for itching or watering eyes within 12 months

The data shows that the mill department reported the highest response for experiencing itching/ watering eyes with six (42%) responses. The warehouse and administration department were next with two (14.2%) each, followed by the lab and packing departments with one (7.1%) each.

4.4.12 MEDICATION

Table 22: Showing the number of respondents currently taking medication

		Frequency	Percent
Are you currently taking medication?	Yes	4	6.3
	No	59	93.7
	Total	63	100.0

Table 22 indicates that only four (6.3%) respondents took medication while 59 (93.7%) claimed not to.

4.4.13 SKIN DISORDER HISTORY

Table 233: Showing the number of respondents that had a skin disorder

		Frequency	Percent
Have you ever had any skin disorders or conditions?	Yes	8	12.7
	No	55	87.3
	Total	63	100.0

Table 23 indicates that only 8 (12.7%) respondents had ever had any skin disorders or conditions while the 55 (87.3%) had never had any of such conditions.

Table 24: Respondent's description of skin disorder

		Frequency	Percent
Please state the condition/ disorder and describe the signs and symptoms	Acne and itching on cold weather.	1	12.5
	childhood acne	1	12.5
	Eczema	1	12.5
	Fungus if pigmentation on the skin	1	12.5
	I am always scratching my body	1	12.5
	just dry skin with pimples	1	12.5
	My body temperature rises and my feet smell	1	12.5
	When it's hot my skin itches	1	12.5
	Total	8	100.0

Table 24 summarises the disorder, signs and symptoms as described by eight of the respondents. It was found that while some of the respondents' experienced itching in cold weather, another noted having experienced this in hot weather conditions. In terms of skin disorders, it was found that the respondents had suffered from eczema acne, pimples. Some of the respondents also complained of smelly feet.

4..4.14 FREQUENCY OF DOCTORS VISIT

Table 25: Respondent’s frequency of doctor visit

		Frequency	Percent
How often do you visit the doctor?	I don't know	4	6.3
	Never	14	22.2
	Not very often	39	61.9
	Often	6	9.5
	Total	63	100.0

Table 25 indicates that 39 (61.9%) respondents did not often visit the doctor, 14 (22.2%) never visited the doctor, six (9.5%) often visited the doctor while four (6.3%) claimed not to know. The reasons for the respondents' visits to the doctors are typified into seven categories, namely those who visited for flu shots or medication, those who visited for check-ups, those who visited for other ailments, which include infections and back-related problems, those who had had eye related problems and those who had had breathing problems. It was also uncovered that some respondents only visited when sick while others never visited due to no illness.

4.5 RETROSPECTIVE LUNG FUNCTION TEST RESULTS

4.5.1 FEV_1/FVC RESULTS FOR AGE (2019 AND 2020)

Table 26: FEV_1/FVC results for age (2019 AND 2020)

	FEV_1/FVC	
Age	**2019**	**2020**
18-25	89	88
26-35	84	86
36-45	83	84.4
46-55	82	84
56-65	79	79
Older than 65	-	94

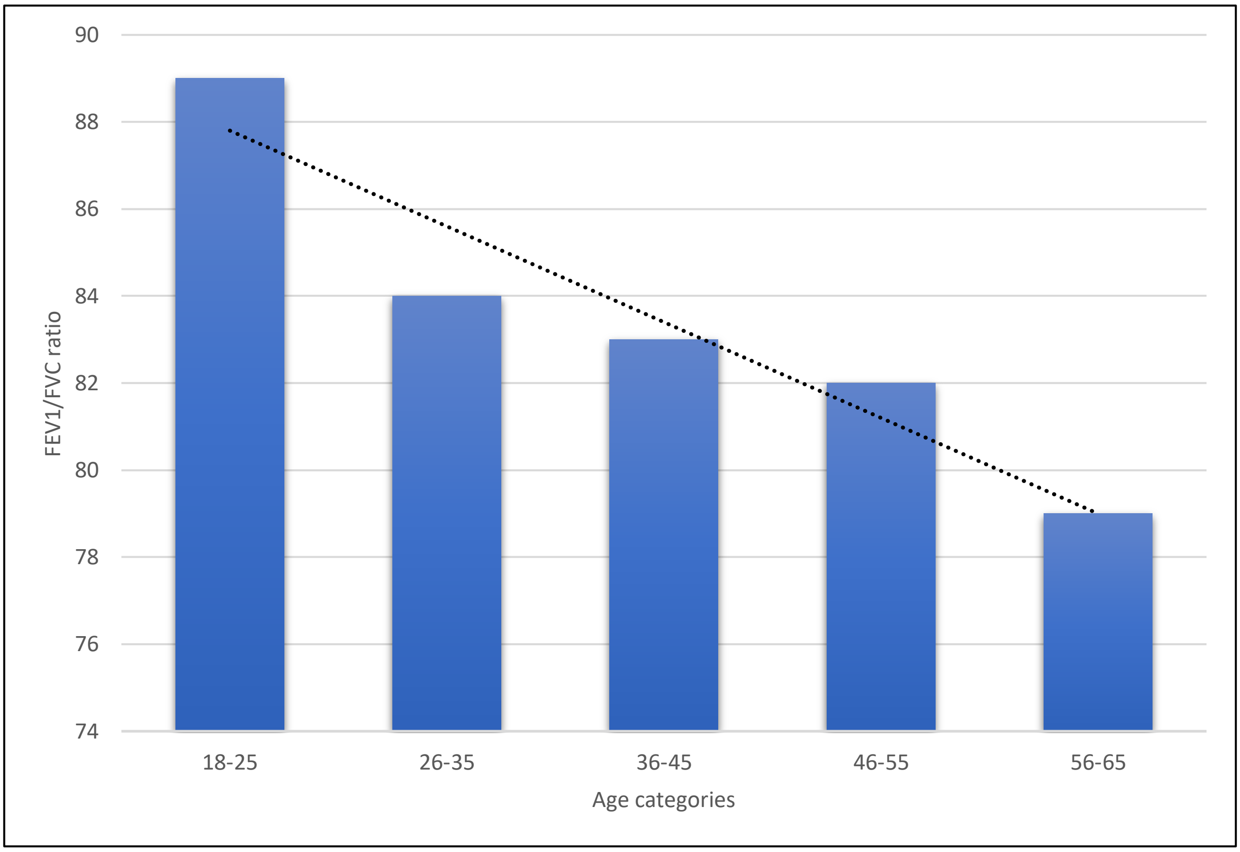

Figure 50: FEV_1/FVC values according to age for 2019

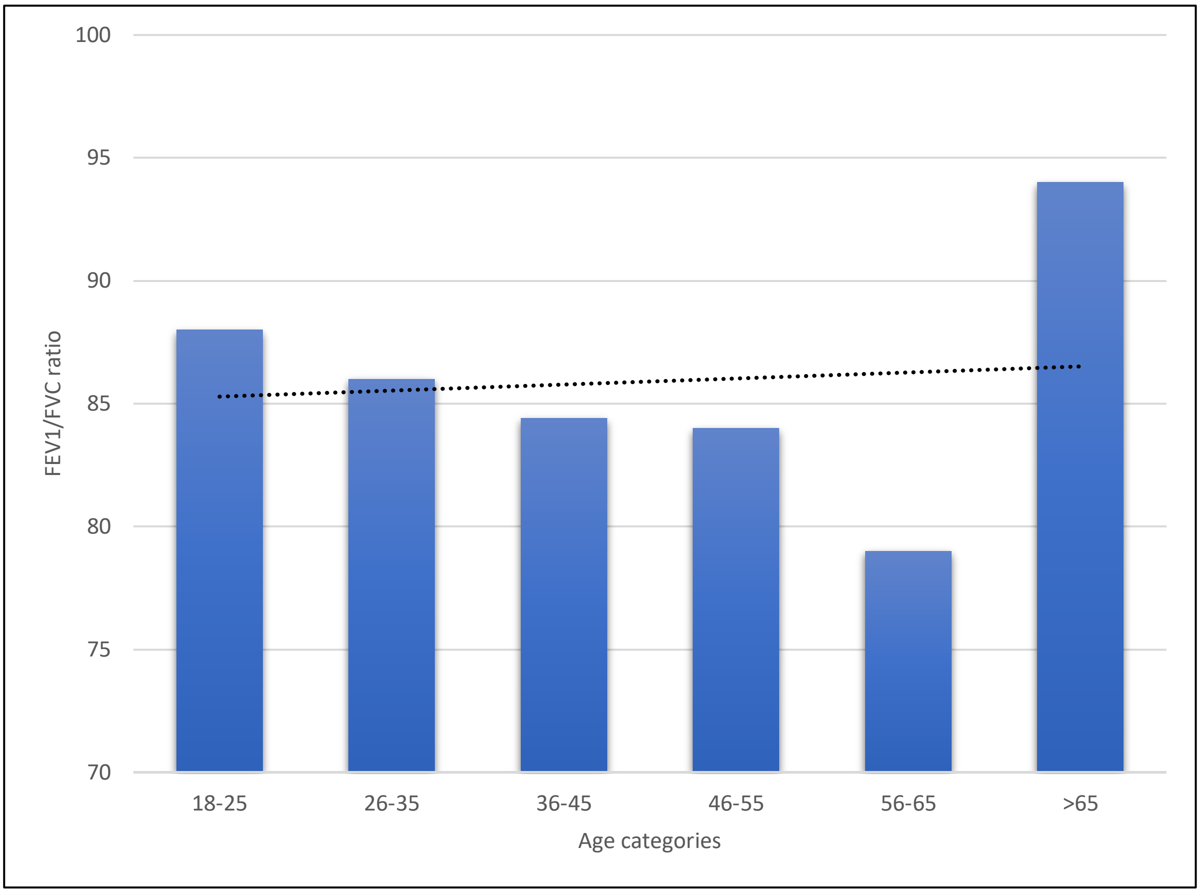

Figure 51: FEV_1/FVC values according to age for 2020

The above table and corresponding column graphs show FEV_1/FVC results from 2019 and 2020 derived from retrospective lung function tests. The categorical variable of age was isolated and compared between the two years. In 2019, a trend can be observed that as the age group increased the FEV_1/FVC values decreased. In 2019, there was no value for the 'older than 65' age group. In 2020, a similar trend can be seen - as the age group increased the FEV_1/FVC value decreased. Peculiarly, the 'Older than 65' age group presented an anomaly of having the highest FEV_1/FVC value.

4.5.2 FEV_1/FVC RESULTS FOR DEPARTMENT (2019 AND 2020)

Table 27: FEV_1/FVC results for department (2019 AND 2020)

	FEV_1/FVC	
Department	**2019**	**2020**
Laboratory	87.5	94
Administration	87	87.8
Packing	84.2	84.1
Warehouse	83.3	85
Mill	82	84.3
Maintenance	82	83.5

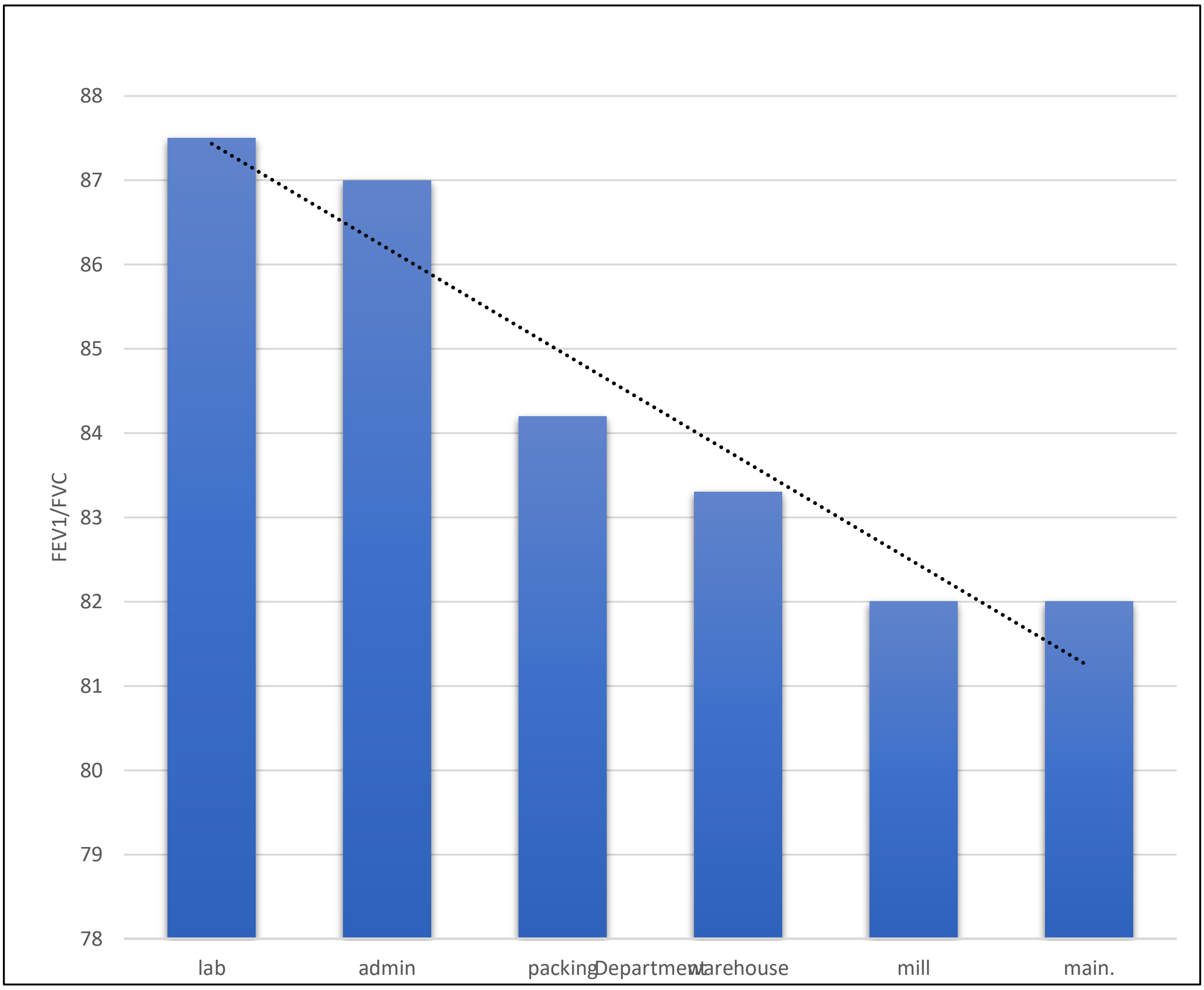

Figure 52: FEV_1/FVC values per department for 2019

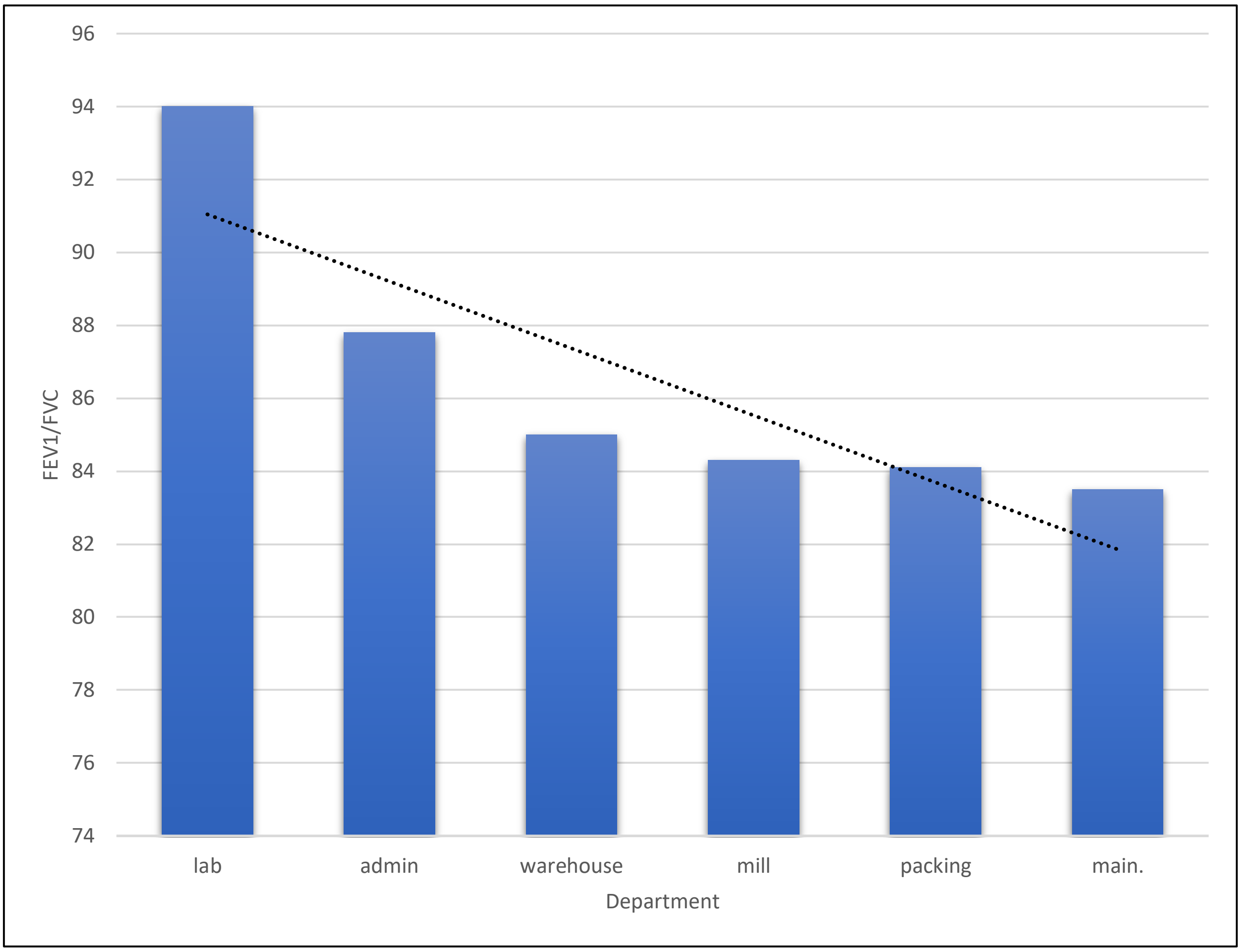

Figure 53: FEV_1/FVC values per department for 2020

The above table shows FEV_1/FVC results from 2019 and 2020 derived from retrospective lung function tests. The categorical variable 'department' was isolated and compared between the two years to determine if a specific department impacted FEV_1/FVC values. In 2019, the laboratory department presented the highest FEV_1/FVC values followed closely by Administration. The packing and warehouse departments were next. The mill and maintenance departments were found to have the same values and had the lowest values amongst the departments. In 2020, the laboratory department again presented the highest FEV_1/FVC values followed by the administration. Unlike 2019, next came the warehouse and then the packing departments. Like 2019, the mill and maintenance departments reported the lowest values however, this time the maintenance department was lower than that of the mill department.

4.5.3 FEV_1/FVC RESULTS FOR USE OF PPE (2019 AND 2020)

Table 2824: FEV_1/FVC results for use of PPE for 2019

2019						
Use of PPE	FVC (Litres)		FEVI (Litres)		FVC/FEVI (%)	
	Mean ±SD	p-value	Mean ±SD	P value	Mean ± SD	p-value
Yes	4.02±0.8		3.37±0.72		84.25±6.2	
No	0.0					

Table 29: FEV_1/FVC results for use of PPE for 2020

2020						
Use of PPE	FVC (Litres)		FEVI (Litres)		FVC/FEVI (%)	
	Mean ±SD	p-value	Mean ±SD	P value	Mean ± SD	p-value
Yes	4.47±1.1	0.108	3.81±0.9	0.158	85.60±6.2	0.184
No	2.64±0.0		2.47±0.0		94.0±00	

The above table shows FEV_1/FVC results from 2019 and 2020 derived from retrospective lung function tests. The categorical variable 'Use of PPE' was isolated and compared between the two years to determine if the use of PPE impacted FEV_1/FVC values. In 2019, FEV_1/FVC values for participants who responded in the affirmative was 84.25. There was no value for 'no'. In 2020, FEV_1/FVC values for 'yes' responses were lower than those that responded 'no' with 85.60 and 94.0 respectively.

4.5.4 FEV_1/FVC RESULTS FOR USE OF RESPIRATORS (2019 AND 2020)

Table 30: FEV_1/FVC results for use of respirators 2019

2019						
Use of respirator	FVC (Litres)		FEV_I (Litres)		FVC/FEV_I (%)	
	Mean ±SD	p-value	Mean ±SD	P value	Mean ± SD	p-value
Yes	4.06±0.8	0.638	3.38±0.6	0.987	83.52±6.5	0.255
No	3.94±1.1		3.37±0.9		85.59±5.6	

Table 31: FEV_1/FVC results for use of respirators 2020

2020						
Use of respirator	FVC (Litres)		FEV_I (Litres)		FVC/FEV_I (%)	
	Mean ±SD	p-value	Mean ±SD	P value	Mean ± SD	p-value
Yes	4.50±1.1	0.551	3.80±0.8	0.868	84.86±6.2	0.157
No	4.32±1.3		3.76±1.1		87.29±6.2	

The above table shows FEV_1/FVC results from 2019 and 2020 derived from retrospective lung function tests. The categorical variable 'Use of Respirator' was isolated and compared between the two years to determine if the use of a respirator impacted FEV_1/FVC values. In 2019, FEV_1/FVC values for participants who responded 'yes' was 84.25 while those who responded 'no' was higher with 85.59. Although the FEV_1/FVC was lower for those who responded, 'yes' it must be noted that the FEV_1 values and FVC values for those who responded 'yes' were higher than those who responded 'no'. In 2020, FEV_1/FVC values for 'yes' responses were lower than those who responded 'no' with 84.86 and 87.29 respectively. Although the FEV_1/FVC was lower for those that responded 'yes' it must be noted that the FEV_1 values and FVC values for those who responded 'yes' were higher than those who responded 'no'.

4.5.5 FEV_1/FVC RESULTS FOR SMOKING (2019 AND 2020)

Table 32: FEV_1/FVC results for smoking for 2019

2019						
Smoke	FVC (Litres)		FEV_l (Litres)		FVC/FEV_l (%)	
	Mean ±SD	p-value	Mean ±SD	P value	Mean ± SD	p-value
Yes	4.94±0.7	0.001	3.99±0.7	0.004	80.8±6.9	0.062
No	3.81±0.8		3.23±0.7		85.1±5.8	

Table 33: FEV_1/FVC results for smoking for 2020

2020						
Smoke	FVC (Litres)		FEV_l (Litres)		FVC/FEV_l (%)	
	Mean ±SD	p-value	Mean ±SD	P value	Mean ± SD	p-value
Yes	5.31±0.8	0.001	4.48±0.8	0.002	84.69±7.8	0.496
No	4.19±1.1		3.59±0.9		86.04±5.8	

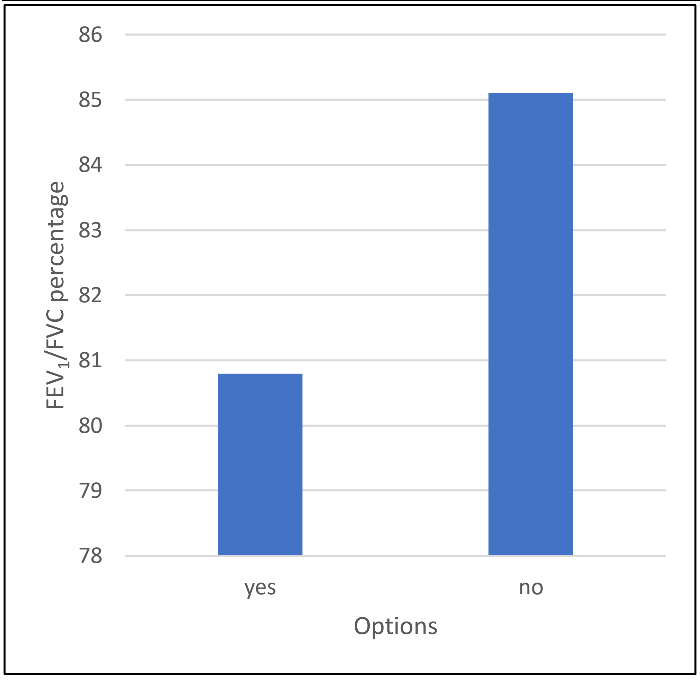

Figure 54: FEV_1/FVC percentages based on smoking habits for 2019

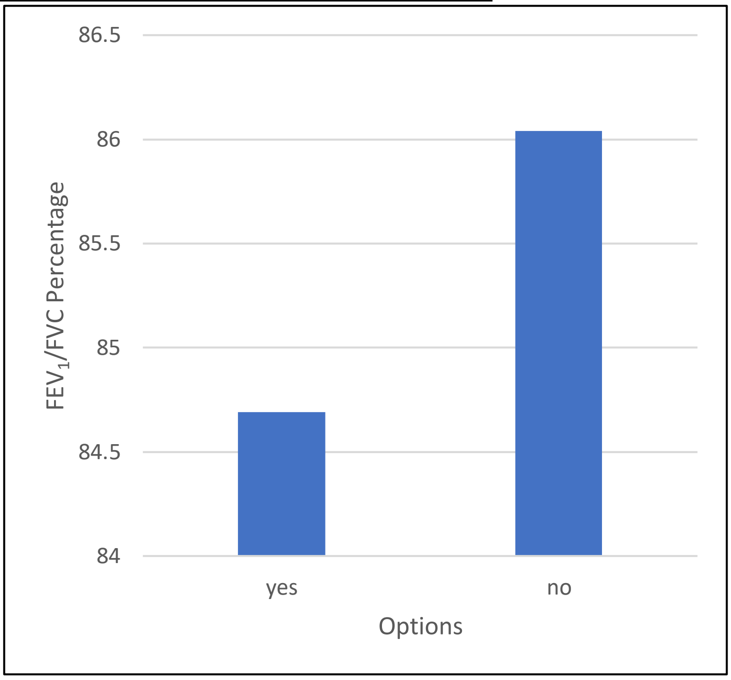

Figure 55: FEV_1/FVC percentages based on smoking habits for 2020

The above table and graphs show FEV_1/FVC results from 2019 and 2020 derived from retrospective lung function tests. The categorical variable ‘Smoking habits’ was isolated and compared between the two years to determine if an individual’s smoking habits impacted FEV_1/FVC values. In 2019, FEV_1/FVC values for participants who responded ‘yes’ was 80.8 while those who responded ‘no’ was higher with 85.1. In 2020, FEV_1/FVC values for ‘yes’ responses were lower than those who responded ‘no’, with 84.69 and 86.04 respectively.

4.6 ENVIRONMENTAL MONITORING RESULTS

This section reviewed the environmental monitoring results for flour dust obtained for 2017, 2019 and 2021. According to the OHS act, Environmental monitoring assessments are to be conducted by an Approved Inspection Authority (AIA) every 24 months.

4.6.1 2017

Table 34: Dust concentrations for 2017

	MILL	PACKING			LAB	WAREHOUSE + DISPATCH			ADMIN
2017	MILLER	PACKING SUPERVISOR	PACKER #1	PACKER #2	LAB TECH	WAREHOUSE SUPERVISOR	FORKLIFT DRIVER #1	FORKLIFT DRIVER #2	ADMIN CLEANER
	2,4296	0,2796	15,3711	2,7233	0,0781	0,2018	0,1064	0,5257	0,4829

Packer #1 from the packing department showed the highest exposure to flour dust. According to the Occupational Health and Safety Act, Hazardous Chemical Agents regulations - the Occupational Exposure Limit for grain dust is 10mg/m^3 – which is indicated on the graph by a black horizontal line. From this line, it is observed that other than packer #1, all other employees across the different departments are well below the standard of 10mg/m^3.

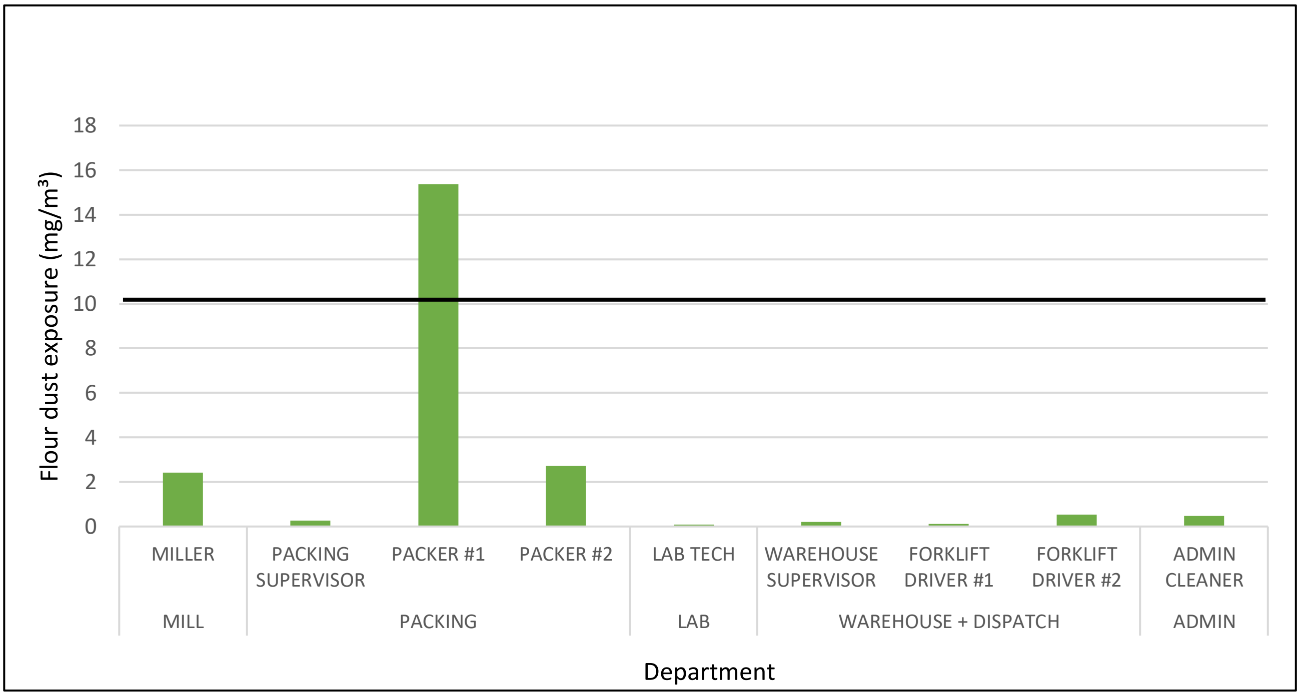

Figure 56: 2017 flour dust exposure for employees across all departments

4.6.2 2019

Table 35: Dust concentrations for 2019

	MILL		PACKING			MILL	LAB	WAREHOUSE + DISPATCH		ADMIN
2019	Mill cleaner	Miller	12.5KG MIXER PACKER	Packer #3	Carousel operator	Maintenance assistant	Lab tech	Vehicle assistant	Forklift operator	Internal cleaner
	27,1332	23,9775	7,0741	12,7511	7,117	13,1787	0,1241	1,866	0,4425	0,5017

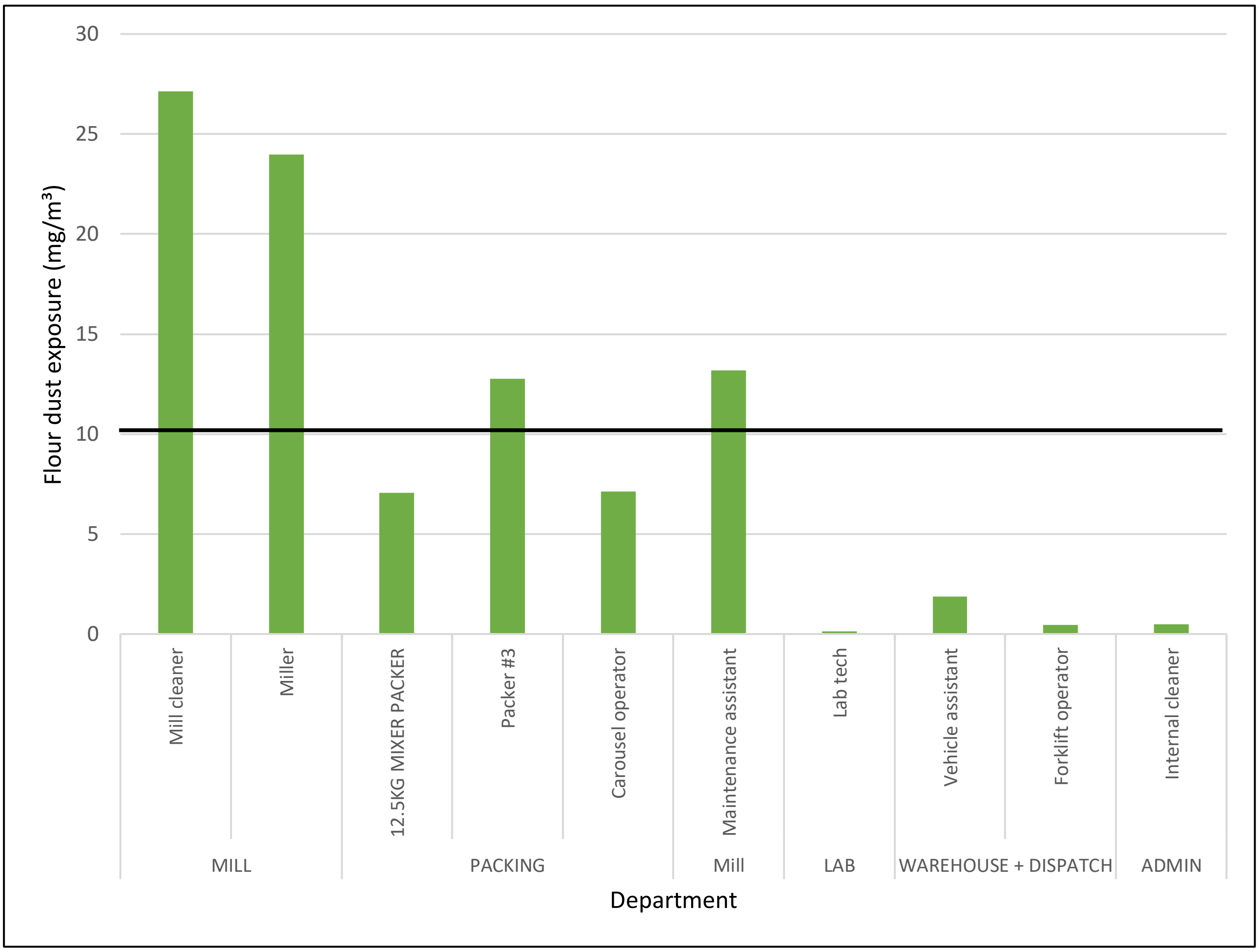

Figure 57: 2019 flour dust exposure for employees across the departments

According to the Occupational Health and Safety Act, Hazardous Chemical Agents regulations - the Occupational Exposure Limit for grain dust is 10mg/m^3 – is indicated on the graph by a black horizontal line. From this line, it was observed that four employees showed results above the legal exposure limit. The mill cleaner showed the highest exposure of 27.1332mg/m^3, almost three times higher than the legal limit of 10mg/m^3. The next highest exposure belonged to the miller, then the maintenance assistant and finally packer #3. The four highest exposure results (mill cleaner, miller, maintenance assistant and packer #3) were above the legal limit. The three highest exposures (Mill cleaner, miller and maintenance assistant) were from employees working in the mill department. Notably, the carousel operator and the 12.5kg mixer packer were close to the 10mg/m^3 limit with exposure results of 7.117 and 7.0741 respectively.

4.6.2 2021

Table 36: dust concentrations for 2021

	MILL					PACKING		LAB	WAREHOUSE + DISPATCH	ADMIN
2021	Workshop	Mill cleaner	Mill packer	Miller	Mill cleaner	Packer #1	Packer #2	lab tech	Forklift driver	Weighbridge operator
	1,195	1,684	12,2359	0,2344	1,3935	8,5761	13,9165	2,102	0,8608	0,2517

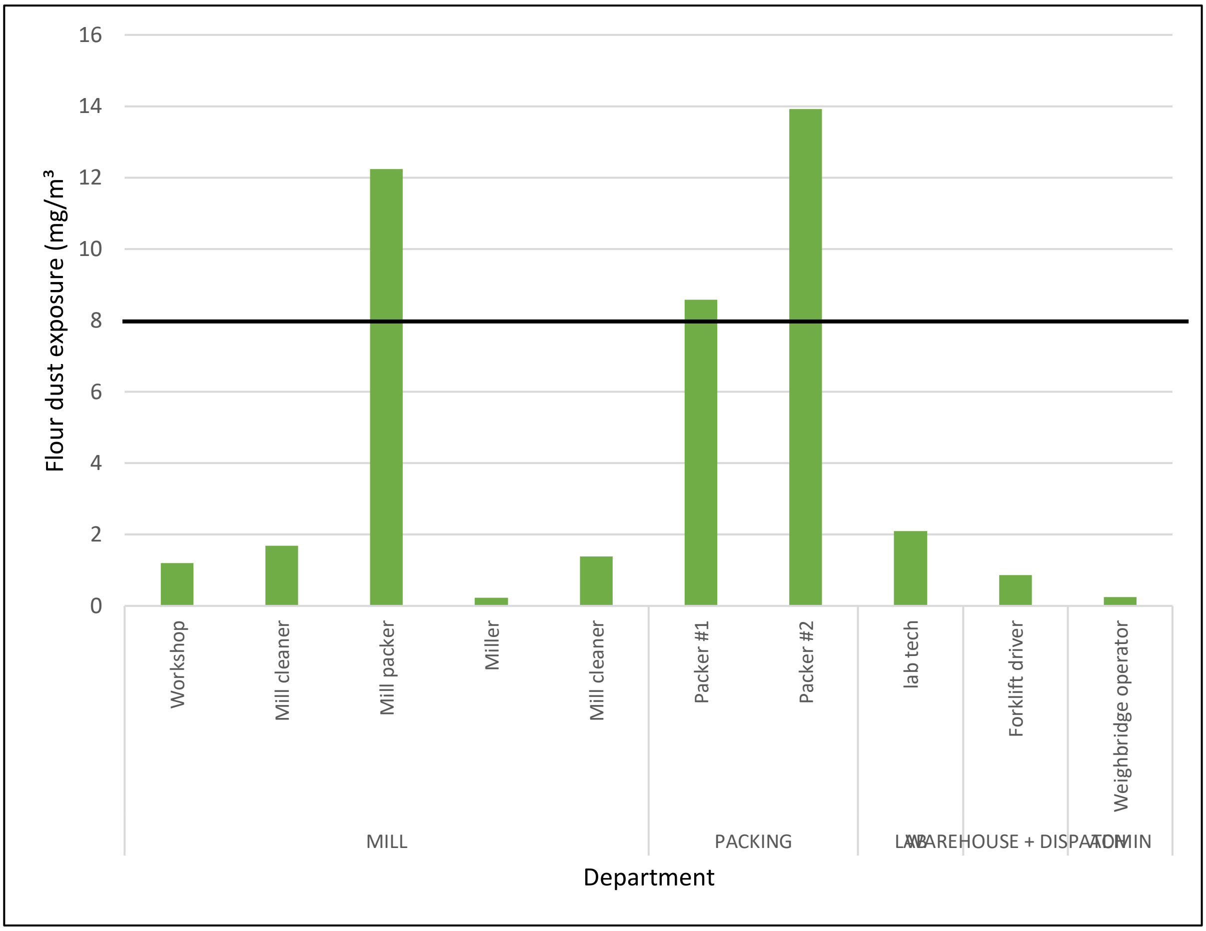

Figure 58: 2021 flour dust exposure for employees across all departments

As of 2021, the Occupational Health and Safety Act, Hazardous Chemical Agents regulations amended the Occupational Exposure Limit for grain dust and reduced it to 8mg/m^3 from the previous 10mg/m^3. The new OEL for grain dust is indicated on the graph by a black horizontal line. From this line, it was observed that three employees showed results above the legal exposure limit. Packer #2 showed the highest exposure with 13.9165mg/m^3, followed by the mill packer 12.2359mg/m^3 and lastly packer #1 with 8.5671mg/m^3. Both packers from the packing department formed part of the highest exposures together with the mill packer. Other results were considerably lower than the legal limit.

CHAPTER 5
DISCUSSION

5.1 INTRODUCTION

This study sought to determine the association between relevant respiratory outcomes and flour dust exposure. It was based at a wheat flour mill in the Phoenix Industrial Park area, KwaZulu-Natal. The study made use of three data collection tools to collate the relevant data. Tool one was a self-administered questionnaire in which demographics, work-related information and medical history was investigated to understand the respondents' duration of exposure, area of work and task performed as well as to determine if outcomes are exposure based. Tool 2 consisted of lung function tests in which tests for each respondent were gathered and analyzed according to corresponding questionnaire responses. Lung function tests for 2019 and 2020 were gathered and analyzed to investigate consistency and lung function deterioration. Lung function tests were prohibited in 2021 due to the Coronavirus pandemic. Tool three was the occupational monitoring reports for years 2017, 2019 and 2021, used to determine flour dust concentrations according to personal sampling results.

5.2 QUESTIONNAIRE RESPONSE RATE

The questionnaire response rate of 90% was much higher than the acceptable goal of 86% as deduced by the statistician's report. There was no definitive reason for the increased response rate, however, a study conducted by de Leeuw (2008: 314) explains that self-administered questionnaires are advantageous as interviewers can convince respondents, offer motivation, and at times, may also provide additional instruction or explanations during the data collection process. These aspects could lead to respondents feeling comfortable and better informed, thus, more likely to participate and successfully complete the questionnaire – contributing to the high response rate achieved.

5.3 DEMOGRAPHICS AND PERSONAL DATA

Most of the workforce were males, with females making up only a small percentage. This gender imbalance could be related to the large amount of physical work required in the flour milling environment. This is clearly reflected in the placement of females as compared to males, in that all female respondents formed part of administrative or laboratory departments only, in contrast to no females in the packing, milling, maintenance, warehouse and dispatch departments - areas in which heavy lifting and prolonged periods of standing are necessary. The predominant age group was found to be between 26 – 35 years, which could again be attributed to the large amount of physical labor required in the flour milling process since younger individuals are viewed as stronger and more energetic.

All respondents possessed some form of education with the majority indicating secondary schooling as the highest form of education obtained. There is also a scattering of tertiary education ranging from the National Diploma, Bachelor's degree and Master's degree. A small percentage of respondents only completed primary school.

5.4 RETROSPECTIVE ENVIRONMENTAL MONITORING PER DEPARTMENT

Environmental monitoring was conducted every 24 months and involved evaluating the level of flour dust in the work environment, using air samples to ensure that airborne contaminants remain below recommended guidelines. In 2021, the South African Department of Labour (Act No. 85 of 1993), Hazardous Chemicals Agents Regulations reduced the OEL for Grain dust from 10mg/m^3 to 8mg/m^3. However, even with the recent reduction, the South African OEL is still substantially greater than international standards. It must be noted that whilst globally, some countries recognize grain dust as being different from flour dust, in South Africa, that is not the case. Kakooei and Marioryad (2005: 50) highlighted that there exist varying levels of hygienic standards, TLVs and OELs for flour dust across the globe. The ACGIH reports a 0.5mg/m^3 TLV for inhalable flour dust, while in some Canadian provinces, flour dust has an exposure limit of 10mg/m^3 for total dust and 5mg/m^3 for respirable flour dust. Germany and Denmark have each set OELs of 4mg/m^3 and 3mg/m^3 respectively and in Sweden, the recommended value for flour dust exposure is 3mg/m^3. These values were further supported by Stobnicka and Górny (2015: 245). In South Africa, however, there is no specific OEL for flour dust, hence legal compliance for flour dust exposure is evaluated according to the OEL for grain dust.

In the absence of a flour dust OEL, the present study used the grain dust OEL. According to the retrospective environmental reports, the departments consistently presenting high flour dust exposure include the mill, maintenance and packing departments. These departments generally measured close to or well above the recommended limit across 2017, 2019 and 2021. This may be due to the department-specific procedures and the proximity of which the employees are required to work with the product. In the milling department, employees are required to work hands-on with the wheat and flour at various stages of the process to ensure that product quality is maintained. Additionally, deteriorating, old machinery can cause leaks leading to suspended flour dust (Nieuwenhuijsen *et al.* 1994: 586). Employment and Social Development Canada (2018: 7) has also listed chokes, flour spillages and the cleaning thereof as contributing to the dispersal of flour dust - inadvertently exposing employees. It is important to note that at the study site, the cleaners also form part of the milling department and due to certain cleaning techniques together with their proximity to airborne dust generated during the cleaning procedures, exposure is increased. Additionally, at the study site, the maintenance room is located within the milling department, therefore, the maintenance and milling team experience similar exposures to flour dust. The packing department requires employees to manually hold bags at the end of a spout that transfers flour from the storage bins into the bags. This task generally results in flour blowback, or a phenomenon called "rooster's tail". Employees are within an arm's length away from the product blowback and directly within the breathing zone. These elements explain the high flour dust exposure measured year-on-year.

The laboratory, administration and warehouse and dispatch areas were usually below the recommended limits due to limited exposure to flour dust and due to physical barriers (doors, walls, distance between areas and dust generating equipment) preventing the movement of dust between departments. The differences in exposures could be due to the mil, maintenance and packing departments that are required to work very closely with the product.

Results from the current study reflect previous research (Ahire *et al.* 2017: 70; Nieuwenhuijsen *et al.* 1994: 587) assessing work area and exposure levels. A study conducted in Iran assessed occupational exposure to flour dust by collecting respirable and inhalable dust samples across four different job sites: millers, packers, sweepers and operators. The study revealed that sweepers showed the highest levels of exposure whilst operators showed the lowest levels of exposures. However, Ahire *et al.* (2017: 70) and Nieuwenhuijsen *et al.* (1994: 587) argue that the level of dust exposure is highest in the packing and mixing site of flour mills, particularly among flour millers and hygiene workers. These results are further supported by a study by Khodadadi *et al.* (2011: 421) which states that workers at the flour packing workstations were exposed to high levels of flour dust as compared to husk packing, flour production and wheat unloading. Results obtained from the current study together with previous research indicate that flour dust exposure depends on the work area.

Most of the current employees worked in this flour mill between one to five years indicating that these individuals are still relatively young in the company whereas the owners possessed the longest employment history. During a discussion with the research site's Operations Manager, it was determined that the site typically had a high staff turnover which explained the predominant category for employment duration being one to five years.

Due to the flour mill operating on a 24/7 basis, it was necessary to have dayshift and nightshift teams. Notably, individuals that worked nightshift, worked longer hours in comparison to dayshift staff. However, shifts were structured so that staff obtained the legally required 45-hour work week – suggesting that the longer shift did not necessarily equate to increased exposure to flour dust.

5.5 IMPORTANCE OF PPE

Ahire *et al.* (2017: 71) emphasized the purpose of PPE in the workplace, highlighting its role of safeguarding employees against unsafe workplace hazards. The present study sought to evaluate respondents' understanding of PPE. Most of the respondents were able to correctly identify the definition of PPE as being the clothing/equipment that is designed to protect the wearer's body from injury or infection whilst one fifth of respondents only regarded uniform as PPE. Although both answers were technically correct, it was important to distinguish the definition of PPE from an example of PPE. This gap highlighted the point that although employees could identify types of PPE, they were unaware of the specific functions of each. Additionally, when questioned about PPE use – almost all respondents answered that they used the PPE provided. Overall, respondents displayed favourable attitudes towards wearing PPE, associating PPE use to a range of emotions, such as "comfort", "safety", a "necessity" at the workplace and "happiness". It must be stated that at the study site, PPE inspections are conducted thrice daily - every day. This ensured that employees were always wearing the provided PPE.

5.6 IMPORTANCE OF RESPIRATOR USE

Although the study assessed general PPE use, it was equally important to isolate and assess the use of respiratory protective equipment, particularly respirators. It has been demonstrated that while many employees could correctly identify the definition of a respirator, some had little to no understanding of it at all. Due to an obscured definition of a respirator, some respondents were unable to correctly identify a respirator zone – implying that if employees cannot identify when to wear a respirator, they may not wear one and might not be protected against inhaling flour dust. In contrast, a large percentage of respondents were shown to wear respirators and for those that answered "no", a reason was provided, to further understand hindrances. It was revealed that a substantial number of employees did not work in a respirator zone, therefore, respirator use was not compulsory. However, others disclosed "breathing complications"; "wearing a surgical mask instead" and "only using respirators when needed" as reasons. It is worth noting that due to the Coronavirus pandemic, it has become the law to wear a mask whenever in a public area. The workplace enforced this law, therefore, whether employees work in a respirator zone or not, it was compulsory that a face mask was always worn.

According to Johnson (2016: 1), while respirators appeared simple, they may interfere with certain abilities such as respiration, thermal equilibrium, vision, communication, feelings of well-being, eating/ sneezing as well as interactions with other equipment. In 1998, a study by Akbar-Khanzadeh (1998: 72) found that up to 91% of employees reported the inability to verbally communicate as a factor of discomfort. Further to that, a study conducted by Akbar-Khanzadeh and Bisesi (2000: 196) revealed that when evaluating the comfort level of half-mask respirators, only 8% of employees felt their respirators were comfortable, 30% tolerated the respirators while 62% rated the respirators as uncomfortable – concluding that respirators affect comfort and work performance (Johnson 2016: 1; Tam and Fung 2008: 71). Interestingly, although previous studies reported discomfort as a factor influencing respirator use – the current study did not. Apart from breathing complications, respondents did not comment on the comfort level of the respirators. Akbar-Khanzadeh and Bisesi (2000: 197) explained that discomfort from wearing a respirator may be reduced via natural adaptation, endurance training and continuous use. It is therefore possible that due to the Coronavirus pandemic and the mandatory use of face masks, employees became acclimated to wearing respirators resulting in respondents overlooking potential discomfort.

5.7 FLOUR DUST AND LUNG FUNCTION

Large bodies of literature across the globe have linked flour dust exposure to decreased lung function (Iyogun *et al.* 2019: 52; Gholami *et al.* 2018: S782; Tosho *et al.* 2015: 61; Hosseinabadi *et al.* 2013: 145; Mohammadien *et al.* 2013: 3 and Wagh *et al.* 2006: 398), arguing a myriad of reasons relating to exposure and the adverse effects. Lung function is typically assessed using spirometric tests, a noninvasive test evaluating ventilatory function (Pierce 2005: 535). Spirometry tests rely on various measurements to make a diagnosis, however, the most crucial are the FVC, FEV_1 and FEV_1/FVC parameters (Wagh *et al.* 2006: 399).

Barroso, Martin, Romero and Ruis (2018: 327) and Sharma and Goodwin (2006: 255) explains that lung function reference values were based on anthropometric factors namely weight, height, sex and age, whereas Mohammadien *et al.* (2013: 4) places large emphasis on duration of employment. Further to Barroso *et al.* (2018: 327) and Mohammadien *et al.* (2013: 3), Kakooei and Marioryad (2005: 52) add that job activities also influence lung function results. In the present study, lung function was analyzed based on age, department, duration of employment, smoking status and use of respirator.

5.7.1 LUNG FUNCTION AND AGE

In the current study, a negative trend in FEV_1/FVC values was observed for 2019 and 2020 – revealing that age is inversely proportional to FEV_1/FVC values. Results show that as one gets older, their FEV_1/FVC values decline – indicating a deterioration in lung function. Although this trend cannot be seen entirely replicated in 2020, due to an unusually high value for the "older than 65" category, the general negative trend is distinguishable. These findings reflect those of Barroso *et al.* (2018: 328), which explains that pulmonary maturity is obtained between the ages of 20 and 25 years - after which lung function steadily declines – particularly the FEV_1, FVC and FEV_1/FVC values.

5.7.2 LUNG FUNCTION AND DEPARTMENT

Apart from anthropometric factors, Kakooei and Marioryad (2005: 54) reported that different job activities in flour mills also influenced the onset of work-related symptoms, describing lowered FVC, FEV_1, PEF and FEV_1/FVC values between workers and controls. In the current study, job activities were viewed as department-specific tasks, therefore, lung function results were analyzed in relation to each department. The present study found a decline in lung function values, particularly the FEV_1/FVC values between each department. Results indicate that among the six departments for 2019 and 2020, the laboratory and administrative staff had higher FEV_1/FVC values in comparison to staff from other departments. The mill and maintenance showed the lowest FEV_1/FVC results for 2019 respectively, whereas in 2020, it was the packing and maintenance departments respectively. These results suggest that production staff have reduced lung function in comparison to non-production staff - surmising that the area of work may be the cause. These findings are consistent with Mohammadien *et al.* (2013: 4) who stated that flour mill workers reported significantly higher respiratory diseases and lower FVC%, FEV_1%, FEV_1/FVC%, $FEF_{25\%}$, $FEF_{50\%}$ and $FEF_{75\%}$ as compared to controls. Furthermore, Mohammadien *et al.* (2013: 4) revealed a statistically significant ($p < 0.002$) relationship between respiratory symptoms reported, work area (links to level of flour dust exposure) and tobacco smoking showing that 96.8% of workers with increased levels of exposure (such as those from the packing unit) reported coughing, expectoration, wheezing and shortness of breath – advocating that work area and the level of flour dust exposure in a specific area plays a role in reduced pulmonary function.

At the research site, the administration and laboratory departments are completely enclosed and isolated from the main production areas. Additionally, the administration department does not interact with flour at all, whereas the laboratory department handle small amounts of flour in a controlled environment. These factors substantially reduce one's exposure to flour dust. The milling and packing departments on the other hand, are required to work closely with flour - milling wheat into flour and physically packing out flour into bags. These activities require employees to be in close contact (within arm's length) with flour for prolonged periods of time– inadvertently exposing employees. It is worth mentioning that at this specific flour mill, the maintenance room is located within the mill area and maintenance employees are required to work hand-in-hand with flour millers regularly – these conditions may provide a reason for the maintenance and milling teams' lung function results appearing similar to each other.

5.7.3 LUNG FUNCTION AND DURATION OF EMPLOYMENT

In addition to the factors discussed above, literature has placed strong emphasis on the duration of employment and its influence on pulmonary function. Gholami *et al.* (2018: S782), Tosho *et al.* (2015: 62), Moghaddasi *et al.* (2014: 115), Mohammadien *et al.* (2013: 4), Wagh *et al.* (2006: 399) and Kakooei and Marioryad (2005:54) have provided substantial evidence indicating that workers employed for a longer period showed a significantly higher prevalence of respiratory symptoms and a decline in lung parameters in comparison to those with a shorter duration of employment. However, the outcomes of the current study have proven to be inconsistent when compared to past research. In 2019, FEV_1/FVC values were irregular and sporadic. Between each of the employment period categories, the FEV_1/FVC values increased and decreased – making it difficult to reach a conclusion. Results from 2020 were more encouraging as findings were more attuned to previous literature (Gholami *et al.* 2018: S782; Tosho *et al.* 2015: 62; Moghaddasi *et al.* 2014: 115; Mohammadien *et al.* 2013: 4; Wagh *et al.* 2006: 399 and Kakooei and Marioryad 2005: 54) – an inversely proportional relationship was developing, showing a decline in FEV_1/FVC values as the years of employment increased. Contrary to other studies however, the longest employed workers also possessed the highest FEV_1/FVC values. This observation may be due to factors such as age, job description and department. The current study found that some individuals in this category comprised of senior management below the age of 40, primarily based in an office environment therefore, exposure to flour dust would be minimal. However, other individuals in this category formed part of the production staff; worked closely with flour and were required to perform labor-intensive tasks. Due to the physically demanding aspect of the job, it is possible that these tasks acted as exercises, in effect, improving lung capacity.

Although farfetched, research conducted by Jun, Kim, Nam and Kim (2016: 1682) and Park and Han (2017: 1455) have disclosed that lung capacity, even amongst the elderly or injured, may be improved by aerobic exercises. Hyun-Ju *et al.* (2016: 1682) discovered that FVC,

FEV_1/FVC, PEF and muscle activity in the *rectus abdominis* (abdominal muscles) had significantly increased after four weeks of exercising ($p < 0.05$) but reduced significantly ($p < 0.05$) in the following two weeks with no exercise – suggesting that for lasting improvement in lung capacity, exercise is required for more than four weeks (Jun *et al.* 2016: 1683). Results from these studies provide the current study with possible explanations, hinting that strenuous work activities can contribute to improved lung capacity and that the duration of employment may have played a part in sustaining the improvement.

5.7.4 LUNG FUNCTION AND SMOKING STATUS

Smoking has long been associated with deteriorating lung function (Dockery *et al.* 1988: 289; Mohammadien *et al.* 2013: 5). Dockery *et al.* (1988: 286) discloses that after a few years of smoking, smokers experience an increased prevalence of abnormal function in the small airways than non-smokers. The same study also declares a distinct correlation between the number of cigarettes smoked and the deterioration of lung function. These findings are supported by Mohammadien *et al.* (2013: 5) which reported statistically significant differences in lung function parameters between smokers and non-smokers (p <0.001), reporting significant differences in FVC%, FEV_1%, FEV_1/FVC%, $FEF_{25\%}$ and $FEF_{75\%}$. Results from the current analysis agrees with Mohammadien *et al.* (2013: 5), revealing that smokers had lower FEV_1/FVC values as opposed to non-smokers for both 2019 (p <0.062) and 2020 (p < 0.496). These results were not statistically significant. Interestingly, the analysis further revealed that non-smokers showed lower mean FEV1 and FVC values for both 2019 and 2020 than smokers and that these results were in fact statistically significant. The results obtained were contrary to articles by Kakooei and Marioryad (2005: 52; Wagh *et al.* 2004: 400; Mohammadien *et al.* 2013: 6) which reported decreased FEV_1 and FVC values between workers and controls. The results obtained raised doubts as to whether smoking was the sole contributor to reduced lung function. Salvi and Salvi and Barnes (2009: 733) have since argued that even when it comes to Chronic Obstructive Pulmonary Disorders (COPD) approximately 25-45% of patients have never smoked – explaining that apart from smoking there are other contributing factors. The same study goes on to state that in a separate study assessing the prevalence of COPD in 12 countries (South Africa included) a high prevalence of COPD in never-smokers was discovered. Additionally, up to 50% of the COPD cases were due to non-smoking causes such as biomass smoke (especially in rural areas), occupational exposure to dust, fumes and toxic gases, history of pulmonary tuberculosis, history of chronic asthma, outdoor air pollution and socioeconomic status. Outcomes from previous studies speculate that non-smokers in the current study could have presented lower FEV_1 and FVC results due to the factors listed above. However, these factors were not measured in this study hence they cannot be justified. The evidence from this study points out that smoking does decrease FEV_1/FVC values.

5.7.5 LUNG FUNCTION AND USE OF RESPIRATORS

The current study found that individuals who wore respirators presented slightly higher mean FVC and FEV_1 values but lower mean FEV_1/FVC values than those who did not wear respirators. The obtained results were unanticipated as respirators are often suggested as a means of hazard mitigation, used to reduce exposure - thereby safeguarding health (Hosseinabadi *et al.* 2013: 139; Louhevaara 1984: 275). Even so, studies have shown that respirator use can affect lung function as well. A recent study by Fikenzer, Uhe, Lavall, Rudolph, Falz, Busse, Heppe and Laufs (2020: 1528) argued that when comparing the effects of wearing surgical masks and FFP2/N95 on cardiopulmonary exercise capacity, both masks lead to impaired lung function. Notably, the FFP2/N95 presented greater impairments than the surgical mask. Fikenzer *et al.* (2020: 1528) explained that increased breathing resistance, lowered breathing frequencies and reduced ventilation resulted in changes of inhalation and exhalation time and a reduced tidal volume. The study concluded that wearing a medical and/or FFP2/N95 mask had a significant impact on pulmonary parameters whilst at rest and during exercise in healthy adults. Similarly, Louhevaara (1984: 275) reported that the use of respiratory devices affected inhaling and exhaling breathing resistance and lead to altered breathing patterns, hyperventilation, Carbon dioxide retention and increased breathing work. It must be noted that due to the Coronavirus pandemic, multiple employees wore surgical masks daily. Additionally, the study site provides FFP2 masks to employees in high-exposure areas according to suggestions provided in the environmental monitoring reports. It is possible that the factors provided by Fikenzer *et al.* (2020: 1528) and Louhevaara (2008: 275) influenced the results obtained in the present study.

5.8 FLOUR DUST AND DRY COUGH

The current study showed that the maintenance department reported the highest percentage for dry cough. The mill department was second, followed closely by the administration and laboratory departments. This can be attributed to the amount of flour dust employees are exposed to within these departments as observed from the environmental monitoring reports – which, as outlined by previous studies (Lagiso, Mekonnen, Abaya, Takele and Workneh 2020: 6; Demeke and Haile 2018: 4; Ahire *et al.* 2017: 70 and Mohammadien *et al.* 2013: 6), would increase the risk of experiencing dry cough.

Dry cough is a frequently reported symptom among flour mill workers worldwide (Lagiso *et al.* 2020: 6; Demeke and Haile 2018: 4; Ahire *et al.* 2017: 70 and Mohammadien *et al.* 2013: 6). A literature has revealed that from a multitude of respiratory symptoms, dry cough and/or productive cough were among the most common. A 2017 Indian study found that up to 34% of flour mill workers reported frequent coughing while another 19% experienced respiratory tract irritation (Ahire *et al.* 2017: 70). Demeke and Haile (2018: 4) reported that the percentage prevalence of dry cough, productive cough, wheezing and breathlessness was 27.7%, 11.1%, 14.8% and 16.6% for exposed workers respectively as compared to 9.3%, 5.6%, 3.7% and 7.4% for non-exposed workers, respectively. These figures were higher for exposed versus unexposed employees. Additionally, results for dry cough were statistically significant ($p < 0.05$). Similarly, Mohammadien *et al.* (2013: 6) reported a higher prevalence of respiratory symptoms among exposed workers as opposed to non-exposed workers - dry cough was particularly high with 87.5% of exposed workers experiencing this symptom. A recent comparative study between flour mill workers and soft drink factory workers showed that chronic respiratory symptoms were higher among flour mill workers. Additionally, the chronic cough and chronic cough with sputum were most commonly reported at 39.3% and 17.9% respectively (Lagiso *et al.* 2020: 6). Evidence points out that flour dust exposure contributes to dry cough (Lagiso *et al.* 2020: 6; Demeke and Haile 2018: 4; Ahire *et al.* 2017: 70 and Mohammadien *et al.* 2013: 6). Research lists prolonged exposure, unhygienic work conditions, inadequate ventilation, duration of employment, intermingling departments and lack of PPE as critical components leading to increased prevalence of respiratory symptoms (Lagiso *et al.* 2020: 6; Demeke and Haile 2018: 4; Ahire *et al.* 2017: 70 and Mohammadien *et al.* 2013: 6).

The current study supports outcomes from earlier research. At the study site, specific factors to consider are the work conditions since previous environmental reports have already shown that the milling and maintenance departments were highly exposed to flour dust. Additionally, the maintenance room is located on the second floor within the mill area which speaks directly to the "intermingling departments" aspect. PPE is available and easily accessible and questionnaire responses have indicated a high PPE usage rate - suggesting that the other aforementioned factors listed require investigation.

5.9 FLOUR DUST AND RHINITIS

Results identified that reports of sneezing, running or blocked nose were experienced across all departments. However, departments with the highest prevalence were the milling, packing, administration and maintenance, respectively. It is noticed that apart from the administration department, all other departments were already identified as being exposed to high concentrations of flour dust - suggesting that the level of flour dust leads to the onset of rhinitis symptoms. These findings are consistent with earlier published work by the National Institute of Occupational Safety and Health (2009: 11) which found that employees in the higher-exposure group reported more work-related runny nose, stuffy nose and frequent sneezing as compared to the lower-exposed group. However, according to Brisman, Jarvholm and Lillienberg (2000: 339) and Bohadana, Massin, Wild, Kolopp and Toamain (1994: 1075), the risk of developing rhinitis exists at lower exposure levels as well. Brisman *et al.* (2000: 339) discovered that exposure to flour dust concentrations above 1mg/m^3 may lead to an increased risk of developing rhinitis - explaining that airborne flour dust particles are large enough to deposit in nasal canals in effect inducing nasal symptoms at lower air concentrations of flour dust. Additionally, Bohadana *et al.* (1994: 1075) relays that despite relatively low exposure to inspirable flour dust, seemingly 'healthy' workers in the bakery industry presented a significantly elevated number of symptoms and airway responsiveness abnormalities. These studies demonstrated that exposure to both high and relatively low concentrations of flour dust can induce rhinitis which could explain why rhinitis symptoms were reported among the high-exposure departments (Mill, maintenance and packing) and low-exposure departments (administration).

5.10 FLOUR DUST AND CONJUNCTIVITIS

Conjunctivitis is a frequently reported yet less severe form of flour-induced allergies (Stobnicka and Górny 2015: 243). According to results, a small proportion of employees reported itching or watery eyes - symptoms commonly associated with conjunctivitis. The mill department reported the highest prevalence, followed by the warehouse, administration, laboratory, packing and maintenance departments respectively. Findings reflect those by Ijadunola *et al.* (2004: 253) of which production staff reported significantly higher prevalence of several non-pulmonary symptoms, particularly eye irritation, eye discharge and conjunctivitis. Additionally, Ijadunola *et al.* (2004: 254) showed that when production staff were compared to internal controls - there were significant differences for eye irritation ($p < 0.01$), nasal catarrh ($p < 0.05$) and skin rash ($p < 0.001$). The production staff also reported higher frequencies of symptoms. Similarly, Ajeel and Al-Yassen (2007: 30), also reported eye allergic symptoms among flour mill workers but none amongst the comparison group of dairy workers and Pepsi Cola workers. A study by Ahire *et al.* (2017: 70) adds that eye irritation was reported by flour mill workers performing various activities. The greatest prevalence was noted for cleaning activities. The findings of the present study concur with Ijadunola *et al.* (2004: 254) and Ahire *et al.* (2017: 70). Although a small percentage of employees from each department reported itchy or watery eyes, the milling department reported the highest percentage by far. This could be due to the increased exposure to flour dust and the proximity which one has to work with flour, combined with the fact that employees did not wear eye protection whilst performing their day-to-day tasks.

5.11 CONCLUSION

The current study uncovered that amongst the six departments; the mill and packing departments were the only two to report both chest tightness and breathing difficulties as well as wheezing and whistling in the chest suggesting once more that production staff were more prone to negative respiratory effects than non-production staff. This was congruent to findings by Hosseinabadi *et al.* (2013: 5) which found that 44% of workers complained of chest tightness and 55% complained of exertional dyspnea. Notably, these symptoms were only reported by the exposed group.

Historical and recent research have conceded that there is a distinct correlation between flour dust exposure and adverse respiratory health effects. This study supports evidence from previous observations.

This study has established a strong relationship between site of work (which determines the level of exposure to flour dust) and the prevalence of respiratory issues. Retrospective environmental monitoring reports have highlighted the departments which presented consistently high flour dust levels, namely, the mill, packing and maintenance departments. Unsurprisingly, these departments also reported a higher prevalence of decreased lung function, breathing complications, chest tightness, rhinitis, dry cough and conjunctivitis. Evidence has revealed that apart from the level of exposure to flour dust, other factors are shown to have influenced results, such as, age, PPE awareness and training, novel Coronavirus pandemic, duration of employment, smoking habits, mixing departments and a lack of a flour dust OEL.

Although the study uncovered similar results to previous research - there were a few unanticipated findings as well. The coronavirus pandemic played a fundamental role in acclimatizing staff towards respiratory protection showing that while other studies reported lower usage due to discomfort, the current study did not. Additionally, the effect of continuous mask/ respirator usage was noticeable - showing improved mean FEV1/FVC values for age, department, use of respirator and even smoking between 2019 (pre-coronavirus) and 2020 (start of coronavirus). Duration of employment in relation to levels of lung function revealed distinctly abnormal results. Although research has indicated that the introduction of aerobic exercises can be used to improve lung function results, in the current study, these effects were unknown. Another anomaly discovered was the adverse effect respirator use had on lung function. Numerous studies have suggested respirators as a control method against dust exposure while simultaneously, other studies have argued the ill-effects of air resistance and adjusted breathing patterns from respirators on lung function.

CHAPTER 6

6.1 RECOMMENDATIONS

In Occupational Health and Safety, the hierarchy of control is applied to prioritize the best way a hazard or contaminant may be controlled. The recommendations provided will follow the same principles, to stay in line with health and safety guidelines.

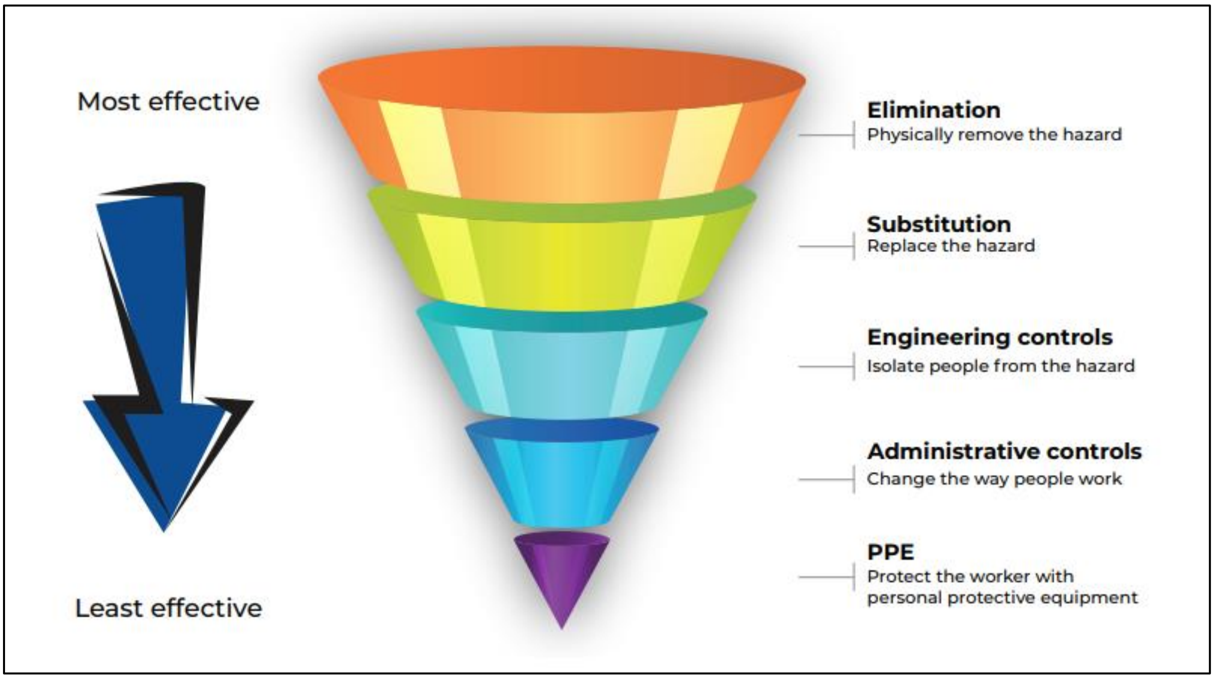

Figure 59: Hierarchy of Control (Centers for Disease Control and Prevention 2015)

6.1.1 ELIMINATION OF THE HAZARD

6.1.1.1. Vibrations from flour milling operations can quickly lead to deterioration of plant equipment and machinery. General wear and tear (bends, leaks, perforations, spillages, malfunctioning sensors) in machines and equipment can result in unwanted airborne flour dust, risking employee exposure. Regular inspections and planned maintenance programmes must be an entrenched practice to identify deteriorating components and to replace/ repair immediately.

6.1.1.2. Negative air pressure in product handling conveyors and sampling points will ensure that air leakage will flow into the equipment rather than outwards, thus significantly reducing dust emissions.

6.1.1.3. Isolate dust generating equipment and processes by installing physical barriers such as walls and strip curtains. Alternatively, enclosures (boxes) can be built around the dust generating source, only allowing for operator visibility and accessibility.

6.1.1.4 Automate dust generating processes. Major dust generating processes, such as the bagging out stations or bag flattening operations directly expose employees to flour dust. Due to these risks, industries are now seeking to automate these processes thereby eliminating operators and the risk of exposure.

Figure 60: Flour blowback (United States of America, Department of Health and Human Services 2012: 158)

6.1.2 SUBSTITUTION

6.1.2.1 It is advised that vacuum cleaners be used to reduce the risk of redistributing flour dust during cleaning activities. If vacuum cleaners cannot be used - soft-bristled brushes and dustmops are suggested. Additionally, long-handled brooms may also be used to increase the distance between the cleaner and the dust. The use of compressed air for cleaning is prohibited.

6.1.2.2 Safety grids on mixing machines should be replaced with solid covers. This will prevent both dust generation when depositing flour into mixing bowls during baking as well as other physical injuries.

Figure 61: Mixer without and with a cover (Baatjies et al. 2014: 813)

6.1.3 ENGINEERING

6.1.3.1 Exhaust hoods should be installed: The exhaust hood surrounds the bag to capture the excess dust released during the bag filling process. Exhaust hoods must also be connected to a Local Exhaust Ventilation system to capture excess dust generated.

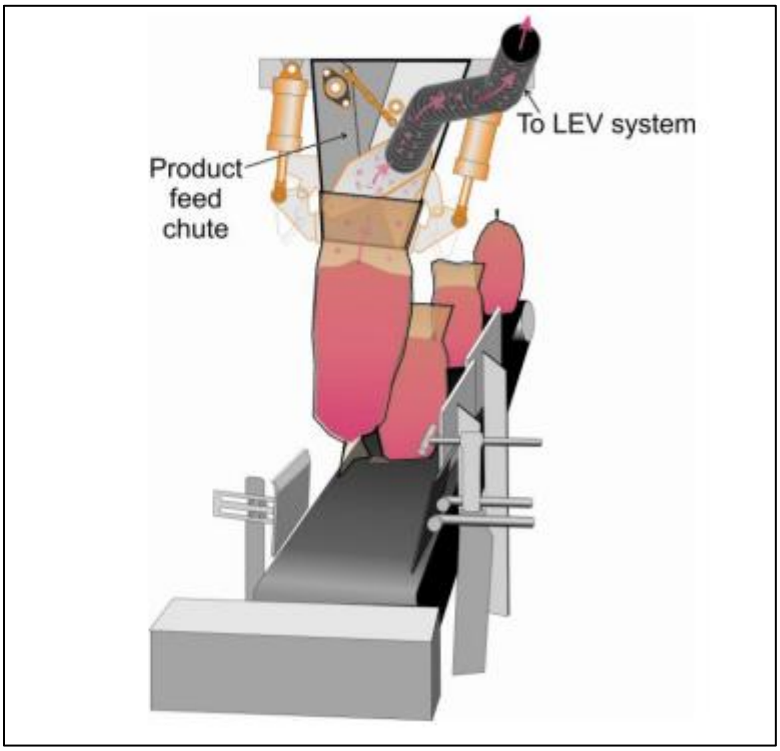

Figure 62: Exhaust hood used when filling flour into bags (United States of America, Department of Health and Human Services 2012: 163)

6.1.3.2 Exhaust hoppers should be installed: Like the exhaust hood design but with the addition of a hopper and screw conveyor. The hopper is placed below the bagging out station to collect excess dust released during the bag filling process. The exhaust hood and LEV system is located between the bagging station and the screw conveyor resulting in lighter particles being captured by the LEV system while heavier particles fall into the screw conveyor and are recycled back into the manufacturing process.

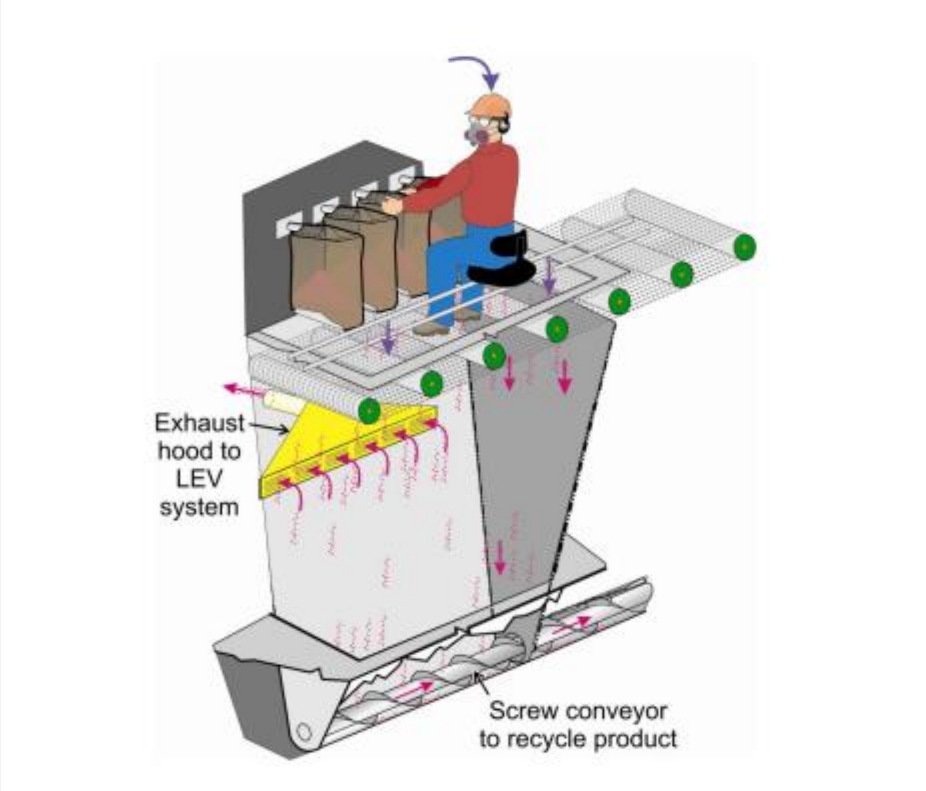

Figure 63: Exhaust hopper installation (United States of America, Department of Health and Human Services 2012: 168)

6.1.3.3 Air cleaning devices are used to clean polluted ventilation airstreams, thereby removing toxic particulate substances. The type of dust plays a great role in determining the type of air cleaning device required. In a flour mill, air cleaning devices to consider include gravity separators (drop out boxes), centrifugal collectors (cyclones), baghouse collectors, cartridge collectors. Cleaning and maintenance of air cleaning devices must be prioritized to ensure that they are operating at their optimum level.

6.1.4 ADMINISTRATIVE CONTROLS

6.1.4.1 Employee's medical history of COPD, sinusitis and eczema must be assessed, affected employees should be placed in departments that have lower concentrations of flour dust. If this cannot be done, schedules to regularly rotate staff should be created to minimize the level of exposure and duration of exposure. This will reduce the risk of aggravating pre-existing conditions.

6.1.4.2 Thorough assessment of spirometry test results year-on-year to determine high-risk individuals and implementing specific controls to reduce employees' exposure must be conducted. Additionally, evaluations may include year-on-year mean lung function assessments to ascertain effectiveness of current interventions.

6.1.4.3 Both area sampling and personal sampling tests instead of just one test should be conducted as these will pinpoint both the areas and tasks responsible for high-flour dust exposure. Interventions may be designed based on these results.

6.1.4.4 Continued implementation of respiratory protection programmes must be enforced. Programmes may include but are not limited to: policies addressing the influence of religion and culture on respirator use; risk assessments to determine the level of exposure, employees requiring respiratory protective equipment and correct respiratory protection based on exposure; medical evaluations to ascertain if employees are medically fit to wear respiratory protection; education and training on use and limitations accompanying respirator use and respirator fit testing.

6.1.4.5 Provision of separate OELs for flour dust and grain dust must be introduced and monitored.

6.2 LIMITATIONS

Limitations encountered during the study comprise the following:

- No spirometry test results for 2021. Lung function tests were prohibited due to the novel Coronavirus.
- The study site does not enforce regular baseline medical surveillance, as a result, there is no consistency in the lung function tests – an accurate assessment of lung function from start of employment till now could not be ascertained.
- Environmental monitoring assessments were based on an eight-hour personal sampling test. This was the only method that the study site opted for as it is the most cost-effective option. Personal sampling is subjective to the worker's task, behaviour and habits. It does not provide an extensive understanding of occupational exposure within a specific area.

- The dust sampling method used (NIOSH 0500 method) is to test for total dust and not specially for flour dust. It, therefore, is unable to specify the exact amount of flour dust to which the employee is exposed. Results are indicative of all dust types that employees may have been exposed to in that work shift.
- The Hazard Chemical Agents Regulations does not stipulate different OELs for flour dust and grain dust.

6.3 CONCLUSION

Earlier literature has provided sufficient evidence linking flour dust exposure to a myriad of detrimental health effects, affecting the respiratory system. The current study supports findings from earlier research.

The present research has established a strong relationship between site of work (which determines level of exposure) and the prevalence of respiratory and conjunctival issues. This statement is supported by the fact that the three departments (mill, packing and maintenance) that presented increased reports of reduced lung function, breathing complications, chest tightness, rhinitis, dry cough, and conjunctivitis, also presented consistently higher flour dust concentrations. Additionally, the study identified that apart from high levels of flour dust exposure, various other factors played a role in deteriorating respiratory health such as age, PPE awareness and training, duration of employment, smoking habits, mixing of departments, the current coronavirus pandemic and the absence of a flour dust OEL.

PPE is the most preferred control measure. However, the current study shows that even when most employees wore respirators/ masks, high counts of respiratory issues were still prevalent. This proved that while PPE is inexpensive, it does not necessarily offer the best protection the against the effects of occupational flour dust exposure, unless it works in conjunction with other control measures. Results emphasize the need to implement measures listed further up the hierarchy of control as these options offer long term solutions and do not rely on worker behaviour to be effective.

Apart from sharing high flour dust concentrations, the mill, packing, and maintenance departments were inappropriately positioned and possessed inadequate physical barriers. This indicates that clear department segregation is vital to protect against exposing employees that have no reason to be exposed.

This study also identified the lack of an appropriate OEL for flour dust. It must be stressed that although grain dust and flour dust is generated from wheat cleaning and milling processes, they are vastly different in composition, source of generation and particle size which all lead to distinct adverse health effects. Therefore, it is inappropriate to use the same OEL for both grain dust and flour dust (Baatjies and Jeebhay 2013: 239). While the OHS HCA now recognize the difference between the two dusts, more can be done by minimizing the OEL. Enforcing stringent controls is difficult if there is no legislative support and guidance.

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APPENDIX A1: STATISTICIAN'S REPORT

What margin of error can you accept? 5% is a common choice	5 %	The margin of error is the amount of error that you can tolerate. If 90% of respondents answer *yes*, while 10% answer *no*, you may be able to tolerate a larger amount of error than if the respondents are split 50-50 or 45-55. Lower margin of error requires a larger sample size.
What confidence level do you need? Typical choices are 90%, 95%, or 99%	95 %	The confidence level is the amount of uncertainty you can tolerate. Suppose that you have 20 yes-no questions in your survey. With a confidence level of 95%, you would expect that for one of the questions (1 in 20), the percentage of people who answer *yes* would be more than the margin of error away from the true answer. The true answer is the percentage you would get if you exhaustively interviewed everyone. Higher confidence level requires a larger sample size.
What is the population size? If you don't know, use 20000	65	How many people are there to choose your random sample from? The sample size doesn't change much for populations larger than 20,000.
What is the response distribution? Leave this as 50%	50 %	For each question, what do you expect the results will be? If the sample is skewed highly one way or the other, the population probably is, too. If you don't know, use 50%, which gives the largest sample size.
Your recommended sample size is	56	This is the minimum recommended size of your survey. If you create a sample of this many people and get responses from everyone, you're more likely to get a correct answer than you would from a large sample where only a small percentage of the sample responds to your survey.

APPENDIX A2: STATISTICIAN'S LETTER

STATISTICIAN DECLARATION FOR CONSULTATION:

I hereby declare that I have read Ms Savanah Hoopdeo's proposal for her Master's research and given appropriate assistance / recommendations.

Signed… ……………………….. Date: 13 February 2020

Deepak Singh

DUT (Panel of Statisticians)

APPENDIX B1: REQUESTING PERMISSION FOR MEDICAL QUESTIONNAIRE

Hi Savanah

I am good, thanks 😊

Please find attached.

Sorry for the delay.

Kind regards

Lynette Abrahams
Email: info@occutrend.co.za
Cell: 082 400 0900
Website: www.occutrendhealthcare.co.za

OCCUTREND HEALTHCARE

From: Savanah Hooper <shoopdeo336@gmail.com>
Sent: 18 February 2020 08:52 PM
To: Info <info@occutrend.co.za>
Subject: Re: Flour dust questionnaire

Hi Lynette,

I am well thanks and how are you?😊

Thank you for the attached documents, they are so incredibly helpful! I will make a few adjustments in accordance with the study and send them back to you for comment.

The missing spaces on the permission letter can include the following:

To: Whom it may concern

Address: 7 Ritson Road, Overport, Durban, 4001

ID Number: 970502 0285 081

Title: Occupational exposure to dust and the associated health risks among employees working in a flour mill

Masters in: Health Sciences

Faculty of Health Sciences

Thanking you again Lynette😊

Kind Regards,

Savanah Hoopdeo

On Mon, Feb 17, 2020 at 8:32 PM Info <info@occutrend.co.za> wrote:

Hi Savanah

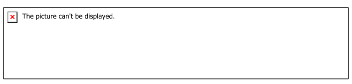
Sorry for the delayed response. I hope that you are doing well 😊

Please find the attached permission letter. Please send me all the information where I have underlined and any other information that you think that I should include, and I will finalize the letter, sign it and send it back to you.

I have included the editable version of the general questionnaire and the respiratory questionnaire. Once you have amended it, you can send it back to me to review, if you like.

Warm regards

Lynette Abrahams
Email: info@occutrend.co.za
Cell: 082 400 0900
Website: www.occutrendhealthcare.co.za



From: Savanah Hooper <shoopdeo336@gmail.com>
Sent: 12 February 2020 03:53 PM
To: info@occutrend.co.za
Subject: Flour dust questionnaire

Hi Lynette,

I trust that you are well.

As discussed, according to research, the major health effects of flour dust are:

1. Asthma

2. Conjunctivitis

3. Rhinitis

4. Dermal reactions

Also,

Please may I receive a formal letter with a letterhead stating that you are permitting me to use and amend your general medical questionnaire to suit the study of assessing "Occupational exposure to flour dust and the associated health risks among employees working in a flour mill"

Nothing has been finalized as yet, however, I would like to work in advance and receive my permissions so I can add them as attachments in my thesis proposal.

Thank you so much for being so accommodating and understanding, it is so highly appreciated.

Kind regards,

Savanah Hoopdeo

APPENDIX B2: PERMISSION LETTER

OCCUTRENDHEALTHCARE..•::•

P O Box 850, Westville 3630 Fax: 0867645291 cell:
oe24000900

Email: info@occutrend.co.za

Website: www.occutrendhealthcare.co.za

To: Whom it may concern

Durban University of Technology

7 Ritson Road
Overport

Durban

4001

17 February 2020

This letter serves to confirm that I permit Savanah Hoopdeo, ID number: [redacted], to use and amend our general medical questionnaire and respiratory questionnaire to suit the study of "Occupational exposure to dust and the associated health risks among employees working in a flour mill" for the express purpose of her Master's degree in Health Sciences. She has agreed that these questionnaires will not be shared with anyone except the faculty of Health Sciences.

Please contact me if you have any queries.

Yours sincerely,

Lynette Abrahams

Director: Occutrend Healthcare

APPENDIX C: IREC LETTER OF ETHINCAL CLEARANCE

Institutional Research Ethics Committee

Research and Postgraduate Support Directorate

2nd Floor, Berwyn Court

Gate 1, Steve Biko Campus

Durban University of Technology

P O Box 1334, Durban, South Africa, 4001

Tel: 031 373 2375

Email: lavishad@dut.ac.za http://www.dut.ac.za/research/institutional_research_ethics

www.dut.ac.za

11 March 2021

Miss S Hoopdeo

9 Glasham Place

Westham

Phoenix

4068

Dear Miss Hoopdeo

Occupational exposure to flour dust and the associated respiratory outcomes among workers in a selected flour mill in KwaZulu-Natal

Ethical Clearance number IREC 150/20

The Institutional Research Ethics Committee acknowledges receipt of your final data collection tool for review. We are pleased to inform you that the data collection tool has been approved. Kindly ensure that participants used for the pilot study are not part of the main study. In addition, the IREC acknowledges receipt of your gatekeeper permission 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

Prof J K

Chairperson:

LETTER OF INFORMATION

Title of the Research Study: Occupational exposure to flour dust and the associated respiratory outcomes among workers in a selected flour mill in KwaZulu-Natal

Principal Investigator/s/researcher:

Savanah Hoopdeo (BTech: Environmental Health)

Co-Investigator/s/supervisor/s:

Dr. Shanaz Ghuman, PhD: Masters Public Health

Dr Vasanthrie Naidoo, D Nursing

Brief Introduction and Purpose of the Study

Grain milling has existed for many years and is even considered one of the oldest industries in South Africa. However, as with all industries, this industry too was found to cause adverse health effects among employees, with signs and symptoms including coughing, breathlessness, hoarseness, asthma and eye problems. Research has revealed that grain and flour dust exposure among flour mill workers results in serious issues relating to the lungs and the skin. In South Africa, there is limited research exploring the prevalence of respiratory disease among grain workers. It was also found that research pertaining to flour dust exposure and skin issues were severely lacking. This gap identified in South African literature highlights a need for further research in this field, which is what this study aims to achieve. This study seeks to explore the Occupational exposure to flour dust and the associated respiratory outcomes among workers in a selected flour mill in KwaZulu-Natal

Good day, I trust that you are keeping well and having a lovely day! I am a student at DUT doing research for my Masters' degree in Health Sciences: Environmental Health and I would like to graciously invite you to participate in the following research study.

What is Research?

Research is a systematic inquiry that involves the collection of data; documentation of critical information; and analysis and interpretation of that data/ information. It is generally used to enhance knowledge.

Outline of the Procedures:

According to the statistician, this study will comprise of 56 participants. The researcher will aim to collect data using three data collection instruments, namely questionnaires, spirometry tests and occupational hygiene reports. The questionnaire will be written in English (Appendix F1) and isiZulu (Appendix F2). The questionnaire will be divided into three sections. Section A will focus on demographic and personal data. Section B will look at work conditions in the flour mill. Section C will assess medical history. Questionnaires will be administered at the study site by the researcher, during normal working hours. The board room will be used as a space for you to complete the relevant letters and to answer the questionnaire. Prior to answering the questionnaire, you are required to first read the letter of information and sign the letter of consent. Permission will be granted from supervisors and top management to allow time for you to answer the questionnaire. You will require at least 45 minutes to complete the questionnaire. Researcher will request for supervisors to allow participants to leave the work area one at a time, so that it does not interrupt with the normal work functions. You will be provided with one questionnaire. After you complete the questionnaire, it is handed to the researcher for collection and storage. You are then permitted to return to work and the next participant is requested for. The researcher will also require access to your spirometry test results. Spirometry, also referred to as the basic lung function test, is the measurement of air volumes and airflow rates of the lung. A spirometry test assesses the parameters of Lung Function and can detect abnormalities and respiratory-related issues. Afterwards the researcher will peruse dust sampling records. Dust sampling is an example of environmental monitoring, and is generally conducted in two ways, area sampling or personal sampling. **Please note: there are no follow-up visits envisioned for this study**.

Due to the current Coronavirus pandemic, the researcher is required to take additional steps during the data collection stage to protect the health and safety of the participants. The research site has a pre-designed coronavirus risk mitigation procedure already in place, specific to boardrooms. To ensure the health and safety of participants, the researcher will comply with this procedure, which entails the following:

1. Boardroom is sanitized using an approved sanitiser with at least 70% alcohol. Areas to be sanitized include the table, all chairs, chair arms, door handles, air conditioning remotes, projector, projector remote, whiteboard markers, whiteboard eraser, window handles and light switches.
2. Each person is permitted entry into the boardroom, only if wearing a face mask.
3. Each person is required to sanitize their hands upon entry.
4. Each person is required to carry their own stationery – however, due to this being a food industry, employees are not permitted to carry pens, unless required. The researcher will provide participants with pens to complete the questionnaire, afterwards the pens will be sanitized, before re-use.
5. Each person is required to maintain a minimum of two meters distance from each other. This is further enforced by floor markings, detailing where each chair must be placed.
6. A register is taken to account for all persons in the boardroom.
7. After use, the boardroom is sanitized again. Areas to be sanitized include the table, all chairs, chair arms, door handles, air conditioning remotes, projector, projector remote, whiteboard markers, whiteboard eraser, window handles and light switches.

Risks or Discomforts to the Participant:

There are no envisioned risks to the you when participating in this study.

Explain to the participant the reasons he/she may be withdraw from the Study:

You may voluntarily withdraw from the study at any time - without fear of consequence or prejudice. Should you wish to withdraw from the study, please contact the researcher using the contact details provided. The researcher will then remove you from the study.

Benefits:

This study will help understand the health effects caused by flour dust exposure. It will potentially help improve working conditions within this industry by better managing the amount of flour dust that it allows into the air. It will also help promote employee health and safety by enforcing relevant legislations more strictly.

Remuneration:

There will be no means of remuneration following your participation in this study.

Costs of the Study:

There are no costs expected from you.

Confidentiality:

You are required to complete questionnaires anonymously. All data collected will be available to the researcher and supervisor only. All data will be kept under lock and key for 5 years in a cupboard accessible only to the researcher or supervisor. Thereafter it will be disposed of by means of shredding. All electronic copies will be deleted. Anonymity and confidentiality will be maintained. The name of the study site will not be mentioned during any point of the research and the information received will be strictly confidential.

Results:

Results will form part of the thesis and will be disseminated to you via a newsletter. Results will only be disseminated once the thesis has been approved and passed by the relevant review and Ethics boards.

Research-related Injury:

No research-related injury envisioned.

Storage of all electronic and hard copies including tape recordings

All physical data will be kept under lock and key for 5 years in a cupboard accessible only to the researcher or supervisor. Thereafter it will be disposed of by means of shredding. All electronic copies will also be kept for a period of 5 years and will be password protected. Only the researcher and supervisor will have knowledge of this password. After 5 years, electronic copies will be deleted.

Persons to contact in the Event of Any Problems or Queries:

Please contact the researcher (083 264 0762), my supervisor (083 588 3245) or the Institutional Research Ethics Administrator on 031 373 2375. Complaints can be reported to the Director: Research and Postgraduate Support Dr L Linganiso on 031 373 2577 or researchdirector@dut.ac.za.

APPENDIX D2: LETTER OF CONSENT FOR PILOT STUDY (ENGLISH)

CONSENT

Full Title of the Study:

Occupational exposure to flour dust and the associated respiratory outcomes among workers in a selected flour mill in KwaZulu-Natal

Names of Researcher/s:

Savanah Hoopdeo (BTech: Environmental Health)

Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, ______________________ (name of researcher), 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/ RightThumbp**

I, ___________________(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 D3: LETTER OF INFORMATION FOR PILOT STUDY (ISIZULU)

ISAZISO

Isihloko sophenyo:

Ukuba sengcupheni yothuli lukafulawa kanye nezingozi zezempilo ezihambisana nakho Phakathi kwabasebenzi endaweni ekhethiwe egaya ufulwa esesifundazweni saKwaZulu-Natal

Umncwaningi:

Savanah Hoopdeo (BTech: Environmental Health)

Abasizi bomcwaningi nomhloli:

Dr. Shanaz Ghuman, PhD: Masters Public Health

Dr Vasanthrie Naidoo, D Nursing

Isihloko sophenyo: Ukuba sengcupheni yothuli lukafulawa kanye nezingozi zezempilo ezihambisana nakho Phakathi kwabasebenzi endaweni ekhethiwe egaya ufulwa esesifundazweni saKwaZulu-Natal

Isingeniso nenjongo yoncwaningo:

Ukugaywa kokusanhlamvu kwaqala emandulo futhi kuthathwa njengemboni endala kwelikamthaniya. Nalemboni njengezinye kutholaka ukuthi nayo iba nomthelela ongemuhle ezimpilweni zabasebenzi. Abasebeni bahaqwa izimpawu zokukhwehlela , ukuncipha komoya, ukusha kwephimbo, isifubasomoya, izinkinga zamehlo kanye nokunye. Ngokocwaningo ukuba sempuqumpuqwini kafulawa nokusanhlamvu kwabasebenzi isikhathi eside, kuholela ezinkingeni zamaphaphu nesikhumba. Kwelengabadi alukho kahle ucwaningo olukhomba ukundlondlobala kwezifo zesifuba kubasebenzi basembonini yokusanhlamvu. Lolu cwaningo lufuna ukuhlola ukuba sengupheni yothuli lukafulawa kanye nezingozi zezempilo ezihambisana nakho phakathi kwabasebenzi endaweni ekhethiwe egaya ufulawa esesifundazweni saKwaZulu-Natal

Usuku oluhle, ngiyethemba ukuthi ungumgcini omuhle futhi unosuku oluhle! Ngingumfundi e-DUT ngenza ucwaningo lweziqu zami zeMasters kwi-Health Sciences: Environmental Health futhi ngithanda ukukumema ngomusa ukuthi ubambe iqhaza esifundweni esilandelayo socwaningo

Luyini Ucwaningo?

Ucwaningo luphenyo oluhlelekile olubandakanya ukuqoqwa kwemininingwane; imibhalo yolwazi olubucayi; kanye nokuhlaziywa nokuchazwa kwaleyo mininingwane. Ngokuvamile isetshenziselwa ukuthuthukisa ulwazi.

Uhlelo oluzolandelwa:

Ngokusho kwesazi sezibalo, lolu cwaningo luzoba nabahlanganyeli abangama-56. Umncwaningi uhlose ukuqoqa imininingwane esebenzisa izinsiza ezintathu, okuyimibuzo, izivivinyo ze-spirometry kanye nemibiko yenhlanzeko emsebenzini. Uhlu lwemibuzo luzobhalwa ngesiNgisi (Isithasiselo F1) nangesiZulu (Isithasiselo F2). Uhlu lwemibuzo luzohlukaniswa izigaba ezintathu. Isigaba A sizogxila kwimininingwane yabantu kanye imininingwane yomuntu siqu. Isigaba B sizobheka izimo zomsebenzi esigayweni sefulawa. Isigaba C sizohlola umlando wezokwelapha. Amaphepha emibuzo azosingathwa endaweni yokucwaninga ngumcwaningi, ngezikhathi zokusebenza ezijwayelekile. Igumbi lebhodi lizosetshenziswa njengesikhala sokuthi ugcwalise izinhlamvu ezifanele futhi uphendule uhlu lwemibuzo. Ngaphambi kokuphendula uhlu lwemibuzo, kudingeka ukuthi uqale ufunde incwadi yolwazi bese usayina incwadi yemvume. Imvume izonikezwa kusuka kubaphathi kanye nabaphathi abaphezulu ukuvumela isikhathi sokuthi uphendule uhlu lwemibuzo. Uzodinga okungenani imizuzu engama-45 ukuqedela uhlu lwemibuzo. Umcwaningi uzocela abaphathi ukuthi bavumele ababambe iqhaza ukuthi baphume endaweni eyodwa ngasikhathi, ukuze kungaphazamisi imisebenzi ejwayelekile yomsebenzi. Uzonikezwa uhlu lwemibuzo olulodwa. Ngemuva kokugcwalisa uhlu lwemibuzo, lunikezwa umcwaningi ukuze aluqoqe futhi alugcine. Uyobe usuvunyelwa ukubuyela emsebenzini bese kucelwa umsebenzi olandeleyo. Umcwaningi uzodinga nokufinyelela kumiphumela yakho yokuhlolwa kwe-spirometry. I-Spirometry, ebizwa nangokuthi ukuhlolwa kokusebenza okuyisisekelo kwamaphaphu, isilinganiso samanani omoya namazinga okuhamba komoya wamaphaphu. ivivinyo se-spirometry sihlola imingcele yokusebenza kwamaphaphu futhi singathola okungajwayelekile nezinkinga ezihlobene nokuphefumula. Ngemuva kwalokho, umcwaningi uzosebenzisa amarekhodi esampuli othuli. Isampuli lothuli luyisibonelo sokuqapha imvelo, futhi ngokuvamile lwenziwa ngezindlela ezimbili, isampuli yendawo noma isampuli yomuntu siqu.

Uyacelwa uqaphele: akukho ukuvakashelwa okulandelwayo okucatshangelwe lolu cwaningo.

Ngenxa yobhubhane lwamanje lweCoronavirus, umcwaningi kudingeka ukuthi athathe ezinye izinyathelo ngesikhathi sokuqoqwa kwedatha ukuvikela impilo nokuphepha kwabahlanganyeli. Indawo yocwaningo lwesifo sobhubhane phecelezi (coronavirus) luvele lusezithebeni ikakhulukazi kumagumbi emihlangano (boardrooms). Ukuqikelela ukuphepha nempilo yababambe iqhaza, umcwaningi uzolandela imigomo efaka okulandelayo:

1. Igumbi lokubamba Imihlangano ihlanzwe ngokusebenzisa isihlanza magciwane evunyelwe okungenani i-70% yotshwala. Izindawo okufanele zihlanzwe zifaka phakathi itafula, zonke izihlalo, izingalo zezihlalo, izibambo zeminyango, izilawuli kude zomoya, iprojektha, irowu yeprojektha, whiteboard marker, irabodi yamhlophe, izibambo zamawindi nokushintshwa kokukhanya.
2. Umuntu ngamunye uvunyelwe ukungena ebhodini, kuphela uma egqoke isifonye yobuso.
3. Umuntu ngamunye kudingeka ukuthi ahlanze izandla zakhe lapho engena.
4. Umuntu ngamunye kudingeka ukuthi aphathe okwakhe kokubhala - kodwa-ke, ngoba le yimboni yokudla, abasebenzi abavunyelwe ukuphatha amapeni, ngaphandle uma kudingeka. Umcwaningi uzohlinzeka ababambiqhaza ngamapeni okugcwalisa uhlu lwemibuzo, ngemuva kwalokho amapeni azohlanjululwa ngaphambi kokusetshenziswa kabusha.
5. Umuntu ngamunye kudingeka alondoloze ubuncane bamamitha amabili ukusuka komunye nomunye. Lokhu kuphoqelelwa ngokudwetshwa phansi, okunemininingwane yokuthi isitulo ngasinye kufanele sibekwe kuphi.
6. Kubhaliswa uhlu lwabakhona ukubhekelela bonke abantu abasegumbini lokuhlala.
7. Ngemuva kokusetshenziswa, igumbi lokuhlala lihlanjululwa futhi. Izindawo okufanele zihlanzwe zifaka phakathi itafula, zonke izihlalo, izingalo zezihlalo, izibambo zeminyango, izilawuli kude zomoya, iprojektha, irowu yeprojektha, omaka abamhlophe, irabodi yamhlophe, izibambo zamawindi nokushintshwa kokukhanya.

Ubungozi kodlala indawo kucwaningo:

Akukho bungozi abubonakalayo kozibandakanye noncwaningo.

Ungayeka nini ukuba yingxenye yocwaningo:

Uvumelekile ukuphuma uma usuthanda ngale kokwesaba. Uma ufisa ukuhoxa ocwaningweni, sicela uxhumane nomcwaningi usebenzisa imininingwane yokuxhumana enikeziwe umcwaningi uzobe esekususa ocwaningweni.

Izithelo ezinhle zocwaningo:

Ucwaningo luzosiza ukuqonda umthelela wempuqumpuqu kafulawa empilweni yomsebenzi. Izosiza ukuphucula isimo sokusebenza ngokuqikelela ubungako bukafulawa obungantanta emoyeni. Izokhuthaza ukunakekelwa kwempilo nokuphepha kwabasebenzi kuqiniswe nokusebenza kwemithetho ephathelene nemboni yokusanhlamvu.

Inkokhelo:

Akukho nkokhelo wayithola ngalolucwaningo

Izindleko zocwaningo:

Akukho zindleko ezilindeleke kuwena

OkuyimFihlo:

Imibuzo uzoyiphendula ngokuyimfihlo.lonke ulwazi luzoba sezandleni zikamcwaningi nomhloli wakhe kuphela. Lonke ulwazi luzogcinwa andaweni ehluthulelwe iminyaka emihlanu emva kweminyaka emihlanu imiqulu yocwaningo izofakwa emishinini odla amaphepha. Ngasosonke isikhathi ulwazi olutholakele luyogcinwa luyimfihlo futhi angeke kwadalulwa ukuthi lutholakale kuphi.

Imiphumela:

Imiphumela izoba yingxenye yomqondo futhi izosatshalaliswa kuwe ngencwadi yezindaba. Imiphumela izosatshalaliswa kuphela uma ithisisi yamukelwe futhi yaphasiswa yibhodi elifanelekile lokubuyekeza Kanye nokuziphatha.

Ukulimala ngenxa yocwaningo:

Akukho kulimala okungenzeka

Ukugcinwa kwawo wonke amakhopi kagesi nawamakhompiyutha ahlanganisa okuqoshiwe:

Yonke imininingwane ephathekayo izogcinwa ikhiyiwe ngokhiye iminyaka engu-5 ekhabetheni elifinyeleleka kuphela kumpathi nakumcwaningi. Ngemuva kwalokho izolahlwa ukugaywe kwamaphepha. Onke amakhophi e-elektroniki azogcinwa isikhathi seminyaka emi-5 futhi azovikelwa nge-password. Umcwaningi nomphathi kuphela abazokwazi ngaleli phasiwedi. Ngemuva kweminyaka emi-5, amakhophi kagesi azosuswa

Uma kunenkinga ungaxhumana nabalandelayo:

Umcwaningi: 0832640762. Umhloli wakhe: 0835883245. Institutional research ethics administrator: 031-3732375. Izikhalazo zingabikwa kuMqondisi: Ucwaningo kanye nokwesekwa kweziqu: Dr L Linganiso on 031 373 2577 or researchdirector@dut.ac.za.

APPENDIX D4: LETTER OF CONSENT FOR PILOT STUDY (ISIZULU)

IMVUME

Isihloko sopheyo:

Ukuba sengupheni yothuli lukafulawa kanye nezingozi zezempilo ezihambisana nakho Phakathi kwabasebenzi endaweni ekhethiwe egaya ufulwa esesifundazweni saKwaZulu-Natal

Umncwaningi:

Savanah Hoopdeo (BTech: Environmental Health)

ISIVUMELWANO SOKUBA INGXENYEYOPHENYO:

Ngiyaqinisekisa ukuthi umcwaningi (igama lakhe)_________________________ ungazisile ngohlobo,nangezithelo ezinhle kanjalo nobubi bocwaningo. Inombolo egunyaza isikhung socwaningo ukusebenza__________________________________

- Ngiyifundile ngayiqonda kahle incwadi emayelana nocwaningo enginikwe yona.
- Ngiyazi ukuthi imiphumela yocwaningo kanye nemininingwane yame ephathelene negama lami iminyaka yami ubulili nokugula kwami kuyogcinwa kuyimfihlo kumqulu wocwaningo.
- Ngenxa yohlobo locwaningo ngiyavuma ukuthi ulwazi olutholakele lungafakwa kwikhomputha.
- Ngivumelekile ukushiya phansi ukuba ingxenye yocwaningo noma nini ngaphandle kokwesaba.
- Ngibe nethuba elanele lokubuza imibuzo ngase ngiziqomela mina ukuba ingxenye yocwaningo.
- Ngiyazi ukuthi ngiyokwaziswa ngemiphumela ebalulekile otholakale ngenxa yami kulolucwaningo.

_________________________	_____________	________	___________________
Igama loyingxenye yocwaningo	**usuku**	**Isikhathi**	**Sayina /beka isithupha sangakokudla**

Mina _________________________ (igama likamcwaningi) ngiyaqinesikisa ukuthi oyingxenye yocwaningo utsheliwe ngehlobo locwaningo Kanye nobui nobuhle balo

Igama eliphelele lomcwaningi	**Usuku**	**Sayina**
Igama eliphelele likafakazi (Uma ekhona)	**Usuku**	**Sayina**
Igama umzali(Uma kufanele)	**Usuku**	**Sayina**

APPENDIX E: LETTER OF APPROVAL FROM GATEKEEPER

20 January 2020

9 Glasham Place

Westham

Phoenix

4068

Request for Permission to Conduct Research

To L. Joseph

I trust that you are well.

My name is Savanah Hoopdeo, a degree student at the Durban University of Technology. The research I wish to conduct for my master's dissertation involves *Occupational exposure to flour dust and the associated respiratory outcomes among workers in a selected flour mill in KwaZulu-Natal.*

I am hereby seeking your consent to collect data from your employees and general work area. This will be in the form of questionnaires and access to confidential health surveillance information and environmental monitoring reports. If consent is granted, a convenient time and date can be arranged for data collection to ensue. All data collected is strictly confidential and the results will be reported in a research paper available to all participants on completion.

I have provided you with a copy of my proposal which includes copies of the questionnaires and consent forms to be used in the research process, as well as a copy of the approval letter which I received from the Institutional Research Ethics Committee (IREC).

If you require any further information, please do not hesitate to contact me on my cell number 083 264 0762 or on my email at shoopdeo336@gmail.com.

Thank you for your time and consideration in this matter.

Yours sincerely,

Savanah Hoopdeo

………………………………….

S Hoopdeo (Miss)

MHSc Student

DUT DURBAN UNIVERSITY OF TECHNOLOGY | INSTITUTIONAL RESEARCH ETHICS COMMITTEE

LETTER OF INFORMATION

Title of the Research Study: Occupational exposure to flour dust and the associated respiratory outcomes among workers in a selected flour mill in KwaZulu-Natal

Principal Investigator/s/researcher:

Savanah Hoopdeo (BTech: Environmental Health)

Co-Investigator/s/supervisor/s:

Dr. Shanaz Ghuman, PhD: Masters Public Health

Dr Vasanthrie Naidoo, D Nursing

Brief Introduction and Purpose of the Study

Grain milling has existed for many years and is even considered one of the oldest industries in South Africa. However, as with all industries, this industry too was found to cause adverse health effects among employees, with signs and symptoms including coughing, breathlessness, hoarseness, asthma and eye problems. Research has revealed that grain and flour dust exposure among flour mill workers results in serious issues relating to the lungs and the skin. In South Africa, there is limited research exploring the prevalence of respiratory disease among grain workers. It was also found that research pertaining to flour dust exposure and skin issues were severely lacking. This gap identified in South African literature highlights a need for further research in this field, which is what this study aims to achieve. This study seeks to explore the Occupational exposure to flour dust and the associated respiratory outcomes among workers in a selected flour mill in KwaZulu-Natal

Good day, I trust that you are keeping well and having a lovely day! I am a student at DUT doing research for my Masters' degree in Health Sciences: Environmental Health and I would like to graciously invite you to participate in the following research study.

What is Research?

Research is a systematic inquiry that involves the collection of data; documentation of critical information; and analysis and interpretation of that data/ information. It is generally used to enhance knowledge.

Outline of the Procedures:

According to the statistician, this study will comprise of 56 participants. The researcher will aim to collect data using three data collection instruments, namely questionnaires, spirometry tests and occupational hygiene reports. The questionnaire will be written in English (Appendix F1) and isiZulu (Appendix F2). The questionnaire will be divided into three sections. Section A will focus on demographic and personal data. Section B will look at work conditions in the flour mill. Section C will assess medical history. Questionnaires will be administered at the study site by the researcher, during normal working hours. The board room will be used as a space for you to complete the relevant letters and to answer the questionnaire. Prior to answering the questionnaire, you are required to first read the letter of information and sign the letter of consent. Permission will be granted from supervisors and top management to allow time for you to answer the questionnaire. You will require at least 45 minutes to complete the questionnaire. Researcher will request for supervisors to allow participants to leave the work area one at a time, so that it does not interrupt with the normal work functions. You will be provided with one questionnaire. After you complete the questionnaire, it is handed to the researcher for collection and storage. You are then permitted to return to work and the next participant is requested for. The researcher will also require access to your spirometry test results. Spirometry, also referred to as the basic lung function test, is the measurement of air volumes and airflow rates of the lung. A spirometry test assesses the parameters of Lung Function and can detect abnormalities and respiratory-related issues. Afterwards the researcher will peruse dust sampling records. Dust sampling is an example of environmental monitoring, and is generally conducted in two ways, area sampling or personal sampling. **Please note: there are no follow-up visits envisioned for this study**.

Due to the current Coronavirus pandemic, the researcher is required to take additional steps during the data collection stage to protect the health and safety of the participants. The research site has a pre-designed coronavirus risk mitigation procedure already in place, specific to boardrooms. To ensure the health and safety of participants, the researcher will comply with this procedure, which entails the following:

1. Boardroom is sanitized using an approved sanitiser with at least 70% alcohol. Areas to be sanitized include the table, all chairs, chair arms, door handles, air conditioning remotes, projector, projector remote, whiteboard markers, whiteboard eraser, window handles and light switches.

2. Each person is permitted entry into the boardroom, only if wearing a face mask.

3. Each person is required to sanitize their hands upon entry.

4. Each person is required to carry their own stationery – however, due to this being a food industry, employees are not permitted to carry pens, unless required. The researcher will provide participants with pens to complete the questionnaire, afterwards the pens will be sanitized, before re-use.

5. Each person is required to maintain a minimum of two meters distance from each other. This is further enforced by floor markings, detailing where each chair must be placed.

6. A register is taken to account for all persons in the boardroom.

7. After use, the boardroom is sanitized again. Areas to be sanitized include the table, all chairs, chair arms, door handles, air conditioning remotes, projector, projector remote, whiteboard markers, whiteboard eraser, window handles and light switches.

Risks or Discomforts to the Participant:

There are no envisioned risks to the you when participating in this study.

Explain to the participant the reasons he/she may be withdraw from the Study:

You may voluntarily withdraw from the study at any time - without fear of consequence or prejudice. Should you wish to withdraw from the study, please contact the researcher using the contact details provided. The researcher will then remove you from the study.

Benefits:

This study will help understand the health effects caused by flour dust exposure. It will potentially help improve working conditions within this industry by better managing the amount of flour dust that it allows into the air. It will also help promote employee health and safety by enforcing relevant legislations more strictly.

Remuneration:

There will be no means of remuneration following your participation in this study.

Costs of the Study:

There are no costs expected from you.

Confidentiality:

You are required to complete questionnaires anonymously. All data collected will be available to the researcher and supervisor only. All data will be kept under lock and key for 5 years in a cupboard accessible only to the researcher or supervisor. Thereafter it will be disposed of by means of shredding. All electronic copies will be deleted. Anonymity and confidentiality will be maintained. The name of the study site will not be mentioned during any point of the research and the information received will be strictly confidential.

Results:

Results will form part of the thesis and will be disseminated to you via a newsletter. Results will only be disseminated once the thesis has been approved and passed by the relevant review and Ethics boards.

Research-related Injury:

No research-related injury envisioned.

Storage of all electronic and hard copies including tape recordings

All physical data will be kept under lock and key for 5 years in a cupboard accessible only to the researcher or supervisor. Thereafter it will be disposed of by means of shredding. All electronic copies will also be kept for a period of 5 years and will be password protected. Only the researcher and supervisor will have knowledge of this password. After 5 years, electronic copies will be deleted.

Persons to contact in the Event of Any Problems or Queries:

Please contact the researcher (083 264 0762), my supervisor (083 588 3245) or the Institutional Research Ethics Administrator on 031 373 2375. Complaints can be reported to the Director: Research and Postgraduate Support Dr L Linganiso on 031 373 2577 or researchdirector@dut.ac.za.

CONSENT

Full Title of the Study:

Occupational exposure to flour dust and the associated respiratory outcomes among workers in a selected flour mill in KwaZulu-Natal

Names of Researcher/s:

Savanah Hoopdeo (BTech: Environmental Health)

Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, ______________________ (name of researcher), 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/ RightThumbprint**

I, ___________________(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 F3: LETTER OF INFORMATION FOR MAIN STUDY (ISIZULU)

ISAZISO

Isihloko sophenyo:

Ukuba sengcupheni yothuli lukafulawa kanye nezingozi zezempilo ezihambisana nakho Phakathi kwabasebenzi endaweni ekhethiwe egaya ufulwa esesifundazweni saKwaZulu-Natal

Umncwaningi:

Savanah Hoopdeo (BTech: Environmental Health)

Abasizi bomcwaningi nomhloli:

Dr. Shanaz Ghuman, PhD: Masters Public Health

Dr Vasanthrie Naidoo, D Nursing

Isihloko sophenyo: Ukuba sengcupheni yothuli lukafulawa kanye nezingozi zezempilo ezihambisana nakho Phakathi kwabasebenzi endaweni ekhethiwe egaya ufulwa esesifundazweni saKwaZulu-Natal

Isingeniso nenjongo yoncwaningo:

Ukugaywa kokusanhlamvu kwaqala emandulo futhi kuthathwa njengemboni endala kwelikamthaniya. Nalemboni njengezinye kutholaka ukuthi nayo iba nomthelela ongemuhle ezimpilweni zabasebenzi. Abasebeni bahaqwa izimpawu zokukhwehlela , ukuncipha komoya, ukusha kwephimbo, isifubasomoya, izinkinga zamehlo kanye nokunye. Ngokocwaningo ukuba sempuqumpuqwini kafulawa nokusanhlamvu kwabasebenzi isikhathi eside, kuholela ezinkingeni zamaphaphu nesikhumba. Kwelengabadi alukho kahle ucwaningo olukhomba ukundlondlobala kwezifo zesifuba kubasebenzi basembonini yokusanhlamvu. Lolu cwaningo lufuna ukuhlola ukuba sengupheni yothuli lukafulawa kanye nezingozi zezempilo ezihambisana nakho phakathi kwabasebenzi endaweni ekhethiwe egaya ufulawa esesifundazweni saKwaZulu-Natal

Usuku oluhle, ngiyethemba ukuthi ungumgcini omuhle futhi unosuku oluhle! Ngingumfundi e-DUT ngenza ucwaningo lweziqu zami zeMasters kwi-Health Sciences: Environmental Health futhi ngithanda ukukumema ngomusa ukuthi ubambe iqhaza esifundweni esilandelayo socwaningo

Luyini Ucwaningo?

Ucwaningo luphenyo oluhlelekile olubandakanya ukuqoqwa kweminininingwane; imibhalo yolwazi olubucayi; kanye nokuhlaziywa nokuchazwa kwaleyo minininingwane. Ngokuvamile isetshenziselwa ukuthuthukisa ulwazi.

Uhlelo oluzolandelwa:

Ngokusho kwesazi sezibalo, lolu cwaningo luzoba nabahlanganyeli abangama-56. Umncwaningi uhlose ukuqoqa imininingwane esebenzisa izinsiza ezintathu, okuyimibuzo, izivivinyo ze-spirometry kanye nemibiko yenhlanzeko emsebenzini. Uhlu lwemibuzo luzobhalwa ngesiNgisi (Isithasiselo F1) nangesiZulu (Isithasiselo F2). Uhlu lwemibuzo luzohlukaniswa izigaba ezintathu. Isigaba A sizogxila kwiminininingwane yabantu kanye imininingwane yomuntu siqu. Isigaba B sizobheka izimo zomsebenzi esigayweni sefulawa. Isigaba C sizohlola umlando wezokwelapha. Amaphepha emibuzo azosingathwa endaweni yokucwaninga ngumcwaningi, ngezikhathi zokusebenza ezijwayelekile. Igumbi lebhodi lizosetshenziswa njengesikhala sokuthi ugcwalise izinhlamvu ezifanele futhi uphendule uhlu lwemibuzo. Ngaphambi kokuphendula uhlu lwemibuzo, kudingeka ukuthi uqale ufunde incwadi yolwazi bese usayina incwadi yemvume. Imvume izonikezwa kusuka kubaphathi kanye nabaphathi abaphezulu ukuvumela isikhathi sokuthi uphendule uhlu lwemibuzo. Uzodinga okungenani imizuzu engama-45 ukuqedela uhlu lwemibuzo. Umcwaningi uzocela abaphathi ukuthi bavumele ababambe iqhaza ukuthi baphume endaweni eyodwa ngasikhathi, ukuze kungaphazamisi imisebenzi ejwayelekile yomsebenzi. Uzonikezwa uhlu lwemibuzo olulodwa. Ngemuva kokugcwalisa uhlu lwemibuzo, lunikezwa umcwaningi ukuze aluqoqe futhi alugcine. Uyobe usuvunyelwa ukubuyela emsebenzini bese kucelwa umsebenzi olandeleyo. Umcwaningi uzodinga nokufinyelela kumiphumela yakho yokuhlolwa kwe-spirometry. I-Spirometry, ebizwa nangokuthi ukuhlolwa kokusebenza okuyisisekelo kwamaphaphu, isilinganiso samanani omoya namazinga okuhamba komoya wamaphaphu. ivivinyo se-spirometry sihlola imingcele yokusebenza kwamaphaphu futhi singathola okungajwayelekile nezinkinga ezihlobene nokuphefumula. Ngemuva kwalokho, umcwaningi uzosebenzisa amarekhodi esampuli othuli. Isampuli lothuli luyisibonelo sokuqapha imvelo, futhi ngokuvamile lwenziwa ngezindlela ezimbili, isampuli yendawo noma isampuli yomuntu siqu. **Uyacelwa uqaphele: akukho ukuvakashelwa okulandelwayo okucatshangelwe lolu cwaningo.**

Ngenxa yobhubhane lwamanje lweCoronavirus, umcwaningi kudingeka ukuthi athathe ezinye izinyathelo ngesikhathi sokuqoqwa kwedatha ukuvikela impilo nokuphepha kwabahlanganyeli. Indawo yocwaningo lwesifo sobhubhane phecelezi (coronavirus) luvele lusezithebeni ikakhulukazi kumagumbi emihlangano (boardrooms). Ukuqikelela ukuphepha nempilo yababambe iqhaza, umcwaningi uzolandela imigomo efaka okulandelayo:

1. Igumbi lokubamba Imihlangano ihlanzwe ngokusebenzisa isihlanza magciwane evunyelwe okungenani i-70% yotshwala. Izindawo okufanele zihlanzwe zifaka phakathi itafula, zonke izihlalo, izingalo zezihlalo, izibambo zeminyango, izilawuli kude zomoya, iprojektha, irowu yeprojektha, whiteboard marker, irabodi yamhlophe, izibambo zamawindi nokushintshwa kokukhanya.
2. Umuntu ngamunye uvunyelwe ukungena ebhodini, kuphela uma egqoke isifonye yobuso.
3. Umuntu ngamunye kudingeka ukuthi ahlanze izandla zakhe lapho engena.
4. Umuntu ngamunye kudingeka ukuthi aphathe okwakhe kokubhala - kodwa-ke, ngoba le yimboni yokudla, abasebenzi abavunyelwe ukuphatha amapeni, ngaphandle uma kudingeka. Umcwaningi uzohlinzeka ababambiqhaza ngamapeni okugcwalisa uhlu lwemibuzo, ngemuva kwalokho amapeni azohlanjululwa ngaphambi kokusetshenziswa kabusha.
5. Umuntu ngamunye kudingeka alondoloze ubuncane bamamitha amabili ukusuka komunye nomunye. Lokhu kuphoqelelwa ngokudwetshwa phansi, okunemininingwane yokuthi isitulo ngasinye kufanele sibekwe kuphi.
6. Kubhaliswa uhlu lwabakhona ukubhekelela bonke abantu abasegumbini lokuhlala.
7. Ngemuva kokusetshenziswa, igumbi lokuhlala lihlanjululwa futhi. Izindawo okufanele zihlanzwe zifaka phakathi itafula, zonke izihlalo, izingalo zezihlalo, izibambo zeminyango, izilawuli kude zomoya, iprojektha, irowu yeprojektha, omaka abamhlophe, irabodi yamhlophe, izibambo zamawindi nokushintshwa kokukhanya.

Ubungozi kodlala indawo kucwaningo:

Akukho bungozi abubonakalayo kozibandakanye noncwaningo.

Ungayeka nini ukuba yingxenye yocwaningo:

Uvumelekile ukuphuma uma usuthanda ngale kokwesaba. Uma ufisa ukuhoxa ocwaningweni, sicela uxhumane nomcwaningi usebenzisa imininingwane yokuxhumana enikeziwe umcwaningi uzobe esekususa ocwaningweni.

Izithelo ezinhle zocwaningo:

Ucwaningo luzosiza ukuqonda umthelela wempuqumpuqu kafulawa empilweni yomsebenzi. Izosiza ukuphucula isimo sokusebenza ngokuqikelela ubungako bukafulawa obungantanta emoyeni. Izokhuthaza ukunakekelwa kwempilo nokuphepha kwabasebenzi kuqiniswe nokusebenza kwemithetho ephathelene nemboni yokusanhlamvu.

Inkokhelo:

Akukho nkokhelo wayithola ngalolucwaningo

Izindleko zocwaningo:

Akukho zindleko ezilindeleke kuwena

OkuyimFihlo:

Imibuzo uzoyiphendula ngokuyimfihlo.lonke ulwazi luzoba sezandleni zikamcwaningi nomhloli wakhe kuphela. Lonke ulwazi luzogcinwa andaweni ehluthulelwe iminyaka emihlanu emva kweminyaka emihlanu imiqulu yocwaningo izofakwa emishinini odla amaphepha. Ngasosonke isikhathi ulwazi olutholakele luyogcinwa luyimfihlo futhi angeke kwadalulwa ukuthi lutholakale kuphi.

Imiphumela:

Imiphumela izoba yingxenye yomqondo futhi izosatshalaliswa kuwe ngencwadi yezindaba. Imiphumela izosatshalaliswa kuphela uma ithisisi yamukelwe futhi yaphasiswa yibhodi elifanelekile lokubuyekeza Kanye nokuziphatha.

Ukulimala ngenxa yocwaningo:

Akukho kulimala okungenzeka

Ukugcinwa kwawo wonke amakhopi kagesi nawamakhompiyutha ahlanganisa okuqoshiwe:

Yonke imininingwane ephathekayo izogcinwa ikhiyiwe ngokhiye iminyaka engu-5 ekhabetheni elifinyeleleka kuphela kumpathi nakumcwaningi. Ngemuva kwalokho izolahlwa ukugaywe kwamaphepha. Onke amakhophi e-elektroniki azogcinwa isikhathi seminyaka emi-5 futhi azovikelwa nge-password. Umcwaningi nomphathi kuphela abazokwazi ngaleli phasiwedi. Ngemuva kweminyaka emi-5, amakhophi kagesi azosuswa

Uma kunenkinga ungaxhumana nabalandelayo:

Umcwaningi: 0832640762. Umhloli wakhe: 0835883245. Institutional research ethics administrator: 031-3732375. Izikhalazo zingabikwa kuMqondisi: Ucwaningo kanye nokwesekwa kweziqu: Dr L Linganiso on 031 373 2577 or researchdirector@dut.ac.za.

APPENDIX F4: LETTER OF CONSENT FOR MAIN STUDY (ISIZULU)

IMVUME

Isihloko sopheyo:

Ukuba sengupheni yothuli lukafulawa kanye nezingozi zezempilo ezihambisana nakho Phakathi kwabasebenzi endaweni ekhethiwe egaya ufulwa esesifundazweni saKwaZulu-Natal

Umncwaningi:

Savanah Hoopdeo (BTech: Environmental Health)

ISIVUMELWANO SOKUBA INGXENYEYOPHENYO:

Ngiyaqinisekisa ukuthi umcwaningi (igama lakhe) ____________________________ ungazisile ngohlobo,nangezithelo ezinhle kanjalo nobubi bocwaningo. Inombolo egunyaza isikhung socwaningo ukusebenza ______________________________________

- Ngiyifundile ngayiqonda kahle incwadi emayelana nocwaningo enginikwe yona.
- Ngiyazi ukuthi imiphumela yocwaningo kanye nemininingwane yame ephathelene negama lami iminyaka yami ubulili nokugula kwami kuyogcinwa kuyimfihlo kumqulu wocwaningo.
- Ngenxa yohlobo locwaningo ngiyavuma ukuthi ulwazi olutholakele lungafakwa kwikhomputha.
- Ngivumelekile ukushiya phansi ukuba ingxenye yocwaningo noma nini ngaphandle kokwesaba.
- Ngibe nethuba elanele lokubuza imibuzo ngase ngiziqomela mina ukuba ingxenye yocwaningo.
- Ngiyazi ukuthi ngiyokwaziswa ngemiphumela ebalulekile otholakale ngenxa yami kulolucwaningo.

______________________	____________	________	________________
Igama loyingxenye yocwaningo	**usuku**	**Isikhathi**	**Sayina /beka isithupha sangakokudla**

Mina _________________________ (igama likamcwaningi) ngiyaqinesikisa ukuthi oyingxenye yocwaningo utsheliwe ngehlobo locwaningo Kanye nobui nobuhle balo

______________________ ____________ ________________________

Igama eliphelele lomcwaningi **Usuku** **Sayina**

______________________ ____________ ________________________

Igama eliphelele likafakazi

(Uma ekhona) **Usuku** **Sayina**

____________________ ___________ _____________________

Igama umzali(Uma kufanele) **Usuku** **Sayina**

APPENDIX G1: QUESTIONNAIRE (ENGLISH)

MAIN QUESTIONNAIRE (ENGLISH)

Note briefly:

- **Please indicate your answer with a X in the appropriate box next to each option.**
- **Please answer all questions**
- **Some questions in Section C may relate to the current Coronavirus pandemic, please note that these questions are referring to health conditions brought on by the workplace and is not pertaining to the coronavirus in any way.**

SECTION A: PERSONAL INFORMATION

	1. What is your age in years?
	18 – 25
	26 – 35
	36 – 45
	46 – 55
	56 – 65
	More than 65

	2. What is your race?
	African
	Coloured
	Indian
	White
	Other

	3. What is your gender?
	Male
	Female
	Other

	4. What is your highest level of education?
	No formal education
	Primary school
	Secondary school
	Vocational Training
	National Diploma
	Bachelor's degree
	Master's degree
	Doctorate Degree

5. Do you have access to <u>basic first aid</u> treatment at work?	
	Yes
	No
	I don't know

6. Which (one) is your most frequent mode of transport to work?	
	Walking
	Bicycle
	Personal vehicle
	Public transport (example bus, taxi, uber)
	Other, please explain

<u>SECTION B: WORK-RELATED INFORMATION</u>

1. How long (in years) have you worked in the flour mill that you are currently employed at?

2. Have you ever been employed in other flour mills previously?	
	Yes
	No

3. If YES to question 2, how long (in years) had your worked in the previous flour mill?

4. In your current place of employment, which area do you work in? (You can tick more than one option)	
	Mill
	Packing
	Laboratory
	Warehouse
	Maintenance
	Administration

5. What is your position or title?

6. Please describe your main task/s during your shift

7. What is your shift?	
	Day shift only
	Night shift only
	Day shift and Night shift
	If both dayshift and nightshift, please explain

8. How many days a week do you work in general?

9.1 How many hours a day do you work?	
	Less than 9 hours
	More than 9 hours
	I don’t know
9**.2 Please elaborate on answer chosen in 9.1**	

10. What is your understanding of Personal Protective Equipment or PPE? (Choose one option?)	
	It is a uniform
	It is a type of machine
	It is the clothing/ equipment that is designed to protect the wearer’s body from injury or infection
	I don’t know what PPE is

11. Does your place of employment provide PPE?	
	Yes
	No
	I don’t know

12. If Yes, please state what PPE you wear?

13. Do you wear your PPE? If you answer NO to this question, please go to question 16.	
	Yes
	No

14. Do you wear your PPE correctly?	
	Yes
	No
	I think so
	I don’t know how to wear the PPE correctly

15. 1 How often do you wear your PPE?	
	All the time
	Sometimes
	I try to wear them when I can
	I hardly wear them
	I don’t wear them at all
15.2 Please explain your option	

16. Please describe how you feel about wearing PPE

17. Have you been for PPE training?	
	Yes
	No

18.1 If YES to question 17, do you think it was helpful?	
	Yes
	No

18. 2 Please state your reason?

19. What is your understanding of a respirator?	
	It is the name of a machine in a flour mill
	It is a medical condition
	A device designed to protect the wearer from inhaling hazardous chemicals
	I don’t know

20. What is your understanding of a respirator zone?	
	The area where the respirator is not supposed to be worn
	The hospital that treats the respirator condition
	A designated area in which a respirator is worn
	I don’t know

21. Do you work in a respirator zone?	
	Yes
	No

22. How do you know if you work in a respirator zone?	
	I think I work in a respirator zone
	The nurse told you about the condition
	There is a sign, designating it as a respirator zone
	I don’t know

23. Do you have/ wear a respirator?	
	Yes
	No

24.1 If NO to question 23, why not?

24.2 What do you use instead?

SECTION C: MEDICAL INFORMATION

1. Do you smoke currently?	
	Yes
	No

2. How long have you been smoking?	
	6 months to 1 year
	2 -5 years
	5 - 10 years
	10 – 15 years
	15- 20 years
	More than 20 years
	Not applicable

3. How many cigarettes do you smoke a day?	
	1 – 5 cigarettes
	6 – 10 cigarettes
	11- 15 cigarettes
	Almost 16 - 20 cigarettes
	More than 20 cigarettes a day
	Not applicable

4.1 If you do not smoke currently, did you smoke before?	
	Yes
	No

4.2 If yes, how long has it been since you have quit smoking?	
	Not applicable

5. What made you quit smoking?	
	Not applicable

6. Do you exercise?	
	Yes
	No

7. How often do you exercise?	
	Once a week
	Twice a week
	Five times a week
	Every day
	When I have the time

8. Do you have a family history of			
	Yes	No	I don't know
Epilepsy or convulsions			
Asthma			
Hayfever			
Sinusitis			
Skin rashes/ dermatological issues			
Cancer, if yes, please state what cancer			

	9. Have you ever had dizziness or unsteadiness?
	Yes
	No
	I don't know

	10.1 Have you ever had allergies? (Example: allergic to seafood)
	Yes
	No
	I don't know

10.2 If YES to question 10.1, please explain what you are allergic to.

	11.1 Have you ever had malignant tumors or cancers?
	Yes
	No
	I don't know

11. 2 If YES to question 11.1, please name the malignant tumor or cancer

	12.1 Does your chest ever feel tight or your breathing becomes difficult?
	Yes
	No

12.2 If YES to question 12.1, please state how many times a week this occurs?

	13. Have you ever had an attack of wheezing or whistling in your chest?
	Yes
	No

	14. Have you ever had an attack of shortness of breath that came on during the day when you were not doing anything?
	Yes
	No

	15. Have you ever had an attack or shortness of breath that came on suddenly with exercise?
	Yes
	No

	16. Which one of the following statements best describe your breathing?
	I never or rarely have trouble with my breathing
	My breathing is never quite right
	I get regular trouble with my breathing, but it always gets completely better

	17. Has your doctor ever told you that you have asthma?
	Yes
	No
	Not applicable

	18.1 Have you had an attack of asthma within the past 12 months?
	Yes
	No

	18.2 If YES to Question 18.1, how often have you suffered asthma attacks?
	Every month
	Every two months
	Every three months
	Every six months
	Not applicable

	18.3 Approximately how many asthma attacks have you suffered per month?
	0 -3
	4- 6
	7- 10
	11 -14

	More than 15
	Not applicable

19. Were you off-duty or hospitalized as a result of asthma?	
	Yes
	No
	Not applicable

20.1 Other than when you have the cold, have you ever had a sneezing, running or blocked nose within the past 12 months?	
	Yes
	No

20.2 If YES to Question 20.1, how often have you experienced the sneezing, running or blocked nose?	
	Every month
	Every two months
	Every three months
	Every six months

20.3 Approximately how many times in a month has this occurred?	
	0 -3
	4- 6
	7- 10
	11 -14
	More than 15

21. Have you had a dry throat within the past 12 months?	
	Yes
	No

22.1. Have you experienced itching or watering of the eyes within the past 12 months?	
	Yes
	No

22.2 If YES to Question 22.1, how often have you experienced the itching or watering of eyes?	
	Every month
	Every two months
	Every three months
	Every six months

22.3 Approximately how many times has this occurred per month?	
	0 -3
	4- 6
	7- 10
	11 -14
	More than 15

23.1 Are you currently taking any medication	
	Yes
	No

23.2 If yes to question 23.1, please name the medication you are currently taking.

24.1 Have you ever had any skin disorders or conditions?	
	Yes
	No
	I don't know

24.2 If YES to the question 24.1, please state the condition/ disorder and describe the signs and symptoms

25. How often do you visit the doctor?	
	Very often
	Often
	I don't know
	Not very often
	Never

26. Please can you elaborate on your reason/s for visiting the doctor.

Thank you for your time and co-operation.

It is highly appreciated.

APPENDIX G2: QUESTIONNAIRE (ISIZULU)

MAIN QUESTIONNAIRE (ISIZULU)

- **Beka uphawu u X esikhaleni**
- **Ngicela uphendule yonke imibuzo**
- **Eminye imibuzo esigabeni cingahle ihlobane nobhadane lwamanje lwi-coronavirus, sicela wazi ukuthi le mibuzo ibhekise ezimeni zezempilo ezilethwe indawo yokusebenza futhi ayilobene ne-coronavirus nganoma iyophi indlela.**

INGXENYE A: ULWAZI LOMUNTU SIQU

1. Uneminyaka emingaki eminyakeni?	
	18 kuya ku 25
	26 kuya ku 35
	36 kuya ku 45
	46 kuya ku 55
	56 kuya ku 65
	ngaphezulu kuka 65

2.Ubuhlanga?	
	UmAfrika
	ngombala
	Indiya
	mhlophe
	obunye ubuhlanga

3. Ubulili?	
	ungowesilisa
	ungowesifazane
	obunye ubulili

4. Ugcine kuliphi ibanga?	
	angifundile
	amabanga aphansi
	e secondary
	isifundo samakhono
	idiploma
	Izuqu
	iziqu eziphezulu
	iziqu zobudokotela

5. uyakwazi ukufinyelela ekwelashweni okuyisisekelo emsebenzini?	
	Yebo
	Cha
	anginalwazi

6. Iluphi uhlobo lwesithuthi osisebenzisa kakhulu uma uya emsebenzini?	
	ngezinyawo
	ngebhayisikili

	ngemoto yami
	isithuthi somphakathi (isibonelo ibhasi, itekisi, uber)
	okuye (naba/chaza)

INGXENYE B: - HLOBENE NOMSEBENZI

1. usebenze isikhathi esingakanani (eminyakeni) emogodini wempuphu osebenza kuwo njengamanje?

2. Uke wasebenza kwenye indawo ephehla ufulawa?	
	Yebo
	Cha

3. Ima impendulo ngu yebo kumbuzo wesibili isikhathi esingakanani khona (eminyakeni)?

4.) Usebenza kweliphi igumbi?	
	uphehla ufulawa
	uyapakisha
	elaborethi
	lakugcinwa khona impahla
	ugcina impahla isesimweni
	ugcina amarekhodi

5. Isiphi isikhundla sakho?

6. shift chaza umsebenzi owenzayo

7. Usebenza ngasiphi isikhathi?	
	emini kuphela
	ebusuku kuphela
	emini kuphela futhi ebusuku kuphela
	uma usebenza kuzozonke izikhathi chaza ukuthi kwenzeka kanjani

8. Usebenza izinsuku ezingaki esontweni, ngenjwayelo?

9.1 Usebenza amahora amangaki ngosuku?	
	Ngaphansi kwamahora angu-9
	Ngaphezu kwamahora angu-9
	Angazi
9.2 Sicela uchaze kabanzi ngempendulo ekethwe ku-9.1	

10. Wazi ukuthi ziyini izimpahla zokuvikela? (khetha i-potion eyodwa)	
	umfaniswano
	uhlobo lomshini
	izingubo noma izimpahla zokuvikela ukulimala noma izifo
	angazi ngeziphahla zokuvikela

11.Niyanikwa izimpahla zokuzivikela?	
	Yebo
	Cha
	anginalwazi

12. Mpahlazini zokuzivikela eninikwazona?

13. Uyazigqoka izimpahla zokuzivikela uma ungazigqoki phendula umbuzo 16	
	Yebo
	Cha

14.Uzigqoka ngokufanele / ngendlela?	
	Yebo
	Cha
	ngicabanga kanjalo
	anginalwazi lokuthi zigqokwa kanjani

15. 1 Uzigqoka kangaki izimpahla?	
	ngasosonke isikhathi
	ngesinye isikhathi
	ngiyazigqoka uma kuvuma
	kuyaqabukela

	angizilokothi

15.2 Sicela uchaze kabanzi ngempendulo ekethwe ku-15.1

16. ake uchaze ngokuthi uzizwa kanjani ngokugqoka izimpahla zokuzivikela

17. Wake waqeqeshelwa ukogqoka izimpahla zokuvikela?	
	Yebo
	Cha

18.1 Uma waqeqeshwa wakubona kuwusizo?	
	Yebo
	Cha

18. 2 cha izizathu zakho

19. Ngokwakho yini isiphefumulo?	
	igama lomshini esigayweni sefulawa
	isifo esithize
	ithuluzi elakhelwe ukuvikela oligqokela ukuhabula ubuthi obunengozi
	anginalwazi

20. Ngokwakho yini isiphefumulo izoni?	
	Indawo lapho umshini wokuphefumula ungafanele ukugqokwa khona
	isibhedlela eselapha isifo sokuphefumula
	indawo eqokelwe lapho kufakwa khona umshini wokuphefumula
	anginalwazi

21. Ngabe usebenza lapho kunesiphefumulo khona?	
	Yebo
	Cha

22. Wazi kanjani ukuthi usebenza lapho kugcinwe khona isiphefumulo?	
	Ngicabanga ukuthi ngisebenza endaweni yokuphefumula
	watshelwa unesi ngalesimo
	indawo eqokelwe lapho kufakwa khona umshini wokuphefumula
	anginalwazi

23. Unaso / uyasigqoka isiphefumulo?	
	Yebo
	Cha

24.1Uma uthi cha kumbuzo 23 kungani?

24.2 Pho usebenzisani?

INGXENYE C: IMINININGWANE YEZOKWELAPHA

1. Uyabhema?	
	Yebo
	Cha

2. unesikhathi esingakanani ubhema	
	Eyisithupha izinyanga kuya onyakeni
	Iminyaka emibili kuya kwemihlanu
	Eyisithupha kuya kweyishumi
	Ishumi nanye kuya kwishumi nanhlanu
	neshumi nesithupha kuya kumashumi amibili
	Ngaphezulu kwe-yeara angamashumi amabili
	Akufaneleki

3. Ubhema imidweza emingaki ngosuku	
	Owodwa kuya kwemihlanu
	Eyisithupha kuya kweyishumi
	Ishumi nanye kuya kwishumi nanhlanu
	Cishe ugwayi weshumi nesithupha kuya kwamashumi amabili
	Ngaphezulu kuka-20 kagwayi ngosuku
	Akufaneleki

4.1 Wake wabhema ngaphambilini	
	Yebo
	Cha

4.2 Uma wake wabhema usuyeke isikhathi esingakanani?	
	Akufaneleki

5. Wayekelani ukubhema?	
	Akufaneleki

6. Uyazivocavoca?	
	Yebo
	Cha

7. Uzivocavoca kangaki?	
	Kanye ngesonto
	kabili ngesonto
	kahlanu esontweni
	zonke isinsuku
	uma nginethuba

8. Emndenini ukhona onalezizifo:			
	Yebo	Cha	Anginalwazi
isithuthwane			
isifuba somoya			
umdlavuza, uma ekhona chaza ukuthi owani			

9. Wake waba nenzululwane?	
	Yebo
	Cha
	anginalwazi

10.1 Kukhona ongazwani nakho empilweni (isibonelo: kungaba ukudla noma okuhlukumeza umzimba ngemizwa)	
	Yebo
	Cha
	anginalwazi

10.2 Uma uthi yebo kumbuzo ongaphezulu chaza kabanzi ukuthi ikuphi noma yini.

11.1 Wake waba nesimila	
	Yebo
	Cha
	anginalwazi

11. 2 uma uthe yebo ngaphezulu chaza kabanzi ngesimila leso

12.1 Uke ucinanelwe isifuba noma uphefumule kanzima?	
	Yes
	Cha
12.2 Uma uthi yebo kumbuzo 12.1 chaza ukuthi kwenzeka kangaki ngesonto.	

13. Uke uncisheke umoya noma isifuba sakho sibe nomsindo?	
	Yebo
	Cha

14. Wake waphelelwa umoya emini ungenzi lutho	
	Yebo
	Cha

15. Wake waphelelwa umoya uzivocavoca?	
	Yebo
	Cha

16. Ukuphefumula kwakho ungakuchaza kanjani?	
	akungaze kungikhathaze
	angiphefumuli kahle
	ngike ngibe nenkinga kodwa kubuye kuphele

17. Udokotela wake washo ukuthi unesifuba somoya	
	Yebo
	Cha
	Akufaneleki

18.1 Uke wahlase isifuba somoya ezinyangeni eziyishumi nambili ezedlule?	
	Yebo
	Cha

18.2 Uma kunguyebo kumbuzo ongaphezulu sikuhlasele kangaki isifuba?	
	nyanga zonke
	njalo emva kwezinyanga ezimbili
	njalo emva kwezinyanga ezintathu
	njalo emva kwezinyanga eziyisithupha
	Akufaneleki
18.3 Cishe sikuhlasela kangaki isifuba ngenyanga	
	cishe kathathu
	kane kuya kokuyisithupa
	kasikhombisa kuya eshumini
	shuminanye kuya kashumi nane
	kwevile kwishumi nesihlanu
	Akufaneleki

19.Wake waphula emsebenzini noma walaliswa esibhedlela ngenxa yesifuba somoya	
	Yebo
	Cha
	Akufaneleki

20.1 Wake wathimula wacinana amakhala noma ubenamafinyala amaningi ungenawo umkhuhlane?	
	Yebo
	Cha

20.2 Uma uthi yebo wasehlaselwa kangaki ukucinani thimula namafinyila amaningi	
	nyanga zonke
	emva kwezinyanga ezimbili
	njalo enyangeni yesithathu
	njalo enyangeni yesithupha

20.3 Cishe kwenzeke kangaki ngenyanga?	
	lutho kuya kathathu
	kune kuya kwisithupa
	kasikhombisa kuya kwishumi
	ishumi nanye kuya kwishumi nane
	ngaphezu kwamashumi amahlanu

21. Suke waba Namthansela evakwa 12 month?	
	Yebo
	Cha

22.1. ake ababa noma akhale amehlo akho ezinyangeni ezilishumi nambili ezedlule?	
	Yebo
	Cha

22.2 uma uthi yebo kumbuzo ongaphezulu kwenzeke kangaki ukubaba nokukhala kwamaehlo?	
	nyanga zonke

	njalo ezinyangeni ezimbili
	njalo ezinyangeni ezintathu
	njalo ezinyangeni eziyisithupha

22.3 Cishe kwenzeke kangaki ngenyanga?	
	mhlambe kathatu
	kane kuya kwisithupa
	kasikhombisa kuya kwishumi
	kashumi nanye kuya kwishumi nane
	kwevile kwishumi nesihlanu

23.1 kukhona umuthi owuphuzayo okwamanje	
	Yebo
	Cha

23.2 Isho ukuthi uphuza muthi muni

24.1Wake waba nesikhumba esibi noma isifo sesikhumba?	
	Yebo
	Cha
	Anginalwazi

24.2 uma kunguyebo kumbuzo ongaphezulu chaza izimpawu zaso nokuthi sasiyini.

25. Uyakangaki kudokotela?	
	kujwayelekile kakhulu
	kujwayelekile
	anginalwazi
	akujwayelekile
	angiyi nhlobo

26. Chaza kabanzi isizathu osiyela kudokotela

Ngiyabonga kakhulu ngesikhathi sakho

APPENDIX H: LETTER OF AGREEMENT

18 September 2020

Savanah Hoopdeo

9 Glasham Place

Westham

Phoenix

4068

This letter serves as a formal agreement between the Safety, Health, Environment and Quality (SHEQ) Manager, and the researcher, Savanah Hoopdeo (Student number: [redacted]) to access employee medical records for the express purpose of her Master's dissertation.

The agreement constitutes of the following:

I, the SHEQ manager:

- Agrees to provide the researcher with the necessary information required to conduct the study.
- Provide the researcher with permission to access medical records of only those employees who provided formal consent via the letter of information and letter of consent.
- Understands that the information shared between the researcher and is strictly confidential and will strive to maintain anonymity and confidentiality of participants to not compromise the participants role in the company.
- Agrees not to disclose discussions and information shared between the researcher and I, with persons not privy to the study as this could jeopardize the letter of information and letter of consent agreements between the participant and the researcher.
- Understands that the researcher should not be held liable for any decision taken by management regarding movement/ re-placement of employees during the study.

APPENDIX I: PROOF OF ETHICS TRAINING

TRREE

Clinical Trials Centre
The University of Hong Kong

Zertifikat
Certificat
Certificado
Certificate

Promouvoir les plus hauts standards éthiques dans la protection des participants à la recherche biomédicale
Promoting the highest ethical standards in the protection of biomedical research participants

Certificat de formation - Training Certificate

Ce document atteste que - this document certifies that

Savanah H

a complété avec succès - has successfully completed

Introduction to Research Ethics

du programme de formation TRREE en évaluation éthique de la recherche
of the TRREE training programme in research ethics evaluation

Release Date: 2020/12/06
CID : apIi7LShGn

Professeur Dominique Sprumont
Coordinateur TRREE Coordinator

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[REV : 20170310]

APPENDIX J: LETTER OF DECLARATION FROM THE EDITOR

Dr Carolyn Turnbull-Jackson

89 J.B.Marks Rd

Glenwood

Durban

0836989557

carolynjackson381@gmail.com

Declaration of Editing of a Dissertation for the Degree Of Master in Public Health :<u>Occupational exposure to flour dust and the associated respiratory outcomes among workers at a selected flour mill in KwaZulu-Natal.</u>

I hereby declare that I carried out language editing of the above by Savanah Hoopdeo student number 21537029(DUT).

I am a professional writer and editor with many years of experience. I specialise in Social Sciences and Humanities ' editing – but am adept at editing in many different subject areas.

Yours sincerely

Carolyn Turnbull-Jackson (D.Ed)

January 2022