The Work Health-Related Behaviours and Economic Costs of Overweight and Obese Corporate and Industrial Employees: A South African Study

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"Not that I have already obtained all this, or have already arrived at my goal, but I press on to take hold of that for which Christ Jesus took hold of me."

Philippians 3:12

DECLARATION

I declare that this study represents original work by the author and has not been submitted in any form at another University. Where use is made of the work of others, it has been duly acknowledged in the text and included in the list of references cited. This thesis serves as fulfilment of the requirements for the degree of Doctor of Philosophy in Sport Science with the Department of Biokinetics and Sport Science in the Faculty of Science and Agriculture at the University of Zululand, South Africa.

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TABLE OF CONTENTS

ABSTRACT

The trend of increasing prevalence of obesity is not only a public health concern, but employers have noticed rising rates of obesity among their employees in the workplace. Excess body weight has been associated with the development of comorbidities, which may in turn negatively affect quality of life, thus decreasing productivity in the workplace and creating an economic burden. The purpose of this study was to assess the work health-related profile of overweight and obese employees, to establish the cost implication of these employees in South African industrial and corporate companies, and to develop a health promotion model to address the condition of being overweight or obese in the workplace.

The study collected data from various corporate and industrial companies. Data was obtained through two methods: 1) employees' medical data from a medical database (part A), and 2) questionnaires completed by employees (part B). For both parts A and B, the age ranged from 18-64 years (40.8 ± 11.0) and no differentiation was made between race groups. Part A consisted of 17 359 employees, whilst 117 employees comprised part B. Employees from both parts A and B were categorized according to BMI – normal weight (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2), and obese (≥ 30 kg/m^2). Employees from part A were further categorized according to obese classes – obese class I (30.0-34.9 kg/m^2), obese class II (35.0-39.9 kg/m^2), and obese class III (≥ 40 kg/m^2). Data collected for part A included BMI, blood glucose, blood cholesterol, and blood pressure; whereas employees from part B completed the following: 1) WHO health at work survey, 2) WHO quality of life questionnaire, 3) international physical activity questionnaire, and 4) dietary record.

SPSS Statistics 24 was used to determine frequencies, associations and correlations; a 95% level of confidence ($p<0.05$) was applied. A non-parametric chi-square test was used to determine significant associations between variables and each BMI category, while the Mann-Whitney test determined significant differences between groups. Prevalence rates of overweight and obese men were 46.4% and 24.4%, respectively, while prevalence rates for overweight and obese women were 26.7% and 18.3%, respectively. Prevalence of comorbidities were observed to increase with increasing BMI, and the measured comorbidities were significantly associated with BMI. Normal weight females performed significantly more moderate intensity exercise compared to overweight and obese females. Significant associations for increased number of snacks, as well as sugar-sweetened beverages (SSB) were observed with overweight and obese males, as well as overweight females. A significant association between self-rated quality of life and self-rated health for each BMI category was observed. Furthermore, a significant association was observed between social relationships and overweight employees, while psychological health and social relationships were significant for obese employees. In all domains of quality of life (QOL), normal weight employees had higher mean scores for the various QOL domains, compared to overweight and obese employees. The prevalence of presenteeism increased with increasing BMI, with presenteeism being significantly associated with both overweight and obese employees. The prevalence of absenteeism increased with increasing BMI, though no significance was observed between groups. Overweight employees cost their respective companies in the range of R30 000 to R50 000 for the period of one year, and obese employees incurred a cost in the range of approximately R340 000 to R450 000. Together, overweight and obese employees incurred a cost of nearly half a million rand annually. These costs are calculated specifically for the study cohort, and would be substantially greater when calculated for the entire working population of South Africa. Results indicated that overweight and obese employees had increased prevalence of comorbidities, poorer quality of life, and increased presenteeism and absenteeism. It is recommended that companies implemement health and wellness programs with a multi-faceted approach to address obesity in the workplace.

Keywords: Obesity, employees, sedentary, physical activity, dietary habits, comorbidities, quality of life, absenteeism, presenteeism, economic burden

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

ACE	Angiotensin converting enzyme
ACSM	American College of Sports Medicine
ACTH	Adrenocorticotropin hormone
ADL	Activities of daily living
AT	Adipose tissue
B	Beta
BBB	Blood brain barrier
BF%	Body fat percentage
BMI	Body mass index
BOD	Burden of disease
CDC	Centres for disease control and prevention
COI	Cost of illness
CVD	Cardiovascular disease
Cm	Centimetre
CRH	Corticotropin-releasing hormone
CRP	C-reactive protein
CT	Computed tomography
D	Day
DBP	Diastolic blood pressure
DXA	Dual X-ray absorptiometry
EPICN	European Prospective Investigation into Cancer and Nutrition
ER	Endoplasmic reticulum
FFA	Free fatty acids
FV	Fruit and vegetables
GH	Growth hormone
GI	Glycaemic index
H	hours
HbA1c	Glycosylated haemoglobin
HCC	Hair cortisol concentrations
HDL	High density lipoprotein
HPA	Hypothalamic-pituitary-adrenal axis

HR	Hazard ratio
HRQL	Health-related quality of life
IL	Interleukin
IL-6	Interleukin-6
IPAQ	International physical activity questionnaire
kcal	Kilo-calories
kg	Kilograms
LDL	Low-density lipoprotein
LTPA	Leisure time physical activity
LWH	Long work hours
M	Metres
MET	Metabolic equivalent
min	minutes
NCD	Non-communicable diseases
NHANES	National Health and Nutrition Examination Survey
NHIS	National Health Interview Survey
NHS	National Health Survey
NO	Nitric oxide
NS	Non-significant
OR	Odds ratio
PAF	Population attributable fraction
QOL	Quality of life
RAAS	Renin-angiotensin aldosterone system
RR	Relative risk
SA	South Africa
SADHS	South African Demographic and Health Survey
SBP	Systolic blood pressure
SD	Standard deviation
SEM	Socio-economic model
SNS	Sympathetic nervous system
SSB	Sugar-sweetened beverages
SSD	Short sleep duration
T2DM	Type II diabetes mellitus

TAG	Triacylglycerol
TIA	Transient ischemic attack
TNF-α	Tumour necrosis factor α
TV	Television
UFC	Urine free cortisol
UPR	Unfolded protein response
US	United States
VLDL	Very low-density lipoprotein
WC	Waist circumference
WHO	World Health Organization
WHR	Waist-hip-ratio

CHAPTER ONE

INTRODUCTION

1.1 INTRODUCTION

1.1.1 Obesity Prevalence

Obesity rates have increased significantly in the past decades, having presently reached epidemic proportions (Restaino, Holwerda, Credeur, Fadel, & Padilla, 2015; Lee et al., 2016). This has become a health concern for countries worldwide, with respectively 39% and 13% of the world's adult population over the age of 18 years being overweight and obese (WHO, 2014). South Africa (SA) has not been spared from the obesity pandemic with respectively 53.9% and 26.8% of the adult population being overweight and obese (WHO, 2014). While other countries have investigated the prevalence of being overweight and obesity amongst employees, no such data is yet available in South Africa.

1.1.2 Overweight and Obesity Defined

Being overweight, and obesity, has been defined as abnormal or excessive accumulation of adipose tissue to an extent that it impairs both physical and psychosocial health and well-being (Lenz, Richter, & Mülhauser, 2009; Borak, 2011). Body mass index (BMI) and waist circumference (WC) are common measurements used to classify being overweight, and obesity in adults (Gelber et al., 2008; Flegal et al., 2009; WHO, 2014). BMI, defined as weight (kg)/height (m^2), is an indirect method used to measure body fatness, and has been shown to be reliable, except in individuals with very muscular builds or extreme heights (Romero-Corral et al., 2008; Rothman, 2008). BMI has long been used as a predictor of morbidity and mortality due to numerous chronic diseases associated with obesity (Lenz et al., 2009; Dixon, 2010; Borak, 2011). The validity and accuracy of the use of BMI will be discussed in more detail in chapter 2.

1.1.3 Factors Contributing to the Development of Obesity

The cause of overweight and obesity is multi-factorial, and involves numerous factors such as behavioural, environmental, social, as well as individual factors (Joubert et al., 2007; Lehnert, Sonntag, Konnopka, Riedel-Heller, & König, 2013). Behavioural factors include dietary habits and patterns, as well as physical activity habits and sedentariness (Hamilton, Hamilton, & Zderic, 2007; Cleland, Schmidt, Dwyer, & Venn, 2008). Energy intake and expenditure determine energy balance within the body, which directly influences BMI. Environmental factors refer to the immediate physical surroundings of an individual, and include community characteristics (such as a rural or urban setting), modernization of technology, and marketing strategies of food (Hamilton et al., 2007; Cleland et al., 2008). Social factors, also known as socio-demographic status, includes level of education, employment and income status, as well as the influences of family and social relationships (Hamilton et al., 2007; Cleland et al., 2008; Sartorius, Veerman, Manyema, Chola, & Hofman, 2015). Individual factors that may contribute towards the development of obesity include genetics, individual physiology, cultural milieus, and gender (Hamilton et al., 2007; Cleland et al., 2008; Sartorius et al., 2015). Environmental, social, and individual factors all influence behavioural factors, which in turn may contribute towards the development of obesity. In the subsequent section behavioural factors, followed by the environmental, social, and finally the individual factors will be briefly discussed. A more in-depth discussion of these factors can be found in chapter 2.

1.1.3.1 Behavioural Factors

Behavioural factors include physical activity habits, sedentary habits, and dietary patterns, all of which independently contribute to increased body weight (Stamatakis, Hirani, & Rennie, 2008; Vioque, Weinbrenner, Castelló, Asensio, & de la Hera, 2008). Sedentary behaviour was long thought to represent the absence of physical activity; however, it is now accepted that physical inactivity and sedentariness can be differentiated and have different physiological consequences (Chau, van der Ploeg, Merom, Chey, & Bauman, 2012; Kilpatrick, Sanderson, Blizzard, Teale, & Venn, 2013). Sedentary behaviour is defined as activities that do not increase energy expenditure substantially above resting level (1.0-1.5 metabolic equivalents) while in a sitting or reclining posture, such as while watching television (TV), using a computer, and other forms of screen based entertainment (Mansoubi et al., 2015; Restaino et al., 2015). Other forms of sedentary behaviour include sitting during commuting, sitting in the domestic environment and the workplace; and sitting during leisure time activities such as talking on the phone, listening to music, and reading (Stamatakis et al., 2008; Thorp, Owen, Neuhaus, & Dunstan, 2011). Independent from being sedentary, low physical activity levels has also been recognized as a key contributor to the development of obesity (Hamilton et al., 2007; Cleland et al., 2008). It is attributable to a multitude of reasons such as increased use of automated transport, decrease in participation in sport/exercise and decreased occupational manual labour (Hamilton et al., 2007; Cleland et al., 2008). Physical activity, along with resting energy expenditure and thermogenesis, contribute to total daily energy expenditure; with physical activity being the behavioural component that can be significantly modified (McArdle, Katch, & Katch, 2010). Physical activity includes both time spent actively exercising or participating in sport, as well as time spent fulfilling daily activities of living such as gardening, household chores, moving from place to place (walking/cycling), active leisure time activities, and occupational physical activity (Abu-Omar & Rütten, 2008; Hallal et al., 2012).

Lower physical activity levels coupled with poor dietary habits leads to a positive energy balance, where energy intake exceeds energy expenditure, with a resultant increase in body weight. Hence dietary habits, in conjunction with decreased physical activity levels, has been extensively investigated as a cause of obesity (Horikawa et al., 2011; Pearson & Biddle, 2011; Lee et al., 2016). Dietary behaviour refers to eating frequency, skipping of meals, meals eaten away from home (fast food/restaurants), portion sizes, and types of food consumed.

1.1.3.2 Environmental Factors

There are several factors that underlie the environmental changes that contribute towards the development of obesity. These include modernization, the use of technology, and the replacement of manual labour with sedentary occupations; which contribute to more sedentary lifestyles (Hamilton et al., 2007; Cleland et al., 2008). Also included is the community characteristics, i.e. movement of population into more urban areas; which allows for easy access to unhealthy, energy dense foods (Hamilton et al., 2007; Cleland et al., 2008). Furthermore, the food environment has become increasingly ‘obesogenic’ due to marketing campaigns, high availability of energy dense foods at a low cost, large portion sizes and supersized products sold as ‘value for money’ (Sartorius et al., 2015; Lee et al., 2016). Eating outside the home has increased substantially, and restricts the ability to control the composition and quality of food (Rosenheck, 2008; Berg et al., 2009). Within family households, being overweight, and obesity tend to be common due to shared genes and lifestyle (Rosenheck, 2008; Berg et al., 2009). These factors have made it more difficult for people to make healthy food choices.

1.1.3.3 Social Factors

Obesity has been linked to low income, low education, minority status, and higher incidence of poverty. Low-income neighbourhoods attract more fast-food outlets and convenience stores; whereas areas that are more affluent have better restaurants, fresher products and better access to healthy foods, and more opportunities for physical activity. However, in South Africa obesity is positively related to wealth, with well-off individuals more likely to be obese than the poor (Alaba & Chola, 2014).

1.1.3.4 Individual Factors

Prevalence trends of being overweight, and obesity among genders in other countries is similar; yet, in South Africa substantially greater rates of obesity is seen amongst women. The gender difference can possibly be attributed to cultural factors, where among many black African women being overweight is perceived to be advantageous and associated with acceptance. An overweight female body image is associated with dignity, respect, wealth, strength, happiness and health, as well as with being treated well by their husbands (Joubert et al., 2007).

Physiological functioning within each individual is unique, and physiological changes to stress may differ amongst individuals. One factor that may lead to adverse physiological changes and increase the risk of developing obesity is poor sleeping habits (Chaput, Després, Bouchard, & Tremblay, 2008; Patel & Hu, 2008). Researchers argue that sleep and weight gain may have bidirectional effects, i.e. poor sleeping patterns may predispose to obesity, and obesity has been associated with poor sleeping patterns (Chaput et al., 2008; Marshall, Glozier, & Grunstein, 2008; Beccuti & Pannain, 2011). In addition to that, obesity also causes daytime drowsiness and fatigue (Beccuti & Pannain, 2011). Poor sleeping patterns have shown to cause hormonal changes, which increase appetite and cravings for energy-dense foods (Knutson, Speigel, Penev, & van Cauter, 2007; Beccuti & Pannain, 2011; Huang, Ramsey, Marcheva, & Bass, 2011). The relationship between poor sleeping patterns and obesity will be discussed in more detail in chapter 2.

1.1.3.5 Work-Related Factors Contributing to Obesity

The current study will not be focusing on the causes of obesity; conversely, associations between work-related factors and behavioural- and social- factors will be investigated. Various adverse workplace conditions may contribute to the development of obesity and disease by affecting behavioural characteristics of employees. These conditions include long work hours and rotating work hours, both of which may result in poor sleeping patterns, availability of food in the canteen and vending machines, and availability/lack of a gymnasium. These adverse workplace conditions influence physical activity habits, dietary patterns, as well as habits such as smoking and drinking alcohol. These factors will be discussed in detail in chapter 3.

1.1.4 Dietary Habits in the Workplace

Dietary habits within the workplace which have been linked to obesity include decreased intake of fruit and vegetables, increased snacking, increased consumption of sugar-sweetened beverages, and poor food choices. Current evidence of the association between fruit and vegetable intake and body weight changes is limited and not fully consistent. Some studies found a strong association between increased fruit and vegetable intake and reduced risk of excess weight gain (Vioque et al., 2008; Ledoux, Hingle & Baranowski, 2011), some found only a weak association (Buijsse et al., 2009; Ledoux et al., 2011), while others found no association (French, Harnack, Toomey, & Hannan, 2007; Ledoux et al., 2011). Few studies have investigated factors within the workplace associated with snacking and obesity. Factors that have been found to increase snacking include sleep deprivation (Nedeltcheva, 2009; Heath et al., 2012), and long work hours (Ko et al., 2007; Di Milia & Mummery, 2009); Escoto et al. (2010) found that long work hours were associated with a high BMI and less healthy food habits. Previous research regarding dietary habits in the workplace is limited; currently no studies have been conducted within the workplace in South Africa investigating the relationship between BMI, fruit and vegetable intake and snacking.

1.1.5 Physical Activity and Sedentary Habits of Employees

Lin, Courtney, Lombardi and Verma, (2015) and Ryde, Brown, Peeters, Gilson and Brown, (2013) found a positive association between BMI and occupational sitting time. However, Eriksen, Rosthøj, Burr and Holtermann (2015) only found a significant positive trend for women, no tendency for an association was observed in men. Interestingly, Chau et al. (2012)

found that employees involved in jobs that were more sedentary were more likely to be sufficiently active during leisure time, than those with more active jobs which involved mostly standing, walking, or heavy labour. With regards to leisure time activity, an inverse relationship has been observed between BMI and average time spent walking and time doing sports (Stamatakis et al., 2008). Furthermore, a positive relationship has been observed between TV viewing or internet and computer use, and excess body weight (Stamatakis et al., 2008; Vandelanotte, Sugiyama, Gardiner, & Owen, 2009; Heinonen et al., 2013). While the relationship between leisure time activity and obesity is clear, the association between occupational sitting and obesity is less clear. Research regarding the association between sedentary behaviours at work and BMI is limited, with no data available for South African employees.

1.1.6 Long Work Hours and Short Sleep Duration

Numerous studies have found a U-shaped relationship in both sleep hours and works hours with the prevalence of obesity (Ko et al., 2007; Jang, Kim, Lee, Myong, & Koo, 2013; Abramowitz, 2016). However, when accounting for confounding factors such as time spent in food preparation and exercise, the effect was decreased in women (Gu et al., 2012; Jang et al., 2013; Abramowitz, 2016). These results are further supported by Di Milia and Mummery (2009), and Di Milia et al. (2013). The relationship between both sleep hours and work hours with obesity has not been explored in employees in South Africa.

1.1.7 Comorbidities Associated with Obesity

Obesity has been found to affect all countries, genders, age groups, ethnicities, and education levels (Dixon, 2010). Obesity is a well-established risk factor for numerous non-communicable diseases, such as type II diabetes mellitus (T2DM), hypertension, cardiovascular disease (CVD), hypercholesterolemia, various cancers, and osteoarthritis (Lenz et al., 2009; Borak, 2011; Cawley & Meyerhoefer, 2012). Furthermore, obesity exacerbates many chronic conditions such as low back pain, osteoarthritis, and other musculoskeletal conditions (Neovius, Johansson, Kark, & Neovius, 2009). These comorbidities associated with obesity negatively impacts many health outcomes, such as quality of life, disability and mortality; and leads to decreased productivity and increased health care utilization (Sullivan, Morrato, Ghushchyan, Wyatt, & Hill, 2008; Hammond & Levine, 2010). The excess medical expenditures that result from treating these obesity-related diseases are significant (Sullivan et al., 2008; Hammond & Levine, 2010). As a greater percentage of a country's population become more obese, so a larger portion of the total annual national health care expenditure is spent on obesity and obesity-related health problems (Sullivan et al., 2008; Hammond & Levine, 2010; Lehnert et al., 2013). Thus, obesity negatively affects the economic outcomes of a country. The physiological changes associated with excess body weight that leads to the development of these diseases will be discussed in detail in chapter two.

The number of comorbidities associated with excess body weight is not well reported, however one author described increased number of comorbidities associated with excess body weight (Sullivan et al., 2008). Furthermore, Sullivan et al. (2008) and Goetzel et al. (2010) indicated that excess body weight was associated with increased visits to a doctor's office. The comorbidities commonly studied, and included in the current study, are T2DM, hypertension, CVD, dyslipidaemia, and stroke. Trends observed in employees have indicated strong associations between excess body weight and risk of T2DM (Oberlinner, Neumann, Ott, & Zober, 2007; Sullivan et al., 2008; Nguyen, Nguyen, Lane, & Wang, 2011; Félix-Redondo et al., 2013; Rolando et al., 2013), hypertension (Oghagbon, Okesina, & Biliaminu, 2008; Clougherty, Eisen, Slade, Kawachi, & Cullen, 2009; Keenan & Rosendorf, 2011; Shihab et al., 2012), CVD (Bogers et al., 2007; Félix-Redondo et al., 2013), dyslipidaemia (Barquera et al., 2007; de Zwaan et al., 2009; Félix-Redondo et al., 2013) and stroke (Strazzullo et al., 2010; Yatsuya et al., 2010). However, the association of these comorbidities with overweight employees is not as clear as with obese employees. The association between these diseases and overweight and obese employees will be discussed in more detail in chapter 3. No information regarding comorbidities associated with excess body weight is available for employees within South Africa. The current study will be investigating the number of comorbidities associated with excess body weight, as well as the number of associated visits to a doctor's office. Furthermore, the prevalence of comorbidities associated with excess body weight will be investigated in employees in South Africa.

1.1.8 Quality of Life

Obesity has become increasingly prevalent in recent decades, and as obesity is associated with substantially increased morbidity and mortality, it is now a major public health concern (de Zwaan et al., 2009; Jia & Lubetkin, 2010). Literature has established that obesity impacts on many aspects of an individual's life, including physical, mental, and social well-being (de

Zwaan et al., 2009; Jia & Lubetkin, 2010; Taylor, Forhan, Vigod, McIntyre, & Morrison, 2013). As mentioned earlier on many comorbidities have been linked to obesity, namely T2DM, hypertension, sleep apnoea, CVDs, osteoarthritis and various cancers (de Zwaan et al., 2009; Lenz, 2009; Borak, 2011). Apart from the physical health issues, obesity has been linked to depression, public distress, and low self-esteem (Atlantis & Baker, 2008; de Zwaan et al., 2009). Furthermore, obese individuals are subject to discrimination in both social and work environments (Atlantis & Baker, 2008; de Zwaan et al., 2009). In turn, this appears to have an adverse effect on an individual's capacity to live a full and active life (de Zwaan et al., 2009), negatively impacting on an individual's quality of life.

1.1.8.1 Quality of Life Defined

Quality of life is a broad, multidimensional concept that usually includes subjective evaluations of both positive and negative aspects of life (Taylor et al., 2013). As early as 1946, the World Health Organization (WHO) defined health as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity". It has since been emphasized that health has dimensionality, and involves physical health state, mental health state, ability to function in a social and work environment, as well as general perceptions of well-being (Kruger, Bowles, Jones, Ainsworth, & Kohl, 2007; Taylor et al., 2013). Health and well-being can range from negative states of disease, to more positive states of well-being, and are influenced by an individual's experiences, beliefs, expectations, and perceptions (Janke, Collins, & Kozak, 2007; Kruger et al., 2007). It has been well-established that obesity has a negative impact on perceived quality of life (Kruger et al., 2007; de Zwaan et al., 2009; Taylor et al., 2013). Even in the absence of obesity comorbidities, obese adults report significantly lower QOL scores though, comorbidities appear to be a confounding factor (Jia & Lubetkin, 2010; Taylor et al., 2013). Many studies also report a dose-response relationship between BMI and the degree of QOL impairment (Sach et al., 2007; de Zwaan et al., 2009; Søltoft, Hammer & Kragh, 2009).

1.1.8.2 Quality of Life: Physical Aspect

As mentioned above, obesity poses physical limitations which impacts on an individual's functional capacity, and ability to perform activities of daily living (ADLs) (Sach et al., 2007; Søltoft et al., 2009; Backholer, Wong, Freak-Poli, Walls, & Peeters, 2012). Common physical conditions associated with obesity include osteoarthritis, lower back pain, and chronic generalized pain (secondary to fibromyalgia) (Taylor et al., 2013). The presence of pain causes a decrease in the overall sense of well-being as well as physical activity; this in turn decreases overall functional capacity (Taylor et al., 2013). Obese individuals have described shortness of breath with stair climbing, pain and discomfort when squatting or kneeling, difficulty in climbing on and off buses; as well as admitting to doing as little physical activity possible (Sach et al., 2007). Further studies (Levine et al., 2008; Pataky, Armand, Müller-Pinget, Golay, & Allet, 2014) have identified gait alterations, posture deficits as well as a greater risk of falling as a consequence of obesity. Gait alterations include a lower gait speed, shorter stride length, and increased step width; this is possibly to increase comfort and decrease the risk of falling (Levine et al., 2008; Pataky et al., 2014). In addition to that, obese individuals have poorer muscular endurance, decreased aerobic endurance, and take more time to accomplish sit-to-stand activities (Pataky et al., 2014). These physical limitations and decrements in functional capacity can be classified as a disability (Backholer et al., 2012) which significantly impacts on one's ability to perform ADLs.

Numerous studies found that normal weight individuals had a significantly higher QOL score, in relation to physical functioning, than individuals who were classified as overweight or obese (de Zwaan et al., 2009; Søltoft et al., 2009; Cameron et al., 2012; Ul-Haq, Mackay, Fenwick, & Pell, 2013). Other studies found a significant association between normal weight and obese individuals, but not between normal weight and overweight individuals (Sach et al., 2007). Moreover, QOL tended to deteriorate with increasing levels of obesity (Sach et al., 2007; de Zwaan et al., 2009; Søltoft et al., 2009).

1.1.8.3 Quality of Life: Mental Aspect

The consequence of chronic pain is a limitation in the participation in activities that are important for personal satisfaction, and may increase the risk of developing mental disorders such as depression (Janke et al., 2007; Taylor et al., 2013). Depression may cause symptoms such as fatigue and hopelessness, which then interferes with one's ability to adhere to other healthy habits such as good nutrition, adherence to treatments and abstinence from smoking, alcohol and drugs (Taylor et al., 2013). Literature provides some level of support for the link between obesity and depression (Sach et al., 2007; Atlantis & Baker, 2008) however, this evidence is weak. In this regard, researchers found that depression prevalence has shown to be higher when obesity is coupled with binge eating, in individuals with bodily pain, and in the female population (Sach et al., 2007; Atlantis & Baker, 2008; Taylor et al., 2013).

Some studies found that mental problems were only observed in obese individuals, but not overweight individuals (Sach et al., 2007; Søltoft et al., 2009). Ul-Haq et al. (2013) found that only obese class III individuals had a significantly lower mental health when compared to normal weight individuals. However, Sach et al. (2007), de Zwaan et al. (2009), and Cameron et al. (2012) found no significance across BMI groups for mental well-being.

1.1.8.4 Quality of Life: Social Aspect

Psychosocial factors identified in obese individuals include internalization of negative weight-based stereotypes, negative self-body image, as well as low self-esteem (Sach et al., 2007; Atlantis & Baker, 2008). Furthermore, obese individuals tend to face prejudice and discrimination both in public and in the workplace (Sach et al., 2007). Obese individuals are often rated as being less qualified for a job, having poorer work habits, as well as having emotional and interpersonal problems (Cameron et al., 2012). Doctors and other health professionals also tend to have negative perceptions of obese individuals, often labelling them as ‘lazy' or having a lack of will-power (Sach et al., 2007; Cameron et al., 2012). Cameron et al. (2012) found strong associations between BMI categories and social functioning, but only in women.

Quality of life associated with excess body weight is poorly investigated in employees, and this applies to South Africa too. Quality of life in various domains including, physical, mental, social, and environmental will be investigated in the current study.

1.1.9 Burden of Disease

Adverse health behaviours as well as the comorbidities associated with obesity independently create a financial burden on employers and the economy of the country (Laaksonen, Piha, & Sarlio-Lähteenkorva, 2007; Tsai, Ahmed, Wendt, Bhojani, & Donnelly, 2008; Andreyeva, Luedicke, & Wang, 2014). As the prevalence rates of obesity within the workplace are increasing, this creates rising costs to the employer; thus, the body weight of employees has become a concern to occupational health researchers as well as employers (Frone, 2008; Howard & Potter, 2014). The financial impact of a disease, in this case obesity, within the workplace and on the economy, has been investigated by many authors using cost-of-illness studies (Laaksonen et al., 2007; Frone, 2008; Tsai et al., 2008; Andreyeva et al., 2014; Howard & Potter, 2014). Cost of illness (COI) is also known as burden of disease (BOD), and it is a definition that encompasses various aspects of the impact of a disease on health outcomes, either in a country, specific region, communities, or even individuals. COI categories include incidence or prevalence of disease and its effect on longevity, morbidity and quality of life, and financial aspects including direct and indirect costs that result from premature death, disability or injury due to corresponding disease and/or its comorbidities (Jo, 2014).

The financial aspects of the BOD have been categorized into either direct medical costs, or indirect productivity-related costs; these costs quantify the amount of consumed or lost resources in monetary terms (Neovius, Johansson, & Neovius, 2009; Lehnert, Sonntag, Konnopka, Riedel-Heller, & König, 2013; Howard & Potter, 2014). Direct medical costs involve costs related to preventative care, diagnosis, and medical treatment related to a disease. These medical treatments include hospitalization, visits to doctors or other medical professionals, medications, and nursing home care (Hammond & Levine, 2010; Howard & Potter, 2014). Indirect costs are associated with four types of productivity losses, namely absenteeism, presenteeism, disability, and premature mortality (Howard & Potter, 2014). The goal of COI studies is to evaluate the economic burden that an illness imposes on society, by itemizing, giving value to, and summing up the costs of a particular condition. Cost of illness studies are important for assisting in the formulation of health care policies and interventions, which is becoming increasingly important not only for the public, but also for employers and companies in South Africa. The majority of these studies have been conducted in the United States, with smaller studies conducted in other countries, but none in South Africa.

Studies from other countries provide evidence that obese employees have significantly higher rates of absenteeism, when compared to normal weight employees (Andreyeva et al., 2014; Howard & Potter, 2014). The relationship between overweight employees and absenteeism is less clear, with some studies reporting a significant association, while others do not (Tsai et al., 2008; Andreyeva et al., 2014; Howard & Potter, 2014). The effect of being overweight and obesity on presenteeism has not been investigated fully, with a wide variation in measurement methods used (Kolbe-Alexander et al., 2008; Kleinman et al., 2014; Bustillos, Vargas, & Gomero-Cuadra, 2015; Yu, Wang, & Yu, 2015). Results from these studies have been mixed, with some studies observing significant differences between both overweight and obese employees compared to normal weight employees, and others only between obese and normal weight employees (Kolbe-Alexander et al., 2008; Kleinman et al., 2014; Bustillos, et al., 2015; Yu et al., 2015). The relationship between excess body weight and productivity in employees in South Africa has not been investigated, and is not known. The contribution of obesity-related absenteeism and presenteeism to the burden of disease in South Africa is unknown.

1.2 Problem Statement

Extensive research into obesity regarding prevalence, association of various lifestyle and work-related factors, association of various comorbidities, quality of life, productivity and economic burden has been conducted. A large proportion of the research has been conducted on the general population, with a smaller proportion conducted on employees within a work environment. Most of these studies were done in the United States, with a small portion of this research being done in other countries. Illness absence in a working population can be a complex phenomenon, influenced by many factors such as age, gender, education, personal health risk factors, and work-related factors. Studies examining the relationship between modifiable health risks and employee absenteeism have shown that overweight and obese employees had significantly higher absence rates (Andreyeva et al., 2014; Howard & Potter, 2014). A few studies have also explored the relationship between the number of health risk factors and absenteeism, and some have demonstrated increased absenteeism with the clustering of health risk factors (Tsai et al., 2008; Yu et al., 2015). In South Africa, research on obesity is substantially less, and the majority of research focuses on children and adolescents. The current study is unique as it is the first of its kind in South Africa. This study will provide information, for the first time, about overweight and obese employees, which will be vital for designing and implementing wellness intervention programs to combat obesity in South Africa. This data is crucial for convincing governments, corporate/industrial companies and health professionals about the significance of the problem of obesity in economic terms, and for putting strategies in place for the prevention and management of obesity. Thus, information from this study could contribute to the prevention and reduction of obesity and its associated costs in South Africa.

1.3 Research Questions

Given the above problem, the study endeavoured to answer the following research questions:

1. What is the prevalence of overweight and obesity among corporate and industrial employees in South Africa?

2. What is the prevalence of comorbidities and risk factors associated with overweight and obese corporate and industrial employees, compared to normal weight employees?
3. What are the lifestyle and work-related factors associated with overweight and obese corporate and industrial employees, including physical activity and sedentary habits, dietary habits, sleeping patterns, alcohol consumption, smoking status, and work hours?
4. What is the quality of life of overweight and obese corporate and industrial employees, compared to normal weight employees?
5. What is the association between excess body weight with productivity, namely absenteeism and presenteeism in corporate and industrial employees?
6. What is the contribution of overweight- and obesity-related absence frequency rates and associated costs to the economic burden of excess body weight in corporate and industrial South African employees?
7. After considering the results, is it possible to develop a workable health promotion model, unique to SA, to address overweight and obesity in the workplace?

1.4 Aims and Objectives

The aim of this study was to assess the work health-related profile of overweight and obese employees; to establish the cost implication of these employees in South African industrial and corporate companies and to develop a health promotion model to address being overweight, and obesity, in the workplace.

1.4.1 Objectives

To fill the knowledge gap, the study had the following objectives:

1. To determine the prevalence of being overweight and obesity in corporate and industrial employees in South Africa.
2. To determine the prevalence of comorbidities and risk factors associated with overweight and obese corporate and industrial employees compared to normal weight employees.
3. To measure the lifestyle and work-related factors associated with overweight and obese corporate and industrial employees, such as physical activity habits and sedentary habits, dietary habits, sleeping patterns, alcohol consumption, smoking status, and work hours.

4. To measure the quality of life of overweight and obese corporate and industrial employees compared to normal weight employees.
5. To determine the association of excess body weight with productivity, namely absenteeism and presenteeism in corporate and industrial employees.
6. To determine the contribution of overweight- and obesity-related absence frequency rates and associated costs to the economic burden of excess body weight in corporate and industrial South African employees.
7. To develop a health promotion model, unique to SA, to address obesity in the workplace.

1.5 Hypotheses

1.5.1 Research Hypothesis 1: The prevalence of being overweight, and obesity, in corporate and industrial employees in South Africa will be compiled from this study.

1.5.2 Research Hypothesis 2: Obese and overweight employees will have more obesity-related comorbidities and health risk factors than that of normal weight employees.

1.5.3 Research Hypothesis 3: Obese and overweight employees will have poorer lifestyle and work-related factors such as physical activity habits and sedentary habits, dietary habits, sleeping patterns, alcohol consumption, and smoking status, than that of normal weight employees.

1.5.4 Research Hypothesis 4: Obese and overweight employees will have poorer quality of life scores compared to normal weight employees.

1.5.5 Research Hypothesis 5: Obese and overweight employees will have greater absence frequency rates than that of normal weight employees.

1.5.6 Research Hypothesis 6: Obese and overweight employees will present a greater economic burden than that of normal weight employees.

1.5.7 Research Hypothesis 7: Based on the results of the study a health promotion model, that will be unique to SA, can be developed to address obesity in the workplace.

1.6 Limitations and Delimitations

1.6.1 Limitations

Participants may not have answered the questionnaire questions honestly or accurately. The following are limitations regarding the food diary: (1) participants may not have been able to quantify the food correctly, (2) participants may not have been honest about what they eat and the amount they eat.

1.6.2 Delimitations

Seventeen thousand three hundred and fifty nine (17359) participants were recruited for part A of this study. One hundred and seventeen (117) participants were recruited for part B of this study, and completed detailed questionnaires on various lifestyle habits.

Participants consisted of both males and females, and all races were included. All participants were between the age of eighteen and sixty five years. Participants were categoried into the following BMI categories: normal weight (18.5 kg/m^2 - 24.9 kg/m^2), overweight (25 kg/m^2 - 29.9 kg/m^2), and obese ($\geq$ 30 kg/m^2) (Thompson et al., 2009). Participants who fell into the underweight category were excluded from the study. Data was collected from companies throughout South Africa.

1.7 Structure of the Thesis

This research study will be presented in the thesis format and written in accordance with the requirements of the University of Zululand (APA Referencing System). The thesis will be presented as follows:

Chapter One: Introduction, Problem Statement, Aims and Objectives: This chapter consists of the introduction to the research study, problem statement, the objectives and research questions.

Chapter Two: Literature Review One: This chapter forms the literature overview wherein relevant and available literature will be reviewed. Evidence is provided for prevalence rates of overweight and obesity within the general population, validity and accuracy of BMI as a measurement of excess body weight, physiological changes that occur within the body due to excess body weight and the associated health concerns, and factors contributing to the development of obesity.

Chapter Three: Literature Review Two: This chapter forms the literature overview wherein relevant and available literature will be reviewed. Evidence is provided for the prevalence rates of overweight and obese employees within the workplace, lifestyle habits and work-related factors associated with overweight and obese employees, prevalence of comorbidities in overweight and obese employees, quality of life of overweight and obese employees, and cost of illness from reduced productivity associated with overweight and obese employees.

Chapter Four: Pilot Study Article: Effect of Obesity on the Work Health-Related Behaviours and Quality of life of South African Mining Employees: A Pilot Study. (Published in the Global Journal of Health Sciences).

Chapter Five: Methodology: This chapter includes the study design, information regarding the study participants, description of the measurements and test protocols used to collect the data, how the data was computed and analysed, as well as the ethical considerations.

Chapter Six: Results and Discussion: In this chapter, the results of the study are presented and discussed according to hypotheses of the study.

Chapter Seven: Summary, Conclusion, Limitations and Recommendations: In this chapter a short summary and conclusion of the study is presented, followed by recommendations for possible further research. Included in the recommendations is the health promotion model developed by the author, to address obesity in the workplace.

Annexure: Necessary information related to the research, will be included in this study as annexures:

Appendix A: World Health Organization (WHO) Health at Work Survey

Appendix B: WHO Quality of Life Questionnaire

Appendix C: International Physical Activity Questionnaire (IPAQ)

Appendix D: Food Diary

Appendix E: Proof of Publication of Pilot Study Article

Appendix F: Ethical Clearance Certificate

Appendix G: Informed Consent Form

1.8 References

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CHAPTER TWO
LITERATURE REVIEW ONE

2.1 Introduction

2.2 Measurement of Obesity

2.3 Health Concerns Associated with Obesity

2.3.1 Cytokines and Chronic Low-Grade Inflammation

2.3.2 Vascular Changes

2.3.3 Dysfunction of the Hypothalamic-Pituitary-Adrenal (HPA) Axis

2.4 Factors Contributing to the Development of Obesity

2.4.1 Physical Inactivity and Sedentary Behaviour

2.4.2 Sedentary Behaviour and Hypokinetic Disease

2.4.3 Physical Activity, Exercise and Physical Fitness

2.4.4 Dietary Habits

2.4.5 Sleeping Patterns

2.5 References

2.1 Introduction

Recent years has seen an exponential increase in global obesity rates, with further increases expected in both children and adults (Gelber et al., 2008; Dixon, 2010). The concern associated with obesity stems from the negative impact that obesity has on health and wellness, as well as on the economy (Borak, 2011). Excess body weight is a significant risk factor for cardiovascular diseases (CVDs), type II diabetes mellitus (T2DM), musculoskeletal disorders, as well as various cancers; all of which contributes to increased mortality and morbidity (Lenz, Richter, & Mülhauser, 2009). Excess body weight is the result of a complex interaction of several factors such as decreased physical activity levels, poor dietary habits, socio-economic status, and an altered interaction with the environment (Dixon, 2010). The effect of these factors is an excessive accumulation of adipose tissue, and is measured using the body mass index (BMI) (Dixon, 2011; Jacobs et al., 2010). It is well-established that increasing BMI results in an increased risk for the diseases and disorders mentioned above, resulting in decreased life-expectancy (Lenz et al., 2009; Dixon, 2010; Borak, 2011). These comorbidities associated with obesity result in greater utilization of health care as well as higher medical expenditures, all of which negatively impacts on the economy (Sullivan, Morrato, Ghushchyan, Wyatt, & Hill, 2008; Borak, 2011). There is also a negative impact observed in the workplace due to obese individuals taking a larger number of sick leave days, resulting in absenteeism from work. Moreover, productivity levels are decreased when individuals are at work, but not feeling well. Further need for support services and disability management contribute to the financial burden (Sullivan et al., 2008; Borak, 2011).

2.2 Measurement of Obesity

Obesity refers to an excess of adipose tissue, and is commonly measured using weight and height to calculate body mass index (BMI). BMI is determined by dividing body mass (in kilograms) by height (in metres squared); based on the assumption that at a given height, higher weight is associated with increased fatness (Flegal et al., 2009). Individuals with a BMI of $\leq$ 24.9 kg/m^2 are considered to be normal weight; overweight is defined as a BMI of 25-29.9 kg/m^2, and obesity as a BMI $\geq$ 30 kg/m^2. Obesity can be further categorized by BMI, with a BMI of 30-34.9 kg/m^2 classified as grade I obesity, 35-39.9 kg/m^2 grade II obesity, and BMI $\geq$ 40 kg/m^2 classified as grade III obesity (Flegal, Kit, Orpana, & Graubard, 2013). While BMI has been used extensively in research, clinically, and by multiple health organizations, some uncertainty exists regarding the accuracy of BMI to measure adiposity.

The primary disadvantage of using BMI is that it does not directly measure body composition; there is no differentiation between lean body mass and fat mass. Thus, an individual whose stature is less than average, has a large bone mass, and/or a large muscle mass may incorrectly be labelled as obese. Furthermore, BMI does not take into account age, gender or fat distribution. Advantages associated with using BMI include the following: it is a quick and convenient method, it is safe and non-invasive, and there is minimal cost involved. Anthropometric indexes of central adiposity and body composition, including waist circumference (WC) and waist-to-hip ratio (WHR), have been proposed to more accurately identify individuals at risk for adverse health consequences of excess weight (Gelber et al., 2008). The clinically defined threshold for abdominal obesity, measured by waist circumference, in women is $\geq$ 88cm, and for males $\geq$ 102cm (Jacobs et al., 2010). Furthermore, the World Health Organization (WHO) recognizes that a waist circumference between 80.0-87.9cm in women and 94.0-101.9cm in men corresponds with the overweight category of BMI (25.0-29.9 kg/m^2).

As mentioned above, although the use of BMI is widespread, the validity of BMI to measure obesity has been criticized (Romero-Corral et al., 2008; Rothman, 2008; Okorodudu et al., 2010). The accuracy of BMI in diagnosing obesity in the adult general population was investigated by Romero-Corral et al. (2008) in the National Health and Nutrition Examination Survey (NHANES). It is worth noting that the study involved a large population sample of 13601 participants, including 6580 males and 7021 females. This study investigated the sensitivity and specificity of the diagnostic performance of BMI, as well as correlation between BMI and both body fat percent and lean body mass. A BMI of ≥ 30 kg/m^2 had a poor sensitivity, with 36% of men and 49% of women being correctly identified as obese. This category however, had a good specificity with 95% of men and 99% of women being correctly identified as not being obese. The overweight category (25-29.9 kg/m^2) had a moderate to good sensitivity, with 84% of men and 88% of women being correctly identified as overweight. A poor specificity (62%) was observed for men, but a moderate to good specificity (84%) was observed in women.

This data suggests that using BMI for diagnostic purposes in the intermediate ranges of body weight may be limited due to the inability of BMI to differentiate between body fat mass and lean body mass. BMI uses total body mass, made up of lean mass and adipose tissue; which have opposite biological effects. Adipose tissue is associated with negative health outcomes, whereas increased lean mass is positively associated with physical fitness, higher calorie expenditure and exercise capacity, all of which are associated with positive health outcomes. In addition to the above, this study investigated the correlation between BMI and body fat percentage (BF%), as well as BMI and lean body mass. Overall in men, BMI had a correlation of $\rho=0.65$ ($p<0.0001$) with BF%, and $\rho=0.73$ with lean body mass ($p<0.0001$); which are both good. In women, BMI had an excellent correlation of $\rho=0.87$ with BF%, and a good correlation of $\rho=0.74$ with lean body mass. While this study highlighted the limitations in using BMI to diagnose obesity, it is important to point out that the use of BMI is not without value. BMI may still be the optimal method used to evaluate changes in body fatness over time, as any increments in BMI most likely represent fat gain, with the exception of body builders. Furthermore, a BMI ≥ 30 kg/m^2 has an excellent specificity for diagnosing obesity in both males and females, as well as for women in the overweight category (25-29.9 kg/m^2) (Romero-Corral et al., 2008; Rothman, 2008; Okorodudu et al., 2010).

The above data is supported by Okorodudu et al. (2010), who found similar results while conducting a systematic review and meta-analysis on the diagnostic value of BMI to identify obesity. The selection criteria for the study were the following: the study must have 1) assessed the performance of BMI to identify excess body fat; 2) provided standard values of diagnostic performance (e.g. sensitivity, specificity, positive predictive value, negative predictive value); and 3) used a body composition technique (e.g. dual-energy X-ray absorptiometry, air-displacement plethysmography, hydrostatic weighing) as the gold standard. Twenty-five (25) articles met the above criteria, and were included in the study; with a total of 31968 adults. BMI displayed an overall sensitivity to identify excess body adiposity of 50% ($p<0.0005$), and an overall specificity of 90% ($p<0.0005$). This study states the same conclusion as Romero-Corral et al. (2008), that BMI has a good specificity, but poor sensitivity in identifying excessive adiposity. These results are further supported by Gradmark et al. (2010) who validated anthropometric measurements of abdominal obesity against computed tomography (CT). BMI had a strong correlation (r 0.71; $p<0.0003$) with CT total subcutaneous adipose tissue. The above studies provide evidence that BMI is a valid measure of obesity.

Many studies (Gelber et al., 2008; Lee, Huxley, Wildman, & Woodward, 2008a; Lee, Lee, Kim, & Kim, 2008b; Gradmark et al., 2010; Huxley, Mendis, Zheleznyakov, Reddy, & Chan, 2010) support the use of waist circumference as a valid measure of central adiposity. Lee et al. (2008a) compared waist circumference measurements, dual-energy X-ray absorptiometry (DXA), and computed tomography (CT) to measure abdominal adiposity and detect metabolic risk factors in obese women. The results showed that WC, DXA, and CT all significantly predicted at least two components of metabolic syndrome, with no significant difference in accuracy level between measurements. These results agree with the findings of Gradmark et al. (2010) who validated anthropometric measurements of abdominal obesity against computed tomography (CT). Waist circumference had a strong correlation (r 0.86; $p<0.0001$) with CT total subcutaneous adipose tissue. These studies confirm that the use of the waist circumference measurement is not inferior to DXA or CT measurements, and is a valid measure of abdominal adiposity.

The correlation between BMI and waist circumference has been investigated to determine whether an association exists. Huxley et al. (2010) stated that one standard deviation increase, in BMI, WC, and WHR, was associated with an increase in risk of cardiovascular disease (CVD) of 17%, 27%, and 36% respectively; thus, indicating a higher BMI is also associated with a higher WC. This is supported by Flegal et al. (2009), who found that WC and BMI were significantly correlated with each other for both men and women, than either was with fat percentage. A strong correlation between BMI and WC for both men ($r=0.78$) and women ($r=0.82$) was observed by Gelber et al. (2008). These studies confirm that increasing BMI is associated with increasing waist circumference measures.

The association between increasing BMI and waist circumference measures with cardiovascular disease (CVD) and morbidity is well established (Gelber et al., 2008; Lee et al., 2008a; Lee et al., 2008b; Huxley et al., 2010; Jacobs et al., 2010). Diabetes is a major risk factor for the development of CVD, and increases the risk fourfold (Thompson, Gordon, & Pescatello, 2014). Huxley et al. (2010) found that the overall relative risk estimate for T2DM incidence associated with one standard deviation increase in BMI and WC, were both 1.87 ($p<0.0005$). Lee et al. (2008b) stated a correlation of BMI with T2DM of 0.67 for men and 0.69 for women. This is further supported by Lenz et al. (2009) who stated the risk of developing T2DM increases by 20% for each 1 kg/m^2 increase in BMI. A 100% increase in risk is seen at a BMI of 27.2-29.3 kg/m^2, with a 300% increase in risk seen in a BMI $\geq$ 24.9 kg/m^2. The same trend is observed in risk for CVD. Lenz et al. (2009) performed a systematic review of the literature on morbidity and mortality risks in overweight and obese individuals; 27 meta-analyses and 15 cohort studies were included. There was no increase in risk observed in overweight women, while there was a 10% increase in risk for overweight men. The risk of developing CVD increased to 50% for both men and women who were obese, and in morbid obesity (BMI > 40 kg/m^2) the risk increased by 200-300%. These results are supported by Gelber et al. (2008) and Jacobs et al. (2010) who found that men and women with higher BMI and WC indexes were more likely to have a history of hypertension, T2DM and high cholesterol. It was further stated that a linear association was found between higher adiposity measures and risk of incident CVD. The above evidence indicates that increases in BMI and WC are associated with increased morbidity.

2.3 Health Concerns Associated with Obesity

2.3.1 Cytokines and Chronic Low-Grade Inflammation

It is well documented that there are several deleterious physiological changes that occur in the body due to obesity (Goossens, 2008; Zou & Shao, 2008; O'Rourke 2009; Hummasti & Hotamisligil, 2010). Adipose tissue (AT) is responsible for buffering the daily influx of dietary fat entering into circulation by suppressing the release of fatty acids into circulation and increasing the clearance of triacylglycerol (TAG). However, this mechanism is not equipped to handle continual excessive caloric intake, and with obesity the buffering capacity for lipid storage in the adipocytes is decreased due to the AT being overloaded with TAG (Goossens, 2008; Hummasti & Hotamisligil, 2010). The storage ability of the AT is overwhelmed, and leads to dysfunction of the AT as well as an increase in circulating free fatty acids (FFA). The result of this is an accumulation of TAG in non-adipose tissues, also known as ectopic lipid deposition; as TAG are cytotoxic to most cells other than the AT, the resultant effect is metabolic and inflammatory changes which lead to metabolic dysfunction. Accumulation of TAG occurs in the pancreas, endothelial cells, liver, as well as the skeletal muscle; resulting in T2DM, hypertension (as the vasodilatory effects of insulin are reduced), steatohepatitis, and peripheral insulin resistance, respectively. Furthermore, in the liver TAG causes increased glucose production, increased hepatic VLDL production, and decreased insulin clearance in the liver; resulting in glucose intolerance, hyperlipidaemia, and hyperinsulinemia, respectively (Goossens, 2008; Hummasti & Hotamisligil, 2010).

In addition to the above, dysfunction within the AT leads to altered adipokine (cytokines released by adipose tissue) signalling (Antuna-Puente, Feve, Fellahi, & Bastard, 2008; O'Rourke, 2009). Cytokines are proteins which are responsible for signalling between cells and have an important immune-regulatory function; they include leptin, adiponectin, interleukin-6 (IL-6), tumour necrosis factor α (TNF-α), and resistin to name a few. In obese individuals, a decrease is seen in adiponectin; while an increase is observed in leptin, TNF-α, IL-6 and resistin (Antuna-Puente et al., 2008; Zou & Shao, 2008; Myers, Leibel, Seeley, & Schwartz, 2010; Sáinz, Barrenetxe, Moreno-Aliaga, & Martínez, 2015). Adiponectin plays a role in increasing insulin sensitivity, decreasing induced inflammatory responses, as well as exerting a protective effect on the blood vessels early in the atherogenesis process. Thus, a long-term decrease in adiponectin contributes to insulin resistance and the development of atherosclerosis (Antuna-Puente et al., 2008; Zou & Shao, 2008).

Leptin has many roles in the body and exerts its effect in both the central nervous system and peripheral tissues (Myers et al., 2010; Sáinz et al., 2015). Leptin is responsible for controlling energy balance (food intake and energy expenditure) through the central nervous system, providing satiety after meals, regulating lipid and glucose metabolism in the peripheral tissues, and regulating insulin sensitivity (Myers et al., 2010; Sáinz et al., 2015). Leptin resistance is highly associated with obesity, and leads to disturbances in energy homeostasis and body composition. Leptin resistance has been defined as a high concentration of circulating leptin (hyperleptinemia), and/or decreased responsiveness to circulating leptin (Myers et al., 2010; Sáinz et al., 2015). Several factors have been identified in initiating leptin resistance in obese individuals. Obesity is associated with systemic and local inflammation caused by the activation of inflammatory signalling by cytokines in the adipose tissue.

The activation of the inflammatory signalling as well as the oxidative stress contributes towards the development of leptin resistance. Increased levels of C-reactive protein (CRP) seen in obese individuals has also been shown to decrease the permeability of leptin at the blood-brain barrier (BBB), thus preventing leptin from reaching it neuron targets in the brain. Another possibility is the inhibition of the leptin signalling cascade within the neurons in the brain, further contributing to leptin resistance (Myers et al., 2010; Sáinz et al., 2015). Some evidence also indicates that over-nutrition or intake of specific nutrients (such as a high sugar or high fat diet) initiates leptin resistance (Myers et al., 2010; Sáinz et al., 2015). The result of leptin resistance is a blunted central and peripheral action of leptin, and impaired hepatic function leading to hyperglycaemia, hyperinsulinemia, and hyperlipidaemia; ultimately causing dysregulation of energy balance (Myers et al., 2010; Sáinz et al., 2015).

Cytokines TNF-α, IL-6 and resistin are elevated in obesity; each of these have a pro-inflammatory influence, leading to the development of chronic low-grade systemic inflammation (Antuna-Puente et al., 2008; Zou & Shao, 2008). They also contribute to insulin resistance by disrupting insulin signalling by interfering with the binding of insulin receptor substrate to the insulin receptor, as well as promoting degradation of the insulin receptor substrate (Hummasti & Hotamisligil, 2010). Furthermore, IL-6 controls the hepatic production of the C-reactive protein (CRP), which is an inflammatory protein and a significant risk factor for cardiovascular disease. A positive relationship has been found between IL-6 levels in AT and circulating CRP levels (Antuna-Puente et al., 2008). Visceral AT produces three times more IL-6 than sub-cutaneous AT, which explains the negative role of central obesity in CVD. Interleukin-6 also directly stimulates hepatic secretion of triglycerides, thus it could directly contribute to visceral-related hypertriglyceridemia (Antuna-Puente et al., 2008). Resistin damages the endothelium by directly stimulating smooth muscle cell proliferation in the human aorta; thus, initiating the development of atherosclerosis (Antuna-Puente et al., 2008). Serum levels of TNF-α, IL-6 and resistin can predict the presence and severity of atherosclerosis, T2DM, and sleep apnoea independent of body weight (O'Rourke, 2009). Some evidence indicates that enlarged adipocytes become hypoxic and undergo necrosis. This recruits macrophages which further induce an inflammatory response via the stimulation of IL-6 and TNF-α; thus, creating a viscous cycle of systemic inflammation (Goossens, 2008; O'Rourke, 2009). Macrophage infiltration in the AT is an important feature of chronic low-grade inflammation in obesity, and it has been shown that BMI is directly correlated with the number of macrophages in the adipose tissue (Antuna-Puente et al., 2008).

Though the immune response dysfunction is primarily found in the AT, it is not isolated to the AT. Macrophages in the liver induce inflammation, which alters liver lipid metabolism and impairs insulin signalling within the liver. Inflammation of the islets within the pancreatic β cells leads to impaired insulin secretion and reduced β cell mass. Skeletal muscle inflammation could directly influence muscle insulin resistance, and inflammation within the brain leads to improper regulation of energy uptake and expenditure. The physiological changes described above leads to chronic low grade systemic inflammation, as well as glucose intolerance, insulin resistance and T2DM (Antuna-Puente et al., 2008; O'Rourke, 2009; Hummasti & Hotamisligil, 2010).

Another altered physiological pathway which has recently been suggested to directly affect glucose and lipid metabolism is the endoplasmic reticulum (ER) (Antuna-Puente et al., 2008; Lionetti et al., 2009; Hummasti & Hotamisligil, 2010). The ER is responsible for producing various proteins, and is highly responsive to cellular nutrient and energy status. Under obese conditions the ER experiences stress either due to disruption or hyper-activation. The specific process that is negatively affected is the unfolded protein response (UPR), which is responsible for maintaining protein quality and integrity. Improper functioning of the UPR negatively affects metabolic homeostasis through the induction of inflammatory signalling networks. This signalling has been proposed to inhibit insulin action, thus leading to insulin resistance (Antuna-Puente et al., 2008; Lionetti et al., 2009; Hummasti & Hotamisligil, 2010). The tissues in which this has been observed includes the hypothalamus, liver, adipose tissue, as well as the muscle tissue. In the adipose tissue, ER stress further contributes to altered adipokine secretion. Endoplasmic reticulum stress has also been implicated in the death of a number of cells, including pancreatic β cells in the later stage of hyperglycaemia and insulin resistance, and adipocytes; which result in the recruitment of macrophages and other inflammatory cells. In addition to the above, ER stress has also been implicated in the rupture of atherosclerotic plaque, leading to emboli and possibly myocardial infarction or stroke (Hummasti & Hotamisligil, 2010). Further studies need to be conducted to confirm this possible link.

2.3.2 Vascular Changes

It is well documented that obesity also leads to significant dysfunction within the kidneys, the consequence of which is hypertension, and if left untreated could result in renal failure (Kotchen, 2010; Kotsis, Stabouli, Papakatsika, Rizos, & Parati, 2010; Landsberg et al., 2013). The primary mechanism contributing towards renal insufficiency is the increased activity in the renin-angiotensin aldosterone system (RAAS) (Hall et al., 2010; Kotchen, 2010). Under normal conditions the RAAS is a regulatory mechanism which prevents extreme variations in arterial pressure induced by changes in salt intake. The RAAS is activated in obesity via three mechanisms: 1) increased stimulation of the sympathetic nervous system (SNS), which results in the increased production of renin; 2) increased adipose tissue mass, and dysfunction within the adipose tissue resulting in increased production of renin, angiotensin II, angiotensinogen, as well as aldosterone by the adipose tissue; and 3) increased pressure on the kidneys from fat accumulation around the kidneys, as well as increased visceral fat accumulation, which results in increased production of renin by the kidneys (Kotsis et al., 2010; Landsberg et al., 2013).

Renin works with angiotensin converting enzyme (ACE) to act on substrates to produce angiotensin II, which is an active hormone that stimulates the secretion of aldosterone. Angiotensin II is a powerful vasoconstrictor which significantly increases peripheral resistance within the vascular tissues, thereby increasing blood pressure. Aldosterone acts to increase renal tubular reabsorption of sodium ions and water in the kidneys and this increases total blood volume and thus blood pressure (Kotsis et al., 2010). Increased levels of aldosterone have been associated with blood pressure, BMI, WC, as well as insulin resistance (Kotchen, 2010). Increased total blood volume results in renal vasodilation, increased glomerular filtration rate, and increased filtered amount of water and electrolytes. This compensation however is insufficient and results in increased extracellular fluid volume. In the progressive stage of obesity, glomerular injury occurs due to overuse, resulting in loss of nephron function. Due to increased RAAS activity and increased sodium ions in the blood, increased arterial pressure is needed to excrete daily salt intake and maintain sodium balance and volume homeostasis; thus, decreasing blood pressure. Under normal conditions an increased salt and fluid intake will result in increased natriuresis (excretion of sodium in urine) and diuresis (excretion of urine), respectively. However, in obese individuals an abnormal relationship is seen between arterial pressure and natriuresis; resulting in increased sodium retention and increased arterial blood pressure (Kotchen, 2009; Landsberg et al., 2013). A viscous cycle ensues, with increased blood flow to kidneys resulting in hyperfiltration and causing gradual progressive sclerosis of glomeruli walls due to physical stress. This in turn leads to further sodium retention, which alters arterial pressure, resulting in the cycle beginning again. Glomerulosclerosis seems to be directly dependent on body weight (Kotsis et al., 2010).

Though renal insufficiency is the primary mechanism contributing to the development of hypertension in obese individuals, there are other hemodynamic and neurohumoral changes which occur (Hall et al., 2010). Chronically increased levels of insulin associated with obesity, known as hyperinsulinemia, stimulates SNS activity which then enhances sodium retention in the kidneys. Long-term hyperinsulinemia also leads to vascular dysfunction, each of these contributes to sustained increase in blood pressure (Landsberg et al., 2013). Increased SNS activity has been shown to play a crucial role in the development of hypertension in obese individuals (Landsberg et al., 2013). The SNS is stimulated via increased insulin levels, obstructive sleep apnoea, as well as a high calorie intake, specifically a diet high in fats and carbohydrates. A high calorie intake has been suggested to increase norepinephrine turnover in peripheral tissues, raising resting plasma norepinephrine concentrations, and stimulate peripheral a_1- and b-adrenergic receptors, leading to elevated sympathetic activity and hypertension (Kotsis et al., 2010).

Endothelial dysfunction is another mechanism which is known to play a significant role in the development of hypertension (Kotsis et al., 2010). As discussed above, obesity represents a state of vascular and systemic inflammation, both of which contribute to endothelial dysfunction. The vascular endothelium plays an important role in the regulation of vascular resistance. Nitric oxide (NO) released from the endothelial walls is crucial for vascular relaxation (vasodilation), which decreases peripheral resistance and thus blood pressure. Nitric oxide also protects the vascular walls from inflammation and platelet aggregation (Kotchen, 2010; Kotsis et al., 2010). Insulin resistance results in a down regulation of the synthesis of NO, and hyperinsulinemia increases vasoconstrictor endothelin-1 levels. This leads to an imbalance between vasodilator and vasoconstrictor actions, resulting in increased peripheral resistance and increased arterial pressure. In addition to this, monocyte adhesion to the vascular wall is promoted, leading to the development of atherosclerosis (Kotchen, 2010; Kotsis et al., 2010). Intima media thickness of vascular walls seen in obese individuals during the early stage of atherosclerosis is directly correlated with BMI and fasting serum glucose levels. With the progression of atherosclerosis, the larger blood vessels become stiffer, and increased velocity in pulse wave is seen, as well as increased arterial stiffness. Long-term SNS and RAAS activity result in small artery vasoconstriction and remodelling, increasing the wall to lumen ratio. The changes to both the large and smaller arteries may act synergistically to increase blood pressure (Kotchen, 2010; Kotsis et al., 2010). The evidence above indicates that obesity is a major risk factor for both hypertension and carotid atherosclerosis. Hypertension is a significant risk factor for many various conditions, including coronary artery disease, cerebrovascular disease, renal insufficiency, atherosclerosis, left ventricular hypertrophy, atrial fibrillation, and congestive heart failure.

2.3.3 Dysfunction of the Hypothalamic-Pituitary-Adrenal (HPA) Axis

There is a clear association between dysregulation of the HPA axis and obesity; with evidence suggesting HPA axis dysregulation being both the cause and effect of obesity (Bose, Oliván, & Laferrère, 2009; Foss & Dyrstad, 2011; Abraham, Rubino, Sinaii, Ramsey, & Nieman, 2013; Rodriguez et al., 2015). The HPA axis forms part of the neuro-endocrine system, and responds to stress to maintain homeostasis. Stress disrupts homeostasis; and chronic, prolonged stress can be harmful and cause several diseases (Bose et al., 2009). In response to stressors, whether internal or external, the hypothalamus releases corticotropin-releasing hormone (CRH) which stimulates the synthesis of adrenocorticotropin hormone (ACTH) from the anterior pituitary gland; this circulates through the blood stream to the adrenal cortex. At the adrenal cortex ACTH stimulates cortisol production and release (Bose et al., 2009). Dysregulation of the HPA axis is evident in obese individuals (Bose et al., 2009; Foss & Dyrstad, 2011; Abraham et al., 2013; Rodriguez et al., 2015), yet there are conflicting results on cortisol levels (Bose et al., 2009; Kumari, Chandola, Brunner, & Kivimaki, 2010; Lucassen and Cizza, 2012; Wester et al., 2014).

Wester et al. (2014) suggested these inconsistencies could be partially explained by the high variability in systemic cortisol levels throughout the day caused by pulsatile secretion, diurnal rhythm, day-to-day fluctuations and various measurement methods (saliva, urine, plasma). To overcome these limitations the authors measured cortisol exposure through scalp hair analysis, which measures long-term cortisol exposure for periods of up to several months. Results indicated obese participants had significantly higher hair cortisol concentrations (HCC) than normal weight and overweight controls, with no significance between normal weight and overweight controls. Within the obese group, no correlation was found between HCC and BMI or waist circumference; nor was there a correlation between HCC and glycated haemoglobin (HbA1c), LDL cholesterol, HDL cholesterol, triglycerides and glucose. Bose et al. (2009) did a review on literature investigating the relationship between obesity, the HPA axis, and metabolic disease. Consistent evidence from the review found a significant correlation between post-prandial salivary cortisol and BMI, waist-to-hip ratio (WHR), fasting glucose, insulin, triglycerides, cholesterol, and blood pressure. Similar correlations were observed in morning salivary cortisol levels, BMI and WHR. These correlations were more evident with upper body obesity than lower body obesity. The above data is partially supported by Kumari et al. (2010) who measured cortisol levels in salivary samples provided over the course of a normal weekday, from 3956 participants. The overall results from this large population study indicate that adiposity is associated with cortisol, however in a non-linear manner. When comparing BMI groups, morning cortisol levels were highest for the underweight group, and lowest for the overweight and obese groups. However, the highest evening values of cortisol was found in the obese and underweight groups. No correlation was found between the morning cortisol levels and BMI or waist circumference.

Results from a review conducted by Lucassen and Cizza (2012) contradict the evidence presented above. When examining morning levels of cortisol in saliva and plasma, no correlation was seen with various measures of adiposity. Other studies investigated in this review measuring 24-hour (h) urine free cortisol (UFC) levels also found no correlation with BMI or waist circumference. However, cortisol's degradation products were positively correlated with these anthropometric measurements, suggesting an increased clearance rate of cortisol in obese individuals. This would suggest a higher turnover of cortisol without necessarily altering circulating levels of cortisol. Abraham et al. (2013) measured 24 h UFC samples and salivary samples of 56 and 57 participants respectively. No correlation between BMI or waist circumference and any cortisol parameter was found in either the overweight or obese group. The results from this study do not support an association between increased systemic cortisol levels and obesity or abdominal adiposity.

Studies that support an association between increased systemic cortisol levels and obesity identify several factors related to obesity that are responsible for increasing cortisol levels. Cytokines (IL, IL-6, TNFα) released by the excess adipose tissue causes chronic low-grade inflammation, but also independently activates the HPA axis at the hypothalamus, anterior pituitary, as well as the adrenal cortex. Activation of these glands stimulates the release of cortisol, increasing systemic cortisol levels. In addition to this, chronic low-grade inflammation stimulates the hypothalamus to release cortisol in an attempt to limit the inflammation. This provides a direct physiological link between obesity, inflammation and cortisol release (Bose et al., 2009; Foss & Dyrstad, 2011; Lucassen & Cizza, 2012). Excess body weight has also been found to increase the activity of the enzyme which converts cortisone into cortisol in the adipose tissue of obese individuals. This occurs secondary to weight gain, thus contributing to further weight gain (Foss & Dyrstad, 2011). As mentioned earlier, obesity is associated with increased levels of the cytokine leptin, as well as leptin resistance. Increased levels of leptin may be a possible trigger for increased release of cortisol (Foss & Dyrstad, 2011).

Cortisol is transported to the peripheral target tissues, where it exerts its effect. A prolonged, increased level of cortisol has numerous detrimental effects, which lead to the development of various diseases. Via stimulation of glycogenolysis and gluconeogenesis in the liver, plasma glucose levels are elevated, this leads to glucose intolerance, insulin resistance, and the development of T2DM (Nader, Chrousos, & Kino, 2010; Lucassen & Cizza, 2012). Similarly, lipolysis is increased, increasing circulating triglycerides and cholesterol, and leading to the development of dyslipidaemia. Cortisol also causes the degradation of protein into amino acids to occur, causing muscle wasting (Nadar et al., 2010; Lucassen & Cizza, 2012). Evidence has also demonstrated that cortisol affects food choice, causing individuals to consume calorie dense foods, and foods that are more palatable; as well as causing an increase in appetite and food intake. In the presence of insulin, cortisol promotes triglyceride accumulation, especially in the visceral adipocytes; leading to an increase in central fat. These factors together increase fat deposition, promote weight gain, and further contribute to increased obesity (Lucassen & Cizza, 2012; Tryon, DeCant, & Laugero, 2013; Rodriguez et al., 2015). Additional effects of increased cortisol include suppression of the immune system, and alteration of mood and cognition (Nadar et al., 2010; Lucassen & Cizza, 2012). All these pathologic changes ultimately can reduce life expectancy. Dysregulation of the HPA axis is a risk factor for a number of physical and mental conditions, including cardiovascular disease, insulin resistance, T2DM, stroke, Cushing’s syndrome, depression, and cognitive impairment.

2.4 Factors Contributing to the Development of Obesity

The cause of obesity is a complex phenomenon, and is not completely understood (Joubert et al, 2007; Lehnert, Sonntag, Konnopka, Riedel-Heller, & König, 2013). It is believed to be an interaction of various factors such as changes in technological, economic, and social aspects, which create what has become known as an ‘obesogenic’ environment. These factors have played a significant role in decreasing daily energy expenditure, and promoting the consumption of energy dense foods. This leads to a positive energy balance, weight gain, and subsequent obesity. The factors contributing to the development of obesity will be discussed in the following section.

2.4.1 Physical Inactivity and Sedentary Behaviour

Sedentary behaviour was long thought to represent the absence of physical activity; however, it is now accepted that physical inactivity and sedentariness can be differentiated and have different physiological consequences (van Uffelen et al., 2010; Chau, van der Ploeg, Merom, Chey, & Bauman, 2012; Kilpatrick, Sanderson, Blizzard, Teale, & Venn, 2013). Sedentary behaviour is defined as activities that do not increase energy expenditure substantially above resting levels (1.0-1.5 metabolic equivalents) while in a sitting or reclining posture, such as when watching television (TV), using a computer and other forms of screen-based entertainment (Pate, O'Neill, & Lobelo, 2008; Mansoubi et al., 2015; Restaino, Holwerda, Credeur, Fadel, & Padilla, 2015). Other forms of sedentary behaviour include sitting during commuting, sitting in the domestic environment and the workplace; and sitting during leisure time activities such as talking on the phone, listening to music, and reading (Stamatakis, Hirani, & Rennie, 2008; Thorp, Owen, Neuhaus, & Dunstan, 2011). Many authors categorize an individual as being sedentary if they do not meet the requirements of minimal exercise for health benefits (Samitz, Egger, & Zwahlen, 2011; Wen et al., 2011; Hallal et al., 2012). To reduce the risk of non-communicable diseases the most recent guidelines recommend a minimum of 150min/week of moderate intensity physical activity, or 75min/week of vigorous intensity physical activity (Samitz et al., 2011; Thompson et al., 2014). These recommendations do not include limiting sedentary behaviour, and an emerging body of evidence indicates that prolonged sedentary behaviour, independent of physical activity, significantly increases the risk of developing obesity as well as number of adverse health effects (Stamatakis et al., 2008; Thorp et al., 2011; Wilmot et al., 2012; Heinonen et al., 2013).

In lieu of the statement above, physical inactivity has become an established risk factor for the development and maintenance of obesity (Stamatakis et al., 2008). A large body of evidence has found a positive correlation between increased sedentary behaviour, BMI and waist circumference (Shields & Tremblay, 2008; Stamatakis et al., 2008; Vandelanotte, Sugiyama, Gardiner, & Owen, 2009; Du et al., 2013; Heinonen et al., 2013). Stamatakis et al. (2008) found an inverse relationship between both BMI and WC, with average time spent walking and time playing sports. A positive relationship was observed between TV viewing and excess body weight, with a stronger correlation with WC than BMI. This is supported by Heinonen et al. (2013) who found that total sedentary time, TV viewing time, screen time and other relaxation were directly associated with WC and BMI in both sexes ($p<0.05$). It was further observed that one additional hour of TV viewing per day was associated with 1.8 ± 0.4 and 2 ± 0.4 cm greater WC in women and men respectively. Similar results were observed when compared to BMI. TV viewing of over 3 h/day was associated with a nearly twofold increased risk of abdominal obesity compared with TV viewing of less than 1 h/day.

A study conducted on 2532 participants by Vandelanotte et al. (2009), investigated the relationship between leisure time internet and computer use and obesity. The main finding of the study was that leisure time internet and computer use were strongly correlated to being overweight or obese. Participants who had high internet and computer use in their leisure time were 2.5 times more likely to engage in more than five hours of other sedentary behaviours in a day. Participants with low internet and computer use participated in less other sedentary behaviours compared to participants with high internet or computer use. Shields and Tremblay (2008) supported these results; men and women who used computers for more than six hours per week had 20% and 30% chance of being obese, respectively. Furthermore, it was found that men who watched five or fewer hours of TV per week had a prevalence of obesity of 14%; this increased significantly to 25% for men averaging twenty-one or more hours per week. The trend was similar in women, with a prevalence of 11% and 24% for those reporting five or fewer hours and twenty-one or more hours, respectively (Shields & Tremblay, 2008).

A study with a large cohort of participants (466 605) observed an inverse relationship between physical activity and sedentary leisure time (Du et al., 2013). Each 1 h/day of sedentary leisure time corresponded to 2.0 MET-h/d less physical activity in men, and 1.6 MET-h/d less physical activity in women. In both men and women, a positive association was observed in both men and women between sedentary leisure time and BMI, WC, and percentage body fat (Du et al., 2013). Sedentary behaviour has been found to replace physical exercise and time spent in other physical activities, and therefore results in reduced energy expenditure. This, coupled with poor diet choices (discussed later), confounds the energy imbalance and leads to the development of obesity.

As the working population spends more than half their waking hours at work, for many adults a large proportion of their daily sedentary time is accrued in the workplace (Ryde, Brown, Peeters, Gilson, & Brown, 2013; Eriksen, Rosthøj, Burr, & Holtermann, 2015; Lin, Courtney, Lombardi, & Verma, 2015). Due to innovations in technology and production, process work has become less strenuous, resulting in increased occupational sitting time and lower daily energy expenditure. Thus, the question has been raised of the impact of prolonged occupational sitting on body weight, and its contribution to the obesity epidemic. Lin et al. (2015) investigated the association between sedentary work and BMI in the US population by assessing changes in BMI over a prolonged period. The study included a large population sample size of 5285 participants, and found a positive association between BMI and occupational sitting time. From 2002 to 2010 the average BMI increased from 27.68 kg/m^2 to 28.45 kg/m^2, equivalent of a weight gain of 2.28kg; this represented a significant association between longer sitting time and higher BMI ($p<0.05$) (Lin et al., 2015). In support of this Ryde et al. (2013) found that adults sitting at work for more than 5.8 h/day were 2.8 times more likely to have high risk WC and 9.0 times more likely to have a high BMI, than those with low levels of sitting at work.

A longitudinal study conducted by Eriksen et al. (2015) investigated changes in BMI and occupational sitting time over a period of five years in 4732 working adults. A significant positive trend was observed for women, with BMI increasing by 0.13 for each unit of increase in occupational sitting, though no tendency for an association was observed for men. The researchers suggest the possibility of changes in body composition, with no significant influence on BMI, which may explain the lack of association between BMI and occupational sitting time. BMI is a poor indicator of body composition and does not differentiate between muscle mass and fat mass. It is possible that extensive sedentary behaviour in men resulted in a reduction of muscle mass and increase in fat mass, with no significant resultant change in BMI (Eriksen et al., 2015).

Chau et al. (2012) raised the question of whether individuals with sedentary occupations tend to have increased sedentary behaviours in leisure time. This study used the Australian National Health Survey (NHS) and involved 5807 men and 4978 women. Workers with jobs involving mostly sitting were more likely to be sufficiently active during leisure-time than those with more active jobs that involved mostly standing, walking, or heavy labour jobs. On the contrary, workers with jobs involving mostly walking or heavy labour were significantly more likely to be sufficiently active through transport-related walking only. However, when compared to workers whose jobs involve mostly standing, workers who spend the majority of their time sitting had a significantly higher risk of being overweight or obese. Furthermore, workers spending less than 4 h/day sitting in leisure time had a significantly lower risk of being overweight (RR=0.93) or obese (RR=0.77) compared to workers spending more than 4 h/day sitting in leisure time. Results of this study showed a clear association between leisure time sitting and obesity risk; while the association between occupational sitting and obesity risk was less distinct. The authors concluded that leisure time sitting, and occupational sitting are independently associated with obesity risk (Chau et al., 2012).

Hadgraft et al. (2015) did not find any compensatory increase in physical activity levels during leisure time activity, for workers with prolonged sitting at work. The results of this study indicated that individuals who had the lowest levels of occupational sitting were more likely to be active during leisure time (Hadgraft et al., 2015). It is evident that increased occupational sitting is a significant contributing factor to weight gain and the development of obesity. The relationship between sedentary behaviours at work and during leisure time is still unclear and needs further investigation.

2.4.2. Sedentary Behaviour and Hypokinetic Disease

Not only does physical inactivity contribute to weight gain and increased risk of obesity, it also significantly contributes to the development of diseases (Haskell, Blair, & Hill, 2009; Lee et al., 2012). Over the past 50 years data has continued to accumulate, highlighting the negative impact of physical inactivity on health, and in 2009 physical inactivity was identified as the fourth leading risk factor for non-communicable diseases (Haskell et al., 2009; Hallal et al., 2012). Hypokinetic disease are conditions or diseases that develop due to lack of sufficient physical activity or too little regular exercise, and include coronary heart disease, T2DM, obesity and lower back pain (Corbin, Welk, Corbin, Welk, & Sidman, 2009).

Lee et al. (2012) investigated the effect of physical inactivity on major non-communicable diseases (NCD) worldwide. Electronic databases were used to search for peer-reviewed reviews, using key words relating to physical activity and non-communicable diseases. The population attributable fraction (PAF) was used, and is a measure used to estimate the effect of a risk factor on disease incidence in a population; i.e. it estimates the proportion of new cases that would not occur if that particular risk factor was absent. Estimated PAF's in South Africa for coronary heart disease was 8.7%, T2DM 10.7%, breast cancer 14.7%, colon cancer 15.5% and all-cause mortality 14.0%. It is estimated that worldwide physical inactivity causes 6-10% of the major NCDs, in turn this unhealthy behaviour causes 9% of premature mortality.

This data is supported by Samitz et al. (2011) who examined the dose-response relationship between physical activity levels and all-cause mortality using a systematic review and meta-analysis of cohort studies. When examining total amount of energy spent on leisure-time activities, and/or activities of daily living it was found that an increment of 1000kcal/week was associated with an 11% lower mortality. Vigorous intensity exercise and sports reported the greatest reduction in mortality (RR=0.91; $p<0.0005$). A smaller reduction was seen in moderate to vigorous leisure time activities (RR=0.94; $p<0.0005$). The smallest reduction was reported for moderate intensity activities of daily living, walking and physical activity for transportation; with combined RRs of 0.96-0.97. The minimal amount of physical activity needed for reduced mortality was investigated by Wen et al. (2011), who specifically looked at leisure-time physical activity (LTPA). The LTPA volume was determined by using the product of intensity (MET) and duration of exercise (h) to calculate MET-h per week. Individuals were then placed into one of five categories: inactive (<3.75 MET-h), low (3.75-

7.49 MET-h), medium (7.50-16.49 MET-h), high (16.50-25.49 MET-h), or very high (≥25.50 MET-h). Individuals in the inactive group had a 17% increased risk of all-cause mortality when compared to the low-activity group. A dose response relationship was observed for those performing moderate to high intensity exercise for all-cause mortality, cancer, cardiovascular disease, and T2DM.

There is a clear association between leisure time sedentary behaviour and hypokinetic disease, yet the effect of sedentary behaviour at work on health is not well known (van Uffelen et al., 2010; Kilpatrick et al., 2013; Saidj, Jørgensen, Jacobsen, Linneberg, & Aadahl, 2013; Stamatakis et al., 2013). Saidj et al. (2013) investigated the separate and joint associations of occupational and leisure-time sitting with cardio-metabolic risk factors. Combined occupational and leisure-time sitting had a detrimental effect on cardio-metabolic risk factors after adjusting for gender, age, education, smoking, alcohol consumption, diet and moderate to vigorous physical activity. These cardio-metabolic risk factors included WC, BMI, body fat percentage, total cholesterol, HDL and LDL cholesterol, triglycerides and insulin. Separate associations were fewer and weaker for occupational sitting time compared to leisure-time sitting; however, HDL cholesterol, triglycerides and insulin was significantly detrimentally associated with occupational sitting time (Saidj et al., 2013).

Van Uffelen et al. (2010) conducted a review on the association between occupational sitting and health risks, with conflicting results. Four studies stated more physical activity at work was associated with lower risk of infarction or CVD. Three studies found no association between occupational sitting and cardiovascular outcomes, and one showed the opposite effect of increased CVD risk with increased occupational activity. Three studies found a decreased risk of T2DM with increased occupational activity; however, one study found no significant association. When examining all-cause mortality, cardiovascular mortality and cancer mortality four prospective studies found an increased mortality risk associated with sitting, one study found no association, and one study found that sitting was associated with a decreased mortality risk (van Uffelen et al. 2010). Stamatakis et al. (2013) found conflicting results for increased all-cause, cancer, and CVD mortality risk between genders. Compared with sitting occupations women with standing or walking occupations had a lower risk of dying from all-causes and cancer, by 32% and 40% respectively, but not from cardiovascular disease. In men, no differences were found in mortality risk from all-causes, cancer or cardiovascular disease between the two groups (Stamatakis et al., 2013).

2.4.3 Physical Activity, Exercise, and Physical Fitness

Though the terms physical activity and exercise are used synonymously, they can be differentiated. Physical activity is defined as any bodily movement that is produced by the contraction of skeletal muscle that substantially increases energy expenditure (Bouchard, Blair, & Haskell, 2007; Thompson et al, 2014). Exercise is a type of physical activity, which is planned and structured, and involves repetitive bodily movements; which is done for maintaining or improving one or more components of fitness (Ortega, Ruiz, Castillo, & Sjöström, 2008; Corbin et al., 2009). Winter and Fowler (2009) argued that this definition is incomplete and inaccurate, and defined exercise as a potential disruption to homeostasis by muscle activity that is either exclusively, or in combination, concentric, eccentric or isometric. The differentiation can be further illustrated by the International Physical Activity Questionnaire (IPAQ), which categorizes physical activity according to various domains. These domains include: 1) work-related (occupational) physical activity; 2) transport; 3) household and garden chores; and 4) leisure/recreation, and sports and exercise. Occupational physical activity refers to activities done at work that cause an increase in energy expenditure (Hallal et al., 2012).

Occupations which largely involve manual labour include the mining and construction sector, farming/agriculture, and select service jobs. However due to the development of new technologies, the level of physical labour required to perform certain jobs has significantly decreased (Abu-Omar & Rütten, 2008; Hallal et al., 2012). Transport involves moving from one place to another, and depending on the mode used, can substantially increase daily energy expenditure levels (Abu-Omar & Rütten, 2008; Hallal et al., 2012). Modes such as using a car, taxi/bus, or train involve sitting and thus does not involve physical activity. However, modes such as walking or bicycling to the various destinations will increase physical activity levels. Household and garden chores are another domain that involves performing physical activity and thus increases daily energy expenditure (Abu-Omar & Rütten, 2008; Hallal et al., 2012). Activities such as hanging up washing, sweeping and mopping, mowing the lawn, and pulling out weeds, all contribute to total amount of energy expended in a day and assist an individual to reach the minimum required physical activity levels for health benefits. Leisure and recreation are described as time free from the demands of work, to do things for amusement and that are enjoyable (Corbin et al., 2009). Some examples may include reading, watching TV, being a spectator at a sporting event, swimming in a pool/sea, playing Frisbee in the park etc. The domain that most significantly increases energy expenditure is participation in sport and exercise (Samitz et al., 2011). This domain of physical activity has also shown to have the most health benefits, with the largest reduction being in mortality (Samitz et al., 2011; Hallal et al., 2012).

In the late 1990s an international group of academics developed a standardized instrument, the International Physical Activity Questionnaire (IPAQ), to measure physical activity levels (Lee, Macfarlane, & Steward, 2011; Hallal et al., 2012). This instrument records physical activity in terms of metabolic equivalents (METs) and metabolic equivalent minutes (MET minutes). Metabolic equivalents refer to the ratio of the metabolic rate during physical activity to the corresponding rate at rest. One MET unit is the energy cost while sitting quietly. A MET minute is calculated by multiplying a MET score by the time (in minutes) that the activity was performed. Walking is equivalent to 3.3 METs, moderate physical activity corresponds to 4.0 METs, and vigorous physical activity measures 8.0 METs. The IPAQ records physical activity in five domains, namely job-related physical activity, transportation, housework/maintenance-related physical activity, leisure time activity and sedentary behaviour. Total physical activity is categorized as either low, moderate or high. To fall into the moderate category, one of the following three criteria needs to be met: 1) three or more days of vigorous activity of at least 20 minutes per day, 2) five or more days of moderate-intensity activity and/or walking for at least 30 minutes per day, or 3) five or more days of any combination of walking, moderate-intensity or vigorous-intensity activities achieving a minimum of at least 600 MET-minutes/week. To qualify for the high category, one of the following two criteria must be met: 1) vigorous-intensity activity on at least three days and accumulating at least 1500 MET-minutes/week, or 2) seven or more days of any combination of walking, moderate- or vigorous-intensity activities accumulating at least 3000 MET-minutes/week. If an individual does meet any of the requirements for the moderate or vigorous category, they would be classified as being physically inactive (Samitz et al., 2011; Hallal et al., 2012).

Physical fitness is a multidimensional concept that has been defined as the body’s ability to function effectively and efficiently, and is associated with a person’s ability to work effectively, enjoy leisure time, be healthy, and resist hypokinetic diseases (Corbin et al., 2009). It has further been defined as a set of attributes that people possess or achieve that relates to the ability to perform physical activity, and is comprised of skill-related, health-related, and physiologic components; each of which contribute to total quality of life (Thompson et al., 2014). Skill-related components of fitness are mostly associated with sport and performance, and include agility, balance, coordination, speed, power, and reaction time (Thompson et al., 2014). The health-related components of fitness include cardiovascular endurance, muscle strength and endurance, flexibility, and body composition. These components are associated with the ability to perform daily activities with ease, and a low risk of the development of premature hypokinetic disease (Corbin et al., 2009; Thompson et al., 2014). Physiologic fitness includes non-performance components that relate to biological systems influenced by habitual activity; they include metabolic fitness, morphologic fitness, and bone integrity.

Cardiovascular endurance is the ability of the heart, blood vessels, blood, and respiratory system to supply nutrients and oxygen; and the ability of the muscles to extract and utilize the nutrients and oxygen to produce energy for physical activity (Corbin et al., 2009; Thompson et al., 2014). As mentioned above, physical activity does not only refer to exercise, but to the ability of an individual to perform activities of daily living (ADLs). In the workplace, such activities that may require the use of the cardiovascular system include walking over various distances and climbing stairs. It is also well documented that good cardiovascular fitness substantially reduces the risk of cardiovascular disease; which in turn will reduce absenteeism in the workplace (Ortega et al., 2008; Wen et al., 2011; Lee et al., 2012). Muscular endurance relates to the ability of the muscles to be repeatedly exerted; while muscular strength is the muscles' ability to exert an external force, or lift a heavy weight (Corbin et al., 2009). Both are important for the ability to perform ADLs, and function in the workplace; also, low levels of muscular strength and endurance have been linked to low back pain (Bell & Burnett 2009; Hoy, Brooks, Blyth, & Buchbinder, 2010). Globally, low back pain is the leading cause of activity limitation, absence from work, and long-term disability (Bell & Burnett 2009; Hoy et al., 2010); the consequence of this is an enormous economic burden on industry and the government. There is a positive association between obesity musculoskeletal disorders, physical disability, osteoarthritis, pain-reducing quality of life, and limitations in activities of daily living (Dixon, 2010). It has further been stated that these physical impairments caused by obesity have limiting effects on one's ability to work due to strain and pain while walking, going up and down stairs, stooping or lifting, and getting up from low chairs (Dixon, 2010). Common musculoskeletal pain experienced by obese individuals include lower limb pain, particularly in the knees and feet following periods of prolonged standing and walking, niggling low back pain, as well as neck and shoulder pain in women with large breasts.

Recommendations for minimal exercise for health benefits is at least 150 minutes a week of moderate intensity aerobic physical activity, though the minimal amount of physical activity needed to prevent weight gain is unclear (Slentz, Houmard, & Kraus, 2009; Lee, Djoussé, Sesso, Wang, & Buring, 2010). The present American College of Sports Medicine (ACSM) recommendations for prevention of weight gain is 150-250 minutes per week; recommendations for promoting clinically significant weight loss are 225-420 minutes per week; and prevention of weight regain following weight loss are 200-300 minutes per week (Swift, Johannsen, Lavie, Earnest, & Church, 2014; Thompson et al., 2014). This is supported by Slentz et al. (2009) who found that 180 minutes of moderate intensity exercise per week was sufficient in preventing weight gain in overweight and mildly obese participants, even without changes in diet. A dose-response was noted with increased physical activity resulting in greater weight loss, fat loss and reductions in measures of central obesity (Slentz et al., 2009).

Donnelly et al. (2009) wrote a position stand for the ACSM to update physical activity recommendations based on new information. Following a review of literature, the authors found that less than 150 minutes per week of physical activity resulted in no significant change in body weight, 150-225 minutes of activity per week resulted in modest weight loss of 2-3kg, and 225-420 minutes of physical activity per week resulted in 5-7.5kg weight loss (Donnelly et al., 2009). Lee et al. (2010) found an inverse relationship between physical activity and weight gain, however this was only observed amongst normal weight women; no relation was seen among heavier women. Women engaging in less than 420 minutes of moderate intensity physical activity per week gained significantly more weight than those engaging in more than 420 minutes per week (Lee et al., 2010). It is imperative to note that changes in weight are affected by the amount of energy expended versus the amount of energy consumed. A positive energy balance from increased energy intake versus energy expenditure will result in weight gain. Thus, when determining recommendations for minimal amount of physical activity for weight loss; dietary habits need to be taken into consideration.

2.4.4. Dietary Habits

Dietary habits, in conjunction with decreased physical activity levels, have been extensively investigated as a cause of obesity; as both affect energy balance in the body (Rosenheck, 2008; Berg et al., 2009; Horikawa et al., 2011; Pearson & Biddle, 2011; Lee et al., 2016). The food environment has become increasingly ‘obesogenic’ due to marketing campaigns, high availability and variety of palatable energy dense foods at a low cost, supersized fast-food products sold as ‘value for money', and ready-made meals sold in large portion sizes. Research has shown that an individual’s food choice is based on taste, cost, convenience, and to a lesser extent, healthfulness and variety (Drewnowski, 2009). This coupled with a large availability of fast-food restaurants and convenience stores providing low-cost foods, which tend to be energy dense and nutrient poor, has played a large role in the development of obesity (Rosenheck, 2008; Berg et al., 2009).

Energy dense foods are high in fat and sugar and are highly processed; this leads to reduced chewing time and faster consumption. The result of this is insufficient time to signal satiety via feedback mechanisms, and thus over-consumption (Berg et al., 2009). Food choices can further be explained in terms of abnormalities in biology, physiology, and behaviour (Drewnowski, 2009). The biological explanation has been observed through the craving for sweets and foods high in fat, driven by central metabolic events, serotonin and dopamine imbalance, and altered leptin levels. Physiological changes occur due to the glycaemic index of foods, satiety deficits, and insulin resistance. Consumption of foods with a high glycaemic index (GI) results in hyperglycaemia, increased production and release of insulin, and hyperinsulinemia in the blood. Insulin causes the removal of glucose from the blood, with hyperinsulinemia resulting in hypoglycaemia, and the return of hunger. Continual consumption of high GI foods leads to the development of glucose intolerance, insulin resistance, decreased insulin sensitivity, and ultimately T2DM (Riccardi, Rivellese, & Giacco, 2008). Behavioural explanations are more psychological of nature and include addictive personalities, cortisol mediated response to stress, or simply seeking comfort in the consumption of high-fat foods (Drewnowski, 2009).

Eating habits that have been investigated for their contribution to obesity include skipping breakfast, increased snacking, late evening meals, speed of eating, and eating habits associated with TV viewing. These habits have been linked to poor body weight control, dyslipidaemia, insulin sensitivity, T2DM, blood pressure, and cardiovascular disease (Berg et al., 2009; Horikawa et al., 2011; Pearson & Biddle, 2011; Lee et al., 2016). Horikawa et al. (2011) performed a meta-analysis on the association between skipping breakfast and the prevalence of overweight and obesity in Asian and Pacific regions. Of the nineteen studies included, only one study did not report a positive association between skipping breakfast and the prevalence of overweight and obesity (Horikawa et al., 2011). Berg et al. (2009) found that the omission of breakfast and lunch was likely to be compensated for by over-eating later in the day among obese individuals. It was also stated that obese individuals ate larger meals and have more intake occasions as non-obese individuals, even though breakfast and lunch were omitted; indicating that more and larger meals were consumed during the second half of the day. Night eating was also observed to be more frequent in severely obese women compared to a control group (Berg et al., 2009).

The above studies are contradicted by Lee et al. (2016) who found no association between skipping breakfast, late evening meals, and overweight and obesity. However, this study found a significant correlation between eating quickly, being overweight, and obesity (Lee et al., 2016). The effect of TV viewing on quantity and quality of food intake is a behaviour that has recently been investigated for its contribution to weight gain. Television viewing has been found to be inversely associated with fruit and vegetable consumption, and positively associated with more energy-dense snack consumption (Shields & Tremblay, 2008; Pearson & Biddle, 2011; Heinonen et al., 2017).

Socio-economic factors have also been shown to impact diet quality and dietary habits (Drewnowski, 2009; Sallis & Glanz, 2009). Although the socio-economic factors are not fully addressed in the current study, it is important to note that obesity has been linked to low income, low education, minority status, and higher incidence of poverty. Low-income neighbourhoods attract more fast-food outlets and convenience stores; whereas areas that are more affluent have better restaurants, fresher produce and better access to healthy foods, and more opportunities for physical activity. However, in South Africa obesity is positively related to wealth, with well-off individuals more likely to be obese than the poor (Alaba & Chola, 2014).

2.4.5 Sleeping Patterns

Concurrent to the rise in global obesity, a similar epidemic of chronic sleep deprivation has emerged (Chaput, Després, Bouchard, & Tremblay, 2008; Patel & Hu, 2008). This can possibly be explained by longer work days, longer commuting time, increased evening/night work, and use of TV and the internet during leisure time; all of which lead to a sacrifice of hours available for sleep (Chaput et al., 2008; Beccuti & Pannain, 2011). This has a major impact on sleep duration, and normal circadian rhythms through exposure to artificial light after sunset, and late evening meals (Chaput et al., 2008; Beccuti & Pannain, 2011).

Chaput et al. (2008) stated that daily sleep duration in the United States has decreased by 1.5 to 2 hours, with 37.1% of young adults sleeping less than 7 hours per night. Poor sleep quality, fatigue and tiredness have become frequent complaints. Short sleep duration has been classified as having less than 7 hours of sleep, with growing evidence suggesting that short sleep duration may be a risk factor for the development of obesity and its complications (Chaput et al., 2008; Marshall, Glozier, & Grunstein, 2008; Beccuti & Pannain, 2011). In a 6-year prospective study Chaput et al. (2008) found that short duration sleepers had higher body weight, BMI, percentage body fat, and WC as compared with average duration sleepers, sleeping 7-8 hours per night. When compared to average duration sleepers, short duration sleeps gained 88% (1.98kg; $p<0.005$) more weight, and experienced a 58% and 124% higher increase in waist circumference and fat percentage, respectively. It was also found that long duration sleepers, sleeping more than 9 hours per night, also had a significantly higher increase in body weight of 71%; which equated to a gain of 1.58kg ($p<0.005$). Furthermore, a higher increase in WC (47%) and fat percentage (94%) was found when compared to average duration sleepers; suggesting that long sleep duration may also contribute to the development of obesity.

These results concur with a growing body of evidence suggesting a U-shaped relationship between sleep duration and BMI. A meta-analysis of prospective studies was performed by Wu, Zhai and Zhang, (2014) and included 14 studies involving 197 906 participants. The overall result was in partial support of Chaput et al. (2008), that short sleep duration is significantly associated with risk of developing obesity; however no significant association was seen between long sleep duration and incidence of obesity. A review done by Marshall et al. (2008) found no consistent pattern of association with either short sleep or long sleep duration and BMI. A review by Patel and Hu (2008) investigated 19 studies focussing on the cross-sectional relationship between sleep duration and weight in adults. Of the 19 studies, 11 found a clear association between short sleep duration and increased weight, two had mixed findings with an association in one gender but not the other, five studies found no association, and one study stated that short sleep duration was associated with reduced weight. Only six studies found evidence that long sleep duration was associated with increased weight. These authors suggest a trend is emerging between short sleep duration and body weight, but the trend between long sleep duration and body weight is not as clear.

Authors have suggested that shorter sleep duration favours a positive energy balance due to more time and opportunities to eat, increased snacking, and daytime fatigue leading to reduced physical activity (Chaput et al., 2008; Patel & Hu, 2008; Nedeltcheva, 2009; Wu et al., 2014). Further evidence suggests sleep loss causes an alteration in the neuroendocrine control of appetite, specifically with the hormones leptin, ghrelin, and insulin (Knutson, Speigel, Penev, & van Cauter, 2007; Beccuti & Pannain, 2011; Huang, Ramsey, Marcheva, & Bass, 2011). Short sleep duration has been found to increase glucose levels, reduce the rate of glucose disposal, decrease insulin sensitivity, decrease insulin secretion, decrease sensitivity to leptin and increase levels of ghrelin (Huang et al., 2011). These factors tend to favour a positive caloric balance through increased appetite and food intake, leading to weight gain over time (Knutson et al., 2007; Beccuti & Pannain, 2011; Huang et al., 2011). As mentioned earlier, leptin is an appetite-inhibiting hormone secreted primarily by the adipose tissue, and promotes satiety. Ghrelin, an appetite-stimulating hormone primarily released by the stomach, exerts the opposite effect by promoting hunger (Beccuti & Pannain, 2011; Huang et al., 2011). Secretions of leptin and ghrelin are normally aligned with the sleep-wake cycle, which is controlled via the circadian system (Laposky, Bass, Kohsaka, & Turek, 2008; Huang et al., 2011).

The circadian system is essential in maintaining internal synchronization between multiple behaviours, physiological systems, and molecular pathways, such as the sleep-wake cycle and hormonal rhythms (Laposky et al., 2008; Huang et al., 2011). Hormonal levels exhibit peaks and troughs of activity at different times of the day. For example, the initial period of nocturnal sleep in humans is characterized by elevated growth hormone (GH) levels and increased blood glucose concentration. For blood glucose levels to be maintained throughout the prolonged fasting state of sleep, there is reduced utilization of glucose by the body's tissues, and the GH increases hepatic gluconeogenesis and reduces insulin release from the pancreatic beta cells. Near the end of the sleep period cortisol levels are increased to contribute to enhanced cardiovascular tone and glucose utilization; two physiological processes that contribute to optimal waking behaviour (Laposky et al., 2008).

Desynchronization of the circadian clock can occur with delayed feeding due to prolonged night-time wakefulness, as is seen in shift-workers. Shift-workers, and other individuals staying awake late at night, perform physical and cognitive tasks at times of the day that may not be aligned with endogenous internal rhythms (Laposky et al., 2008; Huang et al., 2011). Studies have demonstrated that synchronization of feeding/fasting and active/rest periods with the environment light/dark cycle influences body weight consistency (Laposky et al., 2008; Huang et al., 2011). Furthermore, studies have also demonstrated that short sleep duration is not only associated with obesity, but also with T2DM, metabolic syndrome and hypoleptinemia (Laposky et al., 2008; Huang et al., 2011).

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CHAPTER THREE

LITERATURE REVIEW TWO

3.1 Prevalence of Overweight Individuals and Obesity in the Workplace

The trend of an increasing prevalence of obesity is not only a public health concern, but employers have also noticed the rising rates of obesity among their employees in the workplace (Luckhaupt, Cohen, Li, & Calvert, 2014; Nobrega et al., 2016). Factors contributing to the obesity epidemic have been extensively investigated in chapter two; however, several workplace characteristics such as long work weeks, shift work, and food availability may also contribute, at least partially, to the development of obesity and consequently influence health behaviours. As obesity is strongly related to chronic health problems, increased absenteeism and decreased productivity, it has a negative impact within the workplace (Luckhaupt et al., 2014). The relationship between obesity and occupation has not been fully investigated, and understanding the nature of the relationship between obesity and the workplace is key in developing effective prevention and treatment interventions.

Obesity in the workplace has recently been investigated to ascertain the prevalence of obesity, behavioural characteristics associated with obesity, as well as the impact of obesity within the workplace. A search of the internet revealed that studies such as these have only been conducted in the United States (US), with one other study conducted in Malaysia; no studies on the prevalence of obesity within the workplace has been conducted in South Africa. Gu et al. (2014) and Luckhaupt et al. (2014) investigated the prevalence of obesity among US workers using the National Health Interview Survey Occupational Health Supplement (NHISOHS); data regarding prevalence of overweight employees was not investigated. Data was available for 15121 working adults, which represented approximately 135 million people. Data available for 2010 indicated the overall prevalence of obesity among workers was 27.7%, slightly below the national prevalence of obesity of 31.9% (WHO, 2017). The prevalence of obesity among working males and females were 28.2% and 27.0%, respectively; this trend differed slightly from the national trend of 30.9% and 32.8% for males and females, respectively. The lowest prevalence (19.7%) of obesity was seen in the youngest age group 18 to 29 years, with the highest prevalence (31.2%) seen in the age group 45 to 64 years.

Workers with the highest level of education (minimum of a college degree) had the lowest prevalence of obesity (22.3%), with a trend of increased BMI with decreased level of education observed. Prevalence of obesity was highest in former smokers (32.1%), compared to people who had never smoked (27.0%) and current smokers (25.3%). As would be expected, lower obesity prevalence (23.0%), was observed in individuals meeting recommended national physical activity guidelines compared to those not meeting the recommended amount (32.7%). A similar trend was seen in individuals consuming fruits and vegetables more than five times daily (19.3%), compared to those consuming less than 5 servings daily (28.0%). Prevalence of obesity was also categorized according to job characteristics such as weekly work hours and work schedule. Increasing prevalence of obesity was observed with longer working hours, with working more than 40 hours per week being significantly associated with obesity. Prevalence of obesity for working less than 35 hours per week was 24.9%, working 35 to 40 hours the prevalence increased to 27.7%, with working over 40 hours being a significant 30.0%. No significant differences were observed for obesity prevalence according to work schedule; prevalence of obesity for individuals working regular hours during the day and shift workers was similar (Gu et al., 2014; Luckhaupt et al., 2014).

A similar study was conducted in Malaysia, though it was conducted within the setting of a selected public university, and data was obtained for the year 2008 (Cheong, Kandiah, Chinna, Chan, & Saad, 2010). The estimated prevalence of overweight individuals, and obesity for the Malaysian population was 29.1% and 14%, respectively. Prevalence of obesity in Malaysia was less than half that of the US population (Cheong et al., 2010; Luckhaupt et al., 2014). The final sample of the study consisted of 367 participants, of which the majority were female (60.8%). Prevalence of being overweight, and obesity among workers was 28.6% and 16.1%, respectively, slightly higher than the estimated prevalence for the national population. A greater prevalence of being overweight was observed in males (31.9%) compared to females (26.5%). However, an equal prevalence between males and females was observed for obesity (16%). Results from this study followed the same trend as Luckhaupt et al. (2014) with BMI being significantly associated with age ($p=0.001$), gender ($p=0.007$), and working hours ($p=0.046$). No significant relation was observed between BMI and marital status, and monthly household income. The study suggests that socio-demographic factors such as age, gender, and educational status contribute to obesity in this sample of working adults. The authors suggested that average working hours of 7.70 hours per day might be a protection against the development of obesity (Cheong et al., 2010).

The World Health Organization (WHO) provides data on the national prevalence of overweight people and obesity levels in South Africa, although the most recent data provided is for the year 2014 (WHO, 2017). The prevalence of the population in South Africa who are overweight or obese, is 53.9% and 26.8%, respectively. There is a higher prevalence of females (64%) who are overweight when compared to males (43.2%), which is inconsistent with the study conducted by Cheong et al. (2010) as described above. Prevalence of obesity follows a similar trend to that of overweight individuals, with females (37.3%) having a higher prevalence than males (15.7%). With more than double the number of females, compared to males, being obese in South Africa, this trend is significantly different from the trend observed in the US and Malaysia. No data is yet available on the prevalence of overweight people and obesity within the workplace in South Africa; hence, this study will be investigating the prevalence of being overweight or obese within the workplace in South Africa.

3.2 Interrelationships of Work, Obesity and Disease

There are various ways to describe the interrelationship of work, obesity, and disease. Schulte et al. (2007) describe five conceptual modules in which these relationships can be viewed; illustrated in Figure 3.1 below. **Model A** identifies a workplace exposure as the causative factor leading to an occupational disease. The relationship between the workplace exposure and disease may be modified by obesity or weight gain, so that the risk will be greater in the obese workers. **Model B** describes two independent, but possibly confounding pathways to disease. Both obesity and a workplace exposure may serve as independent risk factors in the development of a disease. **Model C** illustrates a combination of model A and B, where the workplace provides a source of adverse environmental exposure and contributes to obesity. Both obesity and the workplace exposure, act either independently or in combination with each other, resulting in modified risk of disease. **Model D** describes that obesity may already exist, and adverse workplace exposures act as a modifier of the obesity-disease relationship. In **model E**, obesity is identified as a causative factor in the development of a particular disease, and a workplace exposure is a causative factor in the development of a different disease, nevertheless, there may be some interaction between the two diseases. The implication is that having one disease may put an employee at increased risk of the other. These models are experimental, and still need testing and validation, but they suggest the different ways in which these factors may interact. Furthermore, other factors such as cultural and social influences may also play a role (Schulte et al., 2007).

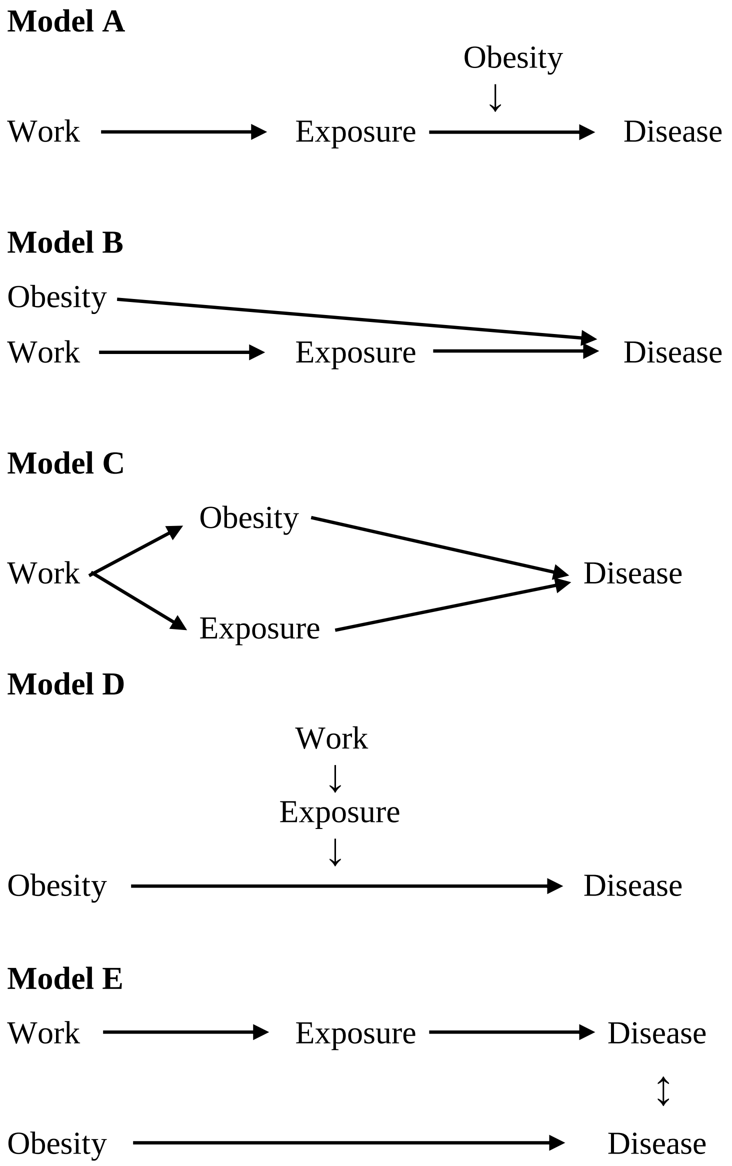

Figure 3.1 Models of the interrelationships of work, obesity, and disease (Schulte et al., 2007).

Adverse workplace conditions that may contribute to the development of obesity and disease include long work hours and rotating work hours, both of which may result in poor sleeping patterns, availability of food in the canteen and vending machines, and availability/lack of a gymnasium (Sallis & Glanz, 2009). These adverse workplace conditions influence physical activity habits, dietary patterns, as well as habits such as smoking and consuming alcohol. The interaction of these factors will be discussed below.

3.3 Physical Activity and Sedentary Habits

Physical activity habits in the workplace and in leisure-time, as well as sedentary behaviours have been discussed in chapter two. As yet, no studies investigating physical activity habits, specifically within the workplace in South Africa, have been conducted.

3.4 Dietary Habits in the Workplace

Dietary factors independent of total energy intake may affect weight gain, with obese individuals consuming different nutrients or following different dietary patterns to non-obese individuals (Vioque, Weinbrenner, Castelló, Asensio, & de la Hera, 2008). Dietary habits in the workplace that have been linked to obesity include decreased fruit and vegetable (FV) intake, increased snacking, increased consumption of sugary beverages, and poor food choices (Vioque et al., 2008; Escoto et al., 2010; Hu & Malik, 2010). Factors that have been described to affect these habits include long work hours, time pressure, food environment, quality of food, work schedules, and cost of food (Escoto et al., 2010; Baskin et al., 2016; Norbrega et al., 2016).

Fruit and vegetables are rich in water and fibre, and are low in energy density (Henrique Bandoni, Bombem, Marchioni, & Jaime, 2010; Ledoux, Hingle, & Baranowski, 2011). Consumption of FV has been proposed to prevent obesity through displacement of energy-dense foods, with the satiating effect of fibre resulting in the consumption of fewer calories, and the regulation of the dietary glycaemic load (Ledoux et al., 2011). However, current evidence of the association between FV intake and body weight changes is limited and not fully consistent (Vioque et al., 2008; Buijsse et al., 2009; Henrique Bandoni et al., 2010; Ledoux et al., 2011). Vioque et al. (2008) conducted a study on the intake of FV in relation to 10-year weight gain among the adult population in Spain. This study involved 206 participants from the general population, and was not specific to a worksite population. The primary finding of the study was a significantly reduced risk of weight gain among participants with a high intake of FV, even when controlling for confounding factors such as anthropometric, lifestyle, and other nutritional variables. It was also found that older people presented with a higher intake of FV, though age did not confound the association between FV intake and weight gain. The authors suggested the observed relationship between increasing FV consumption and lower weight gain may be the result of healthier diet or lifestyles. Participants in this study with higher FV intake exhibited a generally healthier eating pattern, such as the consumption of more fish and legumes and fewer sweets and non-alcoholic drinks, and less saturated fat and proteins (Vioque et al., 2008).

In support of the above, Ledoux et al. (2011) conducted a systematic review on the relationship of FV intake with adiposity. Inclusion criteria were longitudinal or experimental designs, as these are suggestive of causative associations, from peer-reviewed journals. Included in this review were 11 adult experimental studies and 7 adult longitudinal studies, though they were not specific to worksite employees. Of the 11 experimental studies, eight showed an association between higher FV intake and weight loss while the other three did not. The studies showing the expected inverse relationship used more intensive interventions to enhance compliance; whereas the primary focus of the other three studies was to test an intervention’s ability to change behaviours, with adiposity as a secondary outcome. Within the longitudinal studies, three showed the expected inverse relationship, three obtained mixed results (differences between genders, FV consumption, and adiposity), and one showed no relationship between FV consumption and adiposity. Studies that found the expected association or mixed results, tended to be stronger than the one that found no association. For example, studies that observed the inverse relationship followed participants over a longer period of time (5-24 years), used larger sample sizes (206-79 236), and quantified FV intake in more detailed measures (servings per day). The study which found no association followed participants for a period of 6 months, had a population sample size of 193, and categorized participants as either having ‘adequate’ FV intake (≥11 servings per week) or ‘low’ FV intake (<11 servings per week); this cut-off may not have been sensitive enough to detect an effect (Ledoux et al., 2011).

Buijsse et al. (2009) investigated the relationship of FV intake and adiposity using the European adult population from five countries, participating in the European Prospective Investigation into Cancer and Nutrition (EPICN). The population sample size was large and included 89432 participants. However, once again this was not specific to working employees. The findings of this large-scale prospective cohort study were that FV intake was significantly, albeit weakly, associated with smaller weight gains. It was found that a daily increase of 100g of FV related to slightly lower odds of gaining weight. This study did not investigate confounding factors, thus could not exclude the possibility that other factors such as age, gender or level of education, could explain the association found (Buijsse et al., 2009).

Only one article was found regarding the consumption of FV in the workplace, but the association was with socio-demographic factors and not BMI (Henrique Bandoni et al., 2010). The influence of the availability of FV in the workplace on the consumption of FV by workers was investigated in this cross-sectional study. The study had a population sample size of 1342 participants, and was performed in 30 Danish companies that had restaurants and offered meals in the workplace. Availability of FV in the workplace was classified as either adequate (≥2 servings per main meal) or inadequate (<2 servings per main meal). Consumption of FV in the workplace increased significantly according to age, level of education and availability of these foods. Furthermore, it was found that women consumed more FV than men, with less than half the men consuming these foods five or more times a week. For consumption of FV in the workplace availability accounted for 45.9%, level of education contributed 22.5%, and sex and age contributed 20.9% and 20.8% respectively (Henrique Bandoni et al., 2010).

Another dietary habit in the workplace contributing to the development of being overweight and obesity, is poor self-regulation of daily snacking specifically on high-energy food sources (Escoto et al., 2010; Oh & Taylor, 2012; Heath et al., 2012). Snacking in the workplace has been found to be influenced by gender, time of the day, exercise habits, sleep restriction, long work hours, and free availability with proximity to beverages (Escoto et al., 2010; Oh & Taylor, 2012; Heath et al., 2012; Baskin et al., 2016). Heath et al. (2012) investigated the effect of sleep restriction on snacking behaviour during a week of simulated shift work in 24 healthy males in Australia. Participants were divided into two groups: 1) severe sleep restriction (4 h sleep opportunity per 24 h day), and 2) moderate sleep restriction (6 h sleep opportunity per 24 h day). Participants were provided with three standardized meals per day (breakfast, lunch, dinner), and snack opportunities at set time intervals; participants were restricted from eating ad libitum. Participants could choose one snack (sweet, savoury, or healthy) per snack opportunity, or they could choose not to snack. Results of the study indicated that severe sleep restriction, compared to moderate sleep restriction, increased the likelihood of snacking. Participants with severe sleep restriction were more likely to choose a snack from the sweet category, and the odds of choosing a sweet snack increased across the day. Participants in the moderate sleep restriction group were 40% less likely to choose a snack than those in the severe sleep restriction group. Similar findings were observed in a study performed by Nedeltcheva et al. (2009). Limitations of these studies included simulation, rather than real-life situations, and no association of BMI made (Heath et al., 2012).

Sleep restriction is often coupled with overtime at work or long work hours, both of which have been associated with increased snacking behaviour (Ko et al., 2007; Di Milia & Mummery, 2009; Escoto et al., 2010). Escoto et al. (2010) investigated the relationship between work hours, weight status, and weight-related behaviours in metro transit workers in America. Associations were found between number of hours worked per week and BMI, frequency of use of cold beverage and snack vending machines. Transit workers working more than 50 hours per week made more frequent purchases of snacks from vending machines (p=0.002), as well as cold beverages (p=0.004), than those working less than 40 hours per week. The findings of this study showed that long work hours were associated with high BMI and less healthy food habits.

Oh and Taylor (2012) investigated the effect of brisk walking on spontaneous snacking during a workplace simulation, specifically on regular chocolate eaters. The findings of this study showed that 15 minutes of brisk walking reduced chocolate cravings and spontaneous consumption of chocolate. Participants not exercising consumed almost twice as much chocolate as those who exercised. Limitations of this study include a partly assimilated office workstation, and no reference to the association with BMI.

Epidemiological evidence indicates that the consumption of sugar-sweetened beverages (SSB) such as soft drinks, fruit drinks, and energy drinks contributes to weight gain and the development of obesity (Hu & Malik, 2010; Malik, Popkin, Bray, Després, & Hu, 2010). Less is known about SSB consumption associated with BMI within the workplace. One study in America investigated SSB consumption within the workplace, but associations were made with gender, age, education and income status, and not BMI (Davy et al., 2014). Results showed that older participants, female participants, and participants with higher education and income levels were associated with lower SSB consumption (Davy et al., 2014). No studies investigating the use of SSB and its association with BMI and socio-demographic factors has been conducted on employees in the workplace in South Africa.

Several studies have investigated the environmental factors that affect food choice in a work environment (Watkins, Golla, Lartey, & Khubchandani, 2008; Baskin et al., 2016), though very few studies have investigated the association of food choice in a work environment with obesity (French, Harnack, Toomey, & Hannan, 2007). The food environment and availability of food has a powerful influence on eating behaviour; for example, energy dense foods available in a worksite environment, availability of vending machines, food provided by a canteen, and free availability of snacks and beverages to name a few. In a qualitative study performed by Watkins et al. (2008), workers' perceptions on the environmental factors influencing obesity in the workplace was investigated. Employees identified time constraints, cost and quality of food, and shift work as factors contributing to poor food choices (Watkins et al., 2008). A similar study conducted by Norbrega et al. (2016) resulted in the same responses from employees. Baskin et al. (2016) found that proximity of freely available snacks to beverages in the workplace was associated with increased consumption of energy-dense foods, though the significance was only observed in males.

A study conducted in the US on the association between body weight and food choices among metropolitan transit workers found few differences in food choices among the different BMI groups (French et al., 2007). Overweight employees reported a lower percent of fat energy intake compared to normal weight and obese employees; however, total energy intake did not differ significantly among weight categories. Furthermore, no differences were observed among groups for fruit, vegetables, sweets, and snack foods, though obese employees did report more frequent use of snacks, cold food and cold beverage vending machines compared to other employees (French et al., 2007). The current study will not be investigating environmental factors affecting food choice in a work environment; conversely, number of snacks and SSB among normal weight, overweight and obese employees in SA corporate and industrial companies will be investigated.

As demonstrated above, previous research is limited regarding dietary habits in the workplace; and currently no such research has been published in South Africa. No studies have been conducted on employees in South Africa investigating the relationship between BMI, relationship of FV intake with adiposity intake, snacking, and the consumption of SSB. Furthermore, the association of poor sleeping patterns, long work hours, physical activity habits and gender with BMI have not been investigated. As obesity is a major public health concern, with dietary habits a large contributing factor, research in this area is pertinent for the treatment and prevention of obesity.

An additional habit, in conjunction with dietary habits, which may increase energy intake and lead to a positive energy balance, is alcohol intake. The contribution of alcohol to weight gain has been comprehensively investigated, specifically the short-term effect of alcohol on appetite and overall energy intake, as well as the long-term effects of alcohol intake (Yeomans, 2010; Chapman, Benedict, Brooks, & Schiöth, 2012; Traversy & Chaput, 2015). Several authors report that alcohol decreases appetite (Caton, Bate, & Hetherington, 2007; Lloyd-Richardson, Lucero, DiBello, Jacobson, & Wing, 2008; Sayon-Orea, Martinez-Gonzalez, & Bes-Rastrollo, 2011), whereas others report an increase in appetite (Caton et al., 2007; Sayon-Orea et al., 2011; Chapman et al., 2012). A question that has been raised by numerous authors is whether there is a compensatory decrease in food consumption to negate the increased energy intake from alcohol (Caton et al., 2007; Yeomans, 2010; Sayon-Orea et al., 2011). There is very little evidence suggesting that alcohol consumption results in a decrease in subsequent food intake (Caton et al., 2007; Lloyd-Richardson et al., 2008; Sayon-Orea et al., 2011); rather evidence strongly suggests that short-term small doses of alcohol consumed prior to meals causes a clear and consistent increase in food intake (Caton et al., 2007; Yeomans, 2010; Sayon-Orea et al., 2011; Chapman et al., 2012). Furthermore, it has been suggested that alcohol elicits a psychopharmacological effect, and increases food intake via the food-related reward system (Yeomans, 2010). Although the evidence of short-term alcohol intake on food intake is clear, evidence regarding the impact of long-term alcohol intake on weight gain is inconsistent (Yeomans, 2010; Traversy & Chaput, 2015). Evidence suggests a J-shaped relationship between alcohol intake and weight gain, with both non-drinking and heavy drinking associated with a higher BMI or waist-to-hip ratio. Light to moderate alcohol intake may be associated with reduced risk of becoming obese (Yeomans, 2010; Traversy & Chaput, 2015).

3.5 Alcohol Consumption

A more pertinent question in this study is the alcohol consumption habits of overweight and obese employees compared to normal weight employees, and the factors affecting these habits. Many articles have been published regarding decreasing alcohol consumption in employees, though few articles regarding the alcohol consumption habits of employees associated with BMI, as well as the factors influencing these habits, could be found. Taris et al. (2011) investigated the influence of overtime work on health behaviours, including alcohol consumption and smoking, among full time employees. The study included 649 employees from the Dutch population. The study stated that smoking and drinking were not associated with high levels of overtime, but they were associated with BMI (Taris et al., 2011). Chang et al. (2012) reported an increase in the prevalence of alcohol consumption with increasing BMI. Prevalence of alcohol consumption for normal weight employees was 22.5%, and 26.8% and 25.8% for overweight and obese employees, respectively. Cameron et al. (2012) found no association between BMI and alcohol consumption in men, yet obese women drank significantly less alcohol than normal weight and overweight women. There is insufficient data published regarding the alcohol consumption habits of employees in association with BMI, with no such data published in South Africa. As negative health behaviours may have a negative impact on health, there is an urgent need for such associations to be investigated.

3.6 Smoking

Smoking is another adverse health behaviour that may negatively affect health and contribute toward the burden of disease in South Africa; with obesity and smoking identified as the leading causes of preventable morbidity and mortality worldwide (Chiolero, Jacot-Sadowski, Faeh, Paccaud, & Cornuz, 2007; Kim et al., 2012). Chiolero et al. (2007), investigated the association of cigarettes smoked daily with obesity in the general adult population. The population sample included 7844 men, and 9718 women from the Swiss Health Survey. For both sexes, a higher mean BMI was observed in ex-smokers compared to both cigarette smokers and non-smokers. The risk of being obese increased progressively with the number of cigarettes smoked daily, with heavy smokers having a higher mean BMI compared to light and moderate smokers (Chiolero et al., 2007). Kim et al. (2012) who found a positive association between smoking and increased abdominal and visceral fatness support these results. In contradiction to the above results, Chang et al. (2012) found that prevalence of smoking decreased with increasing BMI. Prevalence of smokers in normal weight employees was 45.7%, while prevalence in overweight and obese employees was 37.8% and 38.8%, respectively. A similar trend was seen in Cameron et al. (2012), with prevalence of smoking less in obese individuals compared to normal weight individuals, though significance was only observed in men. This is supported with research by Sach et al. (2007).

The Centers for Disease Control and Prevention (CDC) published a report in 2011 on the prevalence of cigarette smoking in the working population of the US. Prevalence was reported according to age, gender, and level of education, but not for BMI. The following trends were observed: 1) prevalence of cigarette smoking decreased with age (23.8% to 19.8% for age group 18-24 years and 45-64 years, respectively); 2) prevalence of cigarette smoking was higher for males (21.5%) than for females (17.4%); and 3) prevalence decreased with increasing level of education (28.4% and 9.1% for employees with less than a high school diploma and employees with more than a Bachelor's degree, respectively) (CDC, 2011).

Some studies have investigated the association of smoking with long work hours and short sleep duration, in relation to BMI, with varying results (Ko et al., 2007; Lallukka et al., 2008; Di Milia, Vandelanotte, & Duncan, 2013). Lallukka et al. (2008) did a review on the association between working overtime and smoking. The study analysed pooled cross-sectional data of employees from three countries: Britain (Whitehall II Study), Finland (Helsinki Health Study) and Japan (Civil Servants Study). These studies involved large sample sizes of 10 308, 8960, and 2213 participants, respectively. An inverse relationship between working overtime and smoking was found among men from the Japan and Helsinki Studies (Lallukka et al., 2008). Di Milia et al. (2013) who found that smoking was significant in overweight and obese Australian employees who had shorter sleeping times, do not support these results. Ko et al. (2007) also found that although longer working times were associated with smoking, these results were not significant. The percentage of employees who smoked working 7 h or less, 7 to 9 h, or more than 9 h was 11.6%, 18.3%, and 27.2%, respectively (Ko et al., 2007). Data regarding the smoking habits of corporate and industrial employees in South Africa, in relation to working hours and BMI is not known.

3.7 Work-Related Factors and Obesity

The effect of long work hours on various health behaviours has been described in more detail in chapter two and chapter three. Long work hours (LWH) has been shown to increase snacking among employees, and lead to less healthy food choices (Escoto et al., 2010); as well as decreased time for leisure activities and healthy habits such as exercise, healthy food preparation, and sleep (Abramowitz, 2016). Furthermore, LWH coupled with sleep deprivation leads to reduced exercise, consumption of more fast food, and more time spent in sedentary behaviours such as watching TV; all of which contributes to weight gain (Basner et al., 2007; Fogelholm et al., 2007; Stamatakis & Brownson, 2008; Jang, Kim, Lee, Myong, & Koo, 2013). Evidence also shows that short sleep duration (SSD), which may be coupled with LWH, as well as shift work has a negative influence on the circadian rhythm (Laposky, Bass, Kohsaka, & Turek, 2008; Huang, Ramsey, Marcheva, & Bass, 2011). Changes in the circadian rhythm changes hormonal levels, leads to metabolic changes and the development of obesity (Laposky et al., 2008; Huang et al., 2011; Jang et al., 2013). While all these factors have been shown to increase the risk of obesity, the association of LWH with obesity has not yet been described in South Africa.

A cross-sectional study investigating the association of LWH and obesity in Korean adult workers was conducted by Jang et al. (2013). The study included a large sample size of 8889 participants, of which 5241 were males. Results found an independent U-shaped relationship of both sleep hours and work hours with the prevalence of obesity. While long work hours were independently associated with obesity in Korean male adult workers, this relation was not observed in females. These results are partially supported by Abramowitz (2016) who found that ten additional hours spent working were associated with an increase in BMI of 0.424 for women and 0.197 for men. However, this effect was decreased when accounting for confounding factors such as time spent sleeping for both men and women, and time spent in exercise and food preparation for women only. When accounting for screen time for both men and women, the effect is increased. After controlling for all factors, the effect of hours worked on BMI decreases for women, but increases for men (Abramowitz, 2016). The gender differences observed above are supported by Gu et al. (2012) who investigated the association between LWH and adiposity on 408 police officers in America. Body mass index increased with longer work hours even after adjusting for age, physical activity, energy intake, sleep duration, smoking status, police rank, leisure time activities and household income, but this was only observed in male officers and not female officers (Gu et al., 2012). Possible explanations for the differences observed between males and females, is that females may substitute work time for more time spent in physically demanding and healthy food- and eating-related activities; whereas males may substitute work time for more time spent in sedentary activities (Abramowitz, 2016).

A behaviour that has been closely examined for its association with obesity and long work hours is short sleep duration (SSD). The association of short sleep with obesity in a working population was investigated by Ko et al. (2007). The study consisted of a large sample size of 3953 employees working in Hong Kong. Independent associations were found among obesity (BMI), sleeping hours and working hours, with increasing BMI associated with a reduced number of sleeping hours and increasing number of working hours. The highest percentage of obese participants were found in the group with the shorter sleeping times (<6 h) and longer working times (>9 h) (Ko et al., 2007). Similar results were found in two other studies conducted by Di Milia and Mummery (2009) and Di Milia et al. (2013) in employees working in Australia. Di Milia and Mummery (2009) allocated employees into three groups according to average work duration per day: 1) short (8.72 ± 0.56 h), 2) medium (10.95 ± 0.56 h), and 3) long (12.60 ± 0.41 h). It was found that mean BMI was significantly higher ($p<0.001$) in employees who worked long hours (28.14 ± 5.56 kg/m^2), less in the medium group (27.37 ± 4.43 kg/m^2), and lowest in the short working hours group (25.27 ± 4.06 kg/m^2). Obese employees working longer hours slept 18 minutes less per day when compared to normal weight employees ($p<0.06$). The association between obesity and the predictor variables were examined via logistic regression, with adjusted odds ratios (OR) suggesting that older age (OR=2.06), short sleep duration (OR=2.04), and longer working hours (OR=2.82) predicted obesity (Di Milia & Mummery, 2009).

This is supported by Di Milia et al. (2013) who found a positive association between short sleep duration, longer working hours and BMI; even when controlling for confounding variables such as age, gender education level, physical activity, daily sitting time, alcohol consumption and smoking. No such studies investigating the association of work hours and sleeping patterns with BMI and other socio-demographic factors such as age, gender, level of education, and income status have been conducted in South Africa.

3.8 Effect of Working Conditions and BMI on Health

As demonstrated above, working conditions may affect health behaviours at work, and in conjunction with excess body weight, health may subsequently be affected. ***Health*** refers to optimal wellbeing that contributes to one's quality of life, and not merely the absence of disease and illness. Furthermore, optimal health includes high-level mental, social, emotional, spiritual, and physical wellness (Corbin, Welk, Corbin, Welk, & Sidman, 2009; Bellieni & Buonocore, 2009; Huber, 2011). ***Wellness*** is the integration of many different components, namely social, emotional-mental, spiritual, and physical, that contribute to one's quality of life, ability to work effectively and make a significant contribution to society. Moreover, wellness reflects how one feels (a sense of well-being) about life as well as one's ability to function effectively (Corbin et al., 2009). ***Illness*** is a feeling of being ill, and/or symptoms associated with a disease or circumstances that upset homeostasis (Corbin et al., 2009).

As discussed in chapter two, excess body weight is associated with many cardiovascular and metabolic changes, which may lead to the development of various diseases, called comorbidities. Obesity and the prevalence of comorbidities has been extensively investigated, though more within the general public and less within the workplace, and none within the workplace in South Africa (Bogers et al., 2007; Oberlinner, Neumann, Ott, & Zober, 2007; Félix-Redondo et al., 2013; Rolando et al., 2013). The comorbidities that appear to be most prevalent include T2DM and metabolic syndrome, hypertension, cardiovascular disease (CVD), stroke, and dyslipidaemia (Oberlinner et al., 2007; Chang et al., 2012; Félix-Redondo et al., 2013). Other conditions that have been investigated, but seem to be less prevalent, include osteoarthritis, various cancers, gall bladder disease, asthma, sleep apnoea, and depression (Joubert et al., 2007; Sartorius, Veerman, Manyema, Chola, & Hofman, 2015). The focus of the current study will be on the more prevalent conditions and thus, only these will be discussed below.

As mentioned previously, excess body weight and its associations with various comorbidities has been extensively investigated. However, most studies do not report on total number of comorbidities associated with obesity. One study, conducted by Sullivan, Ghushchyan and Ben-Joseph (2008), however, did report on the number of chronic conditions associated with the various weight categories. Normal weight individuals reported mean value for total number of chronic conditions of 1.58, compared to overweight individuals who reported 1.8 chronic conditions, and 2.39 for obese individuals; though significance was not indicated.

Furthermore, medical expenditure associated with obesity has been extensively researched, though few studies report on number of excess visits to the doctor's office associated with excess body weight. Two authors reported this data, and found that excess body weight was associated with increased doctors' visits (Sullivan et al., 2008; Goetzel et al., 2010). Sullivan et al. (2008) only described mean data, and found normal weight individuals visited doctors 5.1 times per year, overweight individuals reported 5.2 visits, and obese individuals 6.4 visits. Goetzel et al. (2010) reported means for annual visits of 3.05, 2.95, and 3.93 for normal weight, overweight, and obese individuals, respectively. Significance ($p<.001$) was only observed between normal weight and obese individuals, with obesity resulting in 20% higher doctors' visits. The current study will be reporting on both total number of conditions and total number of doctor's visits associated with the various body weight categories.

3.8.1 Type II Diabetes Mellitus (T2DM)

Along with the trend of increased obesity, a concurrent trend of increased T2DM has been observed in many countries (Oberlinner et al., 2007; Nguyen, Nguyen, Lane, & Wang, 2011; Rolando et al., 2013). The concern with T2DM is its association with an increased risk for cardiovascular disease and mortality (Nguyen et al., 2011). Most studies classify the presence of T2DM if the participant was told by their doctor they currently have T2DM, if their fasting plasma glucose concentration was ≥ 7.0 mmol/L, if the haemoglobin A1c level was ≥ 6.0%, or the use of anti-diabetic medication(s) such as insulin or oral hypoglycaemic agents (Nguyen et al., 2011; Rolando et al., 2013). Numerous studies, within the general population as well as within the workplace, have found a strong association between excess body weight and the presence of T2DM (Oberlinner et al., 2007; Sullivan et al., 2008; Nguyen et al., 2011; Félix-Redondo et al., 2013; Rolando et al., 2013).

Oberlinner et al. (2007) observed 24006 employees for a period of a year, who did not have T2DM at the start of the study period. By the end of the study period, new cases of T2DM was 2.6% for normal weight employees, 6.1% for overweight employees, and 11.3% for obese employees. Prevalence estimates at the start of the study ranged from 1.3% in normal weight employees, to 13.1% in employees with a BMI ≥ 40 kg/m^2. It was also noted that both the prevalence of obesity and the prevalence of T2DM increased with age. Nguyen et al. (2011) used nationally representative data (inclusive of the working population) from the National Health and Nutrition Examination Survey (NHANES) survey in America, and found increasing prevalence of T2DM with increased BMI. Prevalence of T2DM was found to be 8%, 15%, 23%, 33% and 43% for normal weight, overweight, obesity class I, obesity class II, and obesity class III, respectively. The prevalence of T2DM almost doubled from normal weight to overweight, and almost tripled from normal weight to class I obesity.

Similar prevalence for T2DM across BMI categories was found by Félix-Redondo et al. (2013) in Spain, de Zwaan et al. (2009) in Germany, and Cameron et al. (2012) in Australia. Though these three studies were population-based, it is assumed that working employees are included in this population. Rolando et al. (2013) investigated obesity as a risk factor for T2DM in 3125 employees in the United States. Findings indicated that obese employees who remained obese from baseline for three consecutive years had a 10.1% risk of developing T2DM, whereas employees who were obese at baseline but were able to maintain a BMI below 30 kg/m^2 for the three years had a significantly reduced risk of 2.4%; this equates to a

78% reduced risk of T2DM (OR=0.22, p=0.039). The converse was also observed, in other words, employees who were overweight at baseline, but became and remained obese for the three years, the risk of T2DM increased from 1.2% (for those who remained overweight) to 9.4% (for those who became obese) (OR=8.85, p=0.001). Odds ratios observed by Félix-Redondo et al. (2013) for overweight men and women were 1.71 and 2.53, respectively. For obese men however, the OR was greater than that for obese women, with an OR of 3.08 and 2.95, respectively.

3.8.2 Metabolic Syndrome

Metabolic syndrome is a condition defined by a combination of risk factors associated with obesity that increases the risk of cardiovascular disease and T2DM (Ervin, 2009; Davila et al., 2010; Chang et al., 2012). For metabolic syndrome to be diagnosed, three of the following five criteria need to be met: 1) abdominal obesity, measured by waist circumference (men ≥ 102 cm, women ≥ 88 cm), 2) fasting blood glucose ≥ 5.55 mmol/L, 3) triglycerides ≥ 1.69 mmol/L, 4) HDL-C < 1.03 mmol/L and 5) blood pressure ≥ 130/85 mmHg (Davila et al., 2010; Chang et al., 2012).

Chang et al. (2012) investigated the impact of BMI in incidence of metabolic abnormalities in 2599 metabolically healthy Korean male employees. Measurements at baseline showed a clear dose-response relationship between BMI and age, fasting blood glucose, systolic and diastolic blood pressure, total cholesterol, triglycerides, and low-density lipoprotein cholesterol (LDL). However, high-density lipoprotein cholesterol (HDL) was found to be inversely associated with BMI. The results indicated that the risk for developing any one metabolic abnormality increased across BMI categories (*P* for trend <0.001), with obese employees having a significantly increased risk for hypertriglyceridemia, pre-diabetes, pre-hypertension, low HDL, and metabolic syndrome. Strong associations between higher BMI and increased incidence of metabolic abnormalities was still observed, even after adjustment for updated weight over time. Over time, obesity was positively correlated with a higher incidence of metabolic abnormalities, when compared to normal weight employees. This is suggestive of the adverse metabolic changes that occur over time due to obesity. The association between baseline BMI and metabolic syndrome was measured using incident rate and incident risk. Incident rate, per 100 person-year, was 0.5 for normal weight, 0.8 for overweight, and 0.9 for obese employees. The incident risk (IR) was measured after 1 year, 2 years, and 5 years, with increasing incidence across BMI categories. For normal weight employees, the IR increased from 0.1 to 1.0 from year 1 to year 5, respectively. Overweight employees increased from 0.2 to 3.3, and obese employees increased from 0.3 to 2.7. Davila et al. (2010) observed a similar trend in 8457 employees from the United States. Prevalence of metabolic syndrome among normal weight employees was 4.6%, 15.8% for overweight employees, and 42.5% for obese employees. The OR for overweight employees was stated to be 5.63, and obese employees OR=25.94; both of which were significant ($p<0.05$).

3.8.3 Hypertension

Elevated blood pressure, or hypertension, is defined as a blood pressure reading of ≥ 140/90 mmHg and is diagnosed when measured on three separate occasions, or the use of high blood pressure medication (Oghagbon, Okesina, & Biliaminu, 2008; Keenan & Rosendorf, 2011). Evidence indicates increased prevalence of elevated blood pressure with increased BMI (Oghagbon et al., 2008; Clougherty, Eisen, Slade, Kawachi, & Cullen, 2009; Keenan & Rosendorf, 2011; Shihab et al., 2012).

This is supported by Oghagbon et al. (2008), who found the prevalence of high systolic blood pressure (SBP) and high diastolic blood pressure (DBP) to be greater in obese employees, compared to normal weight employees. Prevalence of high SBP and DBP in normal weight employees was 18.1% and 13.6%, respectively; whereas prevalence of high SBP and DBP in obese employees was 37.8% and 29.7%, respectively. Overweight employees also showed increased prevalence, with 28.4% and 22.4% prevalence for SBP and DB, respectively. Similar prevalence rates were seen among obese civilians from the National Health and Nutrition Examination survey in the United States, with 39.8% prevalence among obese (BMI ≥ 30 kg/m^2) individuals compared to 25.8% prevalence among non-obese (BMI < 30 kg/m^2) individuals (Keenan & Rosendorf, 2011).

In a population based study conducted in Spain on 28887 participants, a significant association ($p<0.001$) between BMI and hypertension was observed (Félix-Redondo et al., 2013). Prevalence was almost double for obese individuals compared to prevalence seen in a study by Keenan and Rosendorf (2011). In men, prevalence of hypertension for normal weight individuals was 31.4%; this increased to 50.0% for overweight individuals, and further increased to 68.4% for obese individuals. In women, prevalence of hypertension was 19.2 % for normal weight individuals, 43.3% for overweight individuals, and 66.6% for obese individuals. These results are further supported by de Zwaan et al. (2009).

Clougherty et al. (2009) analysed hypertension risk in a large cohort of 14 799 employees in the United States. Mean BMI for the cohort was calculated as 29.7 kg/m^2. Odds ratios were calculated and adjusted for age, and presented as either above-median, or below-median. Employees with a BMI above-median had an OR of 2.34, which indicated a significant risk of developing hypertension ($p<.0001$). Shihab et al. (2012) calculated association of BMI with incident hypertension and found overweight men had 1.5 times the risk of developing hypertension, whereas obese men had a fourfold increased risk. Furthermore, it was found that for every 1 kg/m^2 increase in BMI, the risk of developing hypertension increased (HR=1.06). Félix-Redondo et al. (2013), who had similar findings, further support these results. Further observations made included an increased prevalence of hypertension with increasing age, and a decreased prevalence with increasing education and income level (Clougherty et al., 2009; Keenan & Rosendorf, 2011).

3.8.4 Cardiovascular Disease

Cardiovascular disease (CVD) refers to vascular changes that occur in the coronary arteries over time, causing hardening (arteriosclerosis) and narrowing (atherosclerosis) of the arteries (Bogers et al., 2007). These changes may result in angina, myocardial infarction, or death. Risk factors for CVD include hypertension, dyslipidaemia, impaired glucose tolerance, and vascular abnormalities (Bogers et al., 2007; Félix-Redondo et al., 2013).

Bogers et al. (2007) conducted a meta-analysis of twenty-one cohort studies, which included a total of 302 296 participants. Most of these studies were population-based, however a few studies were conducted using employees. The study investigated the association of excess body weight with increased risk of CVD, as well as the mediating effects of blood pressure and cholesterol levels. The relative risk (RR) for CVD for overweight and obesity was 1.32 and 1.81, respectively. Additional adjustment for blood pressure and cholesterol levels statistically significantly reduced the RR to 1.17 for overweight and 1.49 for obesity; which corresponds to a decrease in excess risk of 47% for overweight, and 40% for obesity. The results from this meta-analysis found that a 5-increment increase in BMI was associated with a 29% increase in risk of CVD, yet after adjustment for blood pressure and cholesterol levels, the risk was only 16%. The implication of this study is that adverse effects of excess body weight could account for 45% of the increased risk of CVD; however, independent of these effects there is still a significant risk of CVD associated with excess body weight. Findings from a study conducted by Félix-Redondo et al. (2013) in Spain support this study. Increased risk for CVD was directly related to increased BMI in both men and women. Prevalence of CVD in normal weight men increased from 4.5% to 6.8% in overweight, and further increased to 9.2% in obese men. Though the trend was similar in women, the prevalence rates were less, with 2.1% prevalence in normal weight women, and 4.0% and 5.4% for overweight and obese women, respectively. The coronary risk for obese men (OR=1.18) and women (OR=1.58) was greater than that for overweight men (OR=1.11) and women (OR=1.34).

3.8.5 Dyslipidaemia

Dyslipidaemia refers to dysfunction of lipoprotein metabolism, and includes both lipoprotein overproduction and deficiency (Félix-Redondo et al., 2013). Dyslipidaemias may be manifested by elevation of total cholesterol, LDL and triglyceride concentrations, and a decrease in HDL concentration in the blood (Barquera et al., 2007; Félix-Redondo et al., 2013). As the current study will only be focussing on total cholesterol, only that risk factor will be discussed. Diagnosis of hypercholesterolemia, or high levels of total cholesterol, is made when total cholesterol levels are above 6.2 mmol/L (Barquera et al., 2007; Félix-Redondo et al., 2013).

Félix-Redondo et al. (2013) investigated prevalence and odds ratio for hypercholesterolemia in a large cohort in Spain. Prevalence of hypercholesterolemia increased significantly across BMI categories, with prevalence in men ranging from 37.1% for normal weight men, to 47.4% in overweight and 52.3% in obese men, with a similar trend observed in women. Odds ratio for overweight men and women were 1.45 and 1.14, respectively. Odds ratio for obese men and women were 1.73 and 1.22, respectively. Similar results were described by Barquera et al. (2007), using nationally representative data in Mexico. Obese females were 1.4 times more likely to have hypercholesterolemia, and obese males had a 1.93 times increased risk (Barquera et al., 2007). These results are further supported by de Zwaan et al. (2009).

3.8.6 Stroke

A stroke refers to the sudden death of brain cells in a localized area of the brain due to inadequate blood flow (Winter et al., 2008; Strazzullo et al., 2010). Stroke is one of the major causes of deaths in developed countries, and is a leading cause of long-term disability (Strazzullo et al., 2010; Yatsuya et al., 2010). Well-established risk factors for stroke include age, hypertension, smoking, and T2DM (Strazzullo et al., 2010; Yatsuya et al., 2010). As discussed in chapter 2 and chapter 3, obesity is a precursor of hypertension, T2DM, and their complications; thus, play an important indirect role in the epidemiology of stroke (Strazzullo et al., 2010; Yatsuya et al., 2010). Stroke diagnosis, as defined by the National Survey of Stroke (NSS), is a sudden or rapid onset of neurological symptoms lasting more than 24 hours or leading to death not secondary to trauma, neoplasm, hematologic abnormality, infection, or vasculitis (Yatsuya et al., 2010).

Strazzulo et al. (2010) performed a meta-analysis on excess body weight and incidence of stroke; the study included over 2 million participants from 10 different countries, with none from Africa. These studies were all population-based, but it is assumed that it included working adults. Pooled relative risk (RR) of strokes for overweight and obese participants combined versus normal weight participants was 1.05 (p=0.56), with a RR for obese participants being 1.26 (p=0.005). In support of this Yatsuya et al. (2010) calculated RR for race- and sex- specific associations of obesity with ischemic stroke incidence; the study included a large sample size of 5930 men and 7619 women. Relative rates were higher for black men and women, compared to white men and women, though an increasing trend was seen across BMI quintiles for all races and genders. In quintile two (BMI 23.9-26.1 kg/m^2) black women had an RR of 2.6, while white women had an RR of 1.5; black men and white men had an RR of 4.1 and 2.2, respectively. In the fifth quintile (BMI 32.0-65.9) RR's for black and white women increased to 5.5 and 2.2, respectively; for black men they increased to 8.0 and white men increased to 3.3. Continuous BMI showed a significant linear positive association with ischemic stroke for all race and sex groups. Furthermore, hypertension did not modify the association of obesity with ischemic stroke incidence. In other words, in individuals with and without hypertension, there was a significant positive association between obesity and ischemic stroke incidence (Yatsuya et al., 2010). The above results are partially supported by Winter et al. (2008), who conducted a case-control study on 1137 participants. Results showed a positive association of BMI and risk of stroke or transient ischemic attack (TIA), with an odds ratio of 2.34 (p<0.001); nevertheless, when controlling for other risk factors such as age, gender, physical inactivity and smoking, the association was reduced (OR=1.18) and lost its significance (p=0.45). De Zwaan et al. (2009) also found no association between stroke and the different BMI categories.

3.9 Quality of Life

The association between BMI and comorbidities is well established, and investigating the effects of BMI on one's ability to live a full and active life and on psychosocial well-being is important. The presence of comorbidities and pain can affect the global sense of well-being, quality of life and overall functional capacity (Kruger, Bowles, Jones, Ainsworth, & Kohl, 2007). ***Quality of life*** is a broad multidimensional concept that is defined as an individual's overall satisfaction with life, and encompasses the physical, psychological, and social domains of health; which are seen as distinct areas that are based on one's own values, goals, abilities, and needs (Taylor, Forhan, Vigod, McIntyre, & Morrison, 2013).

Numerous studies have investigated the effect of excess body weight on quality of life (QOL) in the general population, with varying results (Janke, Collins, & Kozak, 2007; de Zwaan et al., 2009; Backholer, Wong, Freak-Poli, Walls, & Peeters 2012). Several studies found that normal weight individuals had a significantly higher QOL score, in relation to physical functioning, than individuals who were classified as overweight or obese (Backholer et al., 2012; Stone & Broderick, 2012). Other studies found a significant association between normal weight and obese individuals, but not between normal weight and overweight individuals (Fjeldstad, Fjeldstad, Acree, Nickel, & Garner, 2008; de Zwaan et al., 2009; Backholer et al., 2012). De Zwaan et al. (2009) found that BMI correlated negatively and significantly ($r=-0.56$; $p<0.001$) with physical functioning. A higher number of comorbid conditions was found to further reduce physical QOL (de Zwaan et al., 2009).

The aspect of the physical domain in which obesity had the greatest impact was pain and mobility (Hitt, McMillen, Thornton-Neaves, Koch, & Cosby, 2007; Backholer et al., 2012; Stone & Broderick, 2012; Pataky, Armand, Müller-Pinget, Golay, & Allet, 2014). Hitt et al. (2007) the association between obesity and pain in 3637 individuals from the general population, residing in the US. Results of the study suggest that obese adults are more likely to experience pain than normal weight adults are. Individuals classified as obese class I were 1.762 times more likely than normal weight individuals to report severe pain, while obese class II individuals were 1.888 times more likely to experience severe pain. Obese class III individuals were most likely to report severe pain – 2.297 times more likely than normal weight individuals were. Stone and Broderick (2012) reported significance of pain across all BMI categories for over two million individuals from the general population. Overweight individuals were 1.20 times more likely to report pain, while obese class I, class II, and class

III individuals were 1.68, 2.36, and 3.54 times, respectively, more likely to report pain. The association between excess body weight and pain is further supported by research conducted by Fjeldstad et al. (2008) and Pataky et al. (2014).

Backholer et al. (2012) found that overweight individuals had 1.04 times the risk of normal weight individuals to suffer from an activity of daily living (ADL) limitation, with a significance of $p=0.03$. Obese class I and class II individuals had 1.16 ($p<0.00001$) and 1.76 ($p=0.0005$) times the risk of normal weight individuals for suffering from a limitation in ADLs, respectively. Furthermore, Backholer et al. (2013) found that a greater proportion of women, compared to men, with all classes of excess body weight had problems with pain and physical functioning. Fjeldstad et al. (2008) investigated the influence of obesity on quality of life in 216 University staff members. The results found that obese individuals had significantly ($p=0.002$) lower quality of life relating to physical function, which supports the results above.

Published data on the association between excess body weight and mental well-being is conflicting; thus, this relationship remains unclear (Scott et al., 2008; Ma & Xiao, 2010). Some studies found that mental problems were only observed in obese individuals, but not overweight individuals (Scott et al., 2008; Bruffaerts et al., 2008). Bruffaerts et al. (2008) found that obese individuals were 1.3 times more likely to have a mood disorder, and 1.4 times more likely to have more than one mental disorder when compared to normal weight individuals. The population sample in the study was representative of over 200 million Europeans. Scott et al. (2008) found that obese individuals had a significantly increased risk of a depressive disorder, with an OR of 1.1, though the association with depressive disorder was concentrated among those with class III obesity (BMI ≥ 35 kg/m^2). The study involved 62277 participants from the US, Europe, the Middle East, and Asia, though it did not report on overweight individuals. Ma and Xiao (2010) investigated the association between excess body weight and depression in 1857 women in the US. Body mass index was positively associated with moderate/severe depressive symptoms ($r=0.49$, $p=0.03$) and major depression ($r=0.72$, $p<0.0001$). The OR for moderate/severe depressive symptoms ranged from 1.10 to 3.44 for overweight to obese class III individuals, while the OR for major depression ranged from 0.91 to 5.25 for overweight to obese class III individuals. However, Fjeldstad et al. (2008) and de Zwaan et al. (2009) found no significance across BMI groups for mental well-being.

Obese individuals report high levels of stigmatization and discrimination and are less likely to reach milestones of social success (Muennig, 2008; Sikorski et al., 2011). As a result, obese persons are more likely to suffer from a negative self-image than thinner persons are. Bacevičienė, Rėklaitienė and Tamošiūnas (2009) investigated the effect of excess body weight on quality of life and satisfaction with body image among 1403 Lithuanian adults. Being obese was associated with a significant decrease in QOL in the psychological domain, however this was only observed in women. Both obese men and women were significantly ($p=0.0001$) less satisfied with their body image as compared to normal weight counterparts. No significant differences were observed between overweight and normal weight adults with regards to quality of life. Millstein et al. (2008) investigated the relationship between body size satisfaction and BMI in 9740 US adults. Results indicated that women were around twice as likely as men to be dissatisfied with their body size. The OR for overweight and obese men was 2.00 and 13.26, respectively, while the OR for overweight and obese women was 5.72 and 21.59, respectively. Among women and men, higher body mass index (BMI) was significantly associated with body size dissatisfaction.

The concept of health-related quality of life (HRQOL) has been described by many authors, and refers to the effect of medical conditions on well-being, physical functioning, and mental functioning. Health-related quality of life represents the functional effects of an illness on a person, as perceived by the person (Kruger et al., 2007). Sach et al. (2007) observed that the highest HRQOL was achieved at a BMI of 26.0 kg/m^2 in men, and 24.5 kg/m^2 in women.

Kruger et al. (2007) observed an inverse relationship between BMI and HRQOL, with prevalence of poor HRQOL among obese adults (23%) being significantly higher than that among overweight (12%) and normal (10%) weight adults. Numerous studies found that HRQOL tended to deteriorate with increasing levels of obesity, yet some studies only found significance between normal weight and obese individuals (Sach et al., 2007; Søltoft, Hammer, & Kragh, 2009; Cameron et al., 2012; Ul-Haq, Mackay, Fenwick, & Pell, 2013). Sach et al. (2007) and Søltoft et al. (2009) found that the aspect of the physical domain in which obesity had the greatest impact was pain and mobility, with overweight and obese individuals significantly more likely to experience mobility problems and to suffer from pain ($p<0.001$). The association between excess body weight and mental HRQOL is not as clear. Some authors finding no significance across BMI groups for mental well-being, whereas others found that mental problems were only observed in obese individuals, but not overweight individuals (Sach et al., 2007; Søltoft et al., 2009; Cameron et al., 2012; Ul-Haq et al., 2013)

Being young and finishing education had positive effects on HRQOL (Søltoft et al., 2009), while increased age was associated with decreased HRQOL (Sach et al., 2007; de Zwaan et al., 2009; Søltoft et al., 2009; Cameron et al., 2012). While quality of life has been extensively researched in the general population, QOL of employees (in association with BMI) has not been fully investigated. Furthermore, no studies investigating QOL in South African employees have been conducted.

3.10 The Burden of Obesity

In the discussion presented in this review thus far, it is clear that several adverse health behaviours, associated with workplace conditions, are related to obesity. These adverse health behaviours as well as the comorbidities associated with obesity independently create a financial burden on employers and the economy of the country (Laaksonen, Piha, & Sarlio-Lähteenkorva, 2007; Tsai et al., 2008; Andreyeva, Luedicke, & Wang, 2014). As the prevalence rates of obesity within the workplace increase, so do obesity-related costs, at the expense of the employer. Thus, the body weight of employees has become a concern to occupational health researchers as well as employers (Frone, 2008; Howard & Potter, 2014). The financial impact of a disease, in this case obesity, within the workplace and on the economy, has been investigated by many authors using cost-of-illness studies (Laaksonen et al., 2007; Frone, 2008; Tsai et al., 2008; Andreyeva et al., 2014; Howard & Potter, 2014). Cost of illness (COI) is also known as burden of disease (BOD), and it is a definition that encompasses various aspects of the impact of a disease on health outcomes, either in a country, specific region, community, or even individual. Cost of illness categories include incidence or prevalence of disease and its effect on longevity, morbidity and quality of life, and financial aspects including direct and indirect costs that result from premature death, disability or injury due to corresponding disease and/or its comorbidities (Jo, 2014).

Prevalence is a measure of disease frequency, and refers to the proportion of the population that has a disease at a particular time (Bustillos, Vargas, & Gomero-Cuadra, 2015; Yu, Wang, & Yu, 2015). Prevalence can also be used to assess the frequency of behaviours or characteristics that might be risk factors for a disease. Prevalence is used as a measure of burden of disease on society. In addition to prevalence of disease, many studies have investigated incidence risk and incidence rate to measure risk of developing a disease (Joubert et al., 2007; Andreyeva et al., 2014). Incidence is a measure of the occurrence of new cases of a disease (or some other outcome) during a specific period of time, and can be expressed as either incidence proportion (cumulative incidence) and/or incidence rate (Joubert et al., 2007; Andreyeva et al., 2014). ***Incidence proportion*** refers to the probability of developing a disease (or some other outcome) over a stated period of time and is an estimate of risk. It is calculated by the number of new cases (of disease/outcome) within a specified period (e.g. 2 years), divided by the size of the population initially at risk. ***Incidence rate*** is a measure of the number of new cases ('incidence') per unit of time ('rate'); time units can be expressed in days, months, or years. The ***odds ratio (OR)*** uses prevalence of a disease at a particular point in time, with no follow-up period, to measure the association between an exposure and an outcome. The OR represents the odds that an outcome will occur given a particular exposure, compared to the odds of the outcome occurring in the absence of that exposure. The OR also gives an indication of the strength of the association, though it is a weaker indication than relative risk (Howard & Potter, 2014; Bustillos et al., 2015). Two measures can also be compared in terms of their absolute differences, this is called ***risk difference***. The risk difference is calculated by subtracting the incidence proportion (relative risk) in the unexposed group (or least exposed group) from the incidence proportion in the exposed group. The risk difference focuses on absolute effect of the risk factor, or the excess risk of disease in those who have the factor compared to those who do not (Howard & Potter, 2014; Bustillos et al., 2015).

Cost of illness studies either use a top-down approach, or a bottom-up approach to determine burden of disease (Jo, 2014). The top-down approach uses the population-attributable fraction (PAF), which measures the proportion of a disease that is due to exposure to the disease or the risk factors. In this case, the disease or risk factor will be excess body weight. In other words, PAF is based on the assumption that obese individuals, if they had not been obese, would have had the same incidence of a particular disease as that found among normal weight individuals. Population-attributable fractions consider both the prevalence of obesity and the relative risks of health outcomes associated with obesity, and provide a useful way to express the burden of morbidity and mortality associated with obesity (Flegal, Panagioyou, & Graubard, 2015). The bottom-up approach calculates cost estimation in two steps: 1) measure and quantify the health input, i.e. measure days absent from work due to illness across the three BMI categories, 2) estimate the unit costs of the input, i.e. estimate daily earnings from annual salary. The total costs are calculated through the multiplication of unit costs by the quantities used, i.e. days absent from work due to illness multiplied by daily earnings (Jo, 2014). As explained in the methods chapter, the bottom-up approach will be used to calculate the cost of illness in the current study.

The financial aspects of the burden of disease has been categorized into either direct medical costs, or indirect productivity-related costs; these costs quantify the amount of consumed or lost resources in monetary terms (Neovius, Johansson, & Neovius, 2009; Lehnert, Sonntag, Konnopka, Riedel-Heller, & König, 2013; Howard & Potter, 2014). Direct medical costs involve costs related to preventative care, diagnosis, and medical treatment related to a disease. These medical treatments include hospitalization, visits to doctors or other medical professionals, medications, and nursing home care (Hammond & Levine, 2010; Howard & Potter, 2014). Indirect costs are associated with four types of productivity losses, namely absenteeism, presenteeism, disability, and premature mortality (Howard & Potter, 2014). The goal of COI studies is to evaluate the economic burden that an illness imposes on society, by itemizing, giving value to, and summing up the costs of a particular condition. Cost of illness studies are important for assisting in the formulation of health care policies and interventions, which is becoming increasingly important not only for the public, but also for employers and companies in South Africa. Most of these studies have been conducted in the United States, with smaller studies conducted in other countries, but none in South Africa. The current study will report on excess days absent due to overweight individuals and obesity, and the associated costs.

3.10.1 Absenteeism

Obesity, along with its comorbidities, may interfere with an employee's capacity to work. Cardiorespiratory fitness, along with the other health-related components of fitness, may also be related to work effort, as well as the possibility to stay at work during a minor illness (Neovius et al., 2009). Poor cardiorespiratory fitness may be a confounding factor in impairing productivity and enabling employee absenteeism from work (Neovius et al., 2009). ***Absenteeism*** refers to time away from work due to illness, and is often measured as sick leave (Lehnert et al., 2013; Andreyeva et al., 2014). For the purpose of this study absenteeism related to sick leave, and for no other reasons, will be investigated.

Andreyeva et al. (2014), investigated estimates of obesity-attributable costs of absenteeism at a state level in the United States. Data on absenteeism was collected from the National Health and Nutrition Examination Survey (NHANES) on full- or part-time employed adults aged 18 and above. The final sample included 14975 employed adults. To calculate obesity-attributable absenteeism costs, the following steps were taken:

- average earnings per state were estimated for year-round, full-time and part-time employees aged 18 or older;
- the annual wage estimates were divided by 240 (250 weekdays minus average ten vacation days) in order to obtain state-specific estimates of average earnings per day of work;
- excess work days missed due to obesity-related health problems, was determined by calculating the difference between average predicted number of missed work days for normal weight and obese employees;
- obesity-attributable absenteeism cost was calculated as the product of state-specific average daily earnings and the difference in missed work days between normal weight and obese employees; this was done separately for obese classes I, II and III;
- total costs of absenteeism among obese employees in each state was calculated by multiplying per employee cost of absenteeism by the population count of obese employees in each state; and
- the final step calculated the percentage of obesity-attributable costs of absenteeism by estimating the total cost of absenteeism among all employed adults ages 18 and above and the cost of absenteeism among obese employees (Andreyeva et al., 2014).

The NHANES steps to calculate obesity-attributable absenteeism, as discussed in the methods chapter will be used to calculate the obesity-attributable absenteeism of SA industrial and corporate employees.

Andreyeva et al. (2014) calculated incident rate ratios (IRR) to assess differences in absenteeism across weight categories ($p<0.01$). Insignificant differences were observed between normal weight and overweight employees, with the number of work days missed due to ill-health for normal weight and overweight employees being 4.25 days and 4.48 days, respectively. Furthermore, when investigating differences among genders between normal weight and overweight employees, no significant differences were observed. Due to the lack of significant differences between the normal weight and overweight employees, this study did not further analyse the incremental costs of absenteeism among overweight employees. Significant differences were observed between normal weight and obese employees, with significance increasing with increased obesity categories. When compared to normal weight employees, the additional workdays missed per year was 1.2 days (27.4% more days; $p<0.05$) for class I obese employees, 1.7 days (40% more days; $p<0.01$) for class II obese employees, and 1.9 days (44% more days; $p<0.01$) for class III obese employees. These authors concluded that though overweight employees appear to be similar to normal weight counterparts in terms of time lost for health reasons, obesity was significantly associated with increased absenteeism among American workers (Andreyeva et al., 2014).

In agreement with the above, Tsai et al. (2008) investigated absenteeism in 4153 employees from the Shell Oil Company in the United States. Absenteeism was investigated due to obesity alone, as well as obesity combined with other risk factors. Within the study population, 38.5% of normal weight employees had no risk factors, and only 8.7% had three or more risk factors present. When this was compared to obese employees, only 11.6% had no risk factors, and 32.2% of obese employees had three or more risk factors present. Results showed that the average number of workdays lost increased across BMI categories and with increasing number of risk factors present. Among employees with three or more risk factors, overweight and obese employees lost 9.1 and 11.5 workdays, respectively, compared to normal weight employees who only lost 8.0 on average workdays annually. The trend was most pronounced among employees with zero risk factors, where overweight and obese employees lost 4.2 and 7.2 workdays, respectively, compared to normal weight employees who only lost on average 2.6 workdays annually. Overall results indicated that per employee per year, normal weight employees lost 3.99 workdays, overweight employees lost 5.61 workdays, and obese employees lost 7.72 workdays. This equates to an excess of 1.62 days for overweight employees, and 3.73 days for obese employees, when compared to normal weight employees. When the study population was taken into account, workdays potentially lost by overweight employees was 2785, and obese employees potentially lost 6460 more workdays (Tsai et al., 2008). The study calculated obesity-attributable absenteeism costs for the USA, but as it has a different currency to South Africa, comparisons cannot be made; thus, it will not be described.

Howard and Potter (2014) investigated the impact of overweight employees, and obesity on absenteeism in the workplace. In addition to that, they investigated whether obesity-related chronic health conditions mediated worker absenteeism. Data was collected from the National Health Interview Survey (NHIS) conducted by the CDC in the United States, and included 16 626 participants. The multivariate logistic regression suggested a dose-response pattern with increasing odds of absenteeism with increasing BMI. However, in support of the study conducted by Andreyeva et al. (2014), the likelihood of absence for overweight employees as compared to normal weight employees did not differ significantly. Conversely, the likelihood of absence was significantly higher with increasing category of obesity, as also observed in the study conducted by Andreyeva et al. (2014). The odds ratio (OR) of being absent for class I obese employees was 1.226 (22.6% higher), 1.572 (57.2% higher) for class II obese employees, and 1.346 (34.6% higher) for class III obese employees. In addition to the above, the authors investigated interactions with five chronic health conditions, namely T2DM, coronary heart disease, other heart disease, hypertension, and stroke.

The only significant interaction that was found was between class III obesity and T2DM; which increased the OR of absenteeism by 2.649 times (164.9%) in class III obese employees. This is significant as it means an employee with class III obesity who is not diabetic has a 34.6% higher likelihood of absenteeism, while an employee with class III obesity who is diabetic has a 164.9% likelihood of absenteeism; relative to the normal weight employees. This finding is supported by Kleinman, Abouzaid, Andersen, Wang and Powers (2014) and Sullivan et al. (2008). This is an important finding as it quantifies a moderating effect of a chronic health condition on the relationship between obesity and worker absenteeism, which has previously been undocumented (Howard & Potter, 2014). Laaksonen et al. (2007) and Kleinman et al. (2014) further support the association between BMI and obesity-related absenteeism.

One study that only partially supports the above findings, was conducted by Frone (2008) on 2722 American employees participating in the National Survey of Workplace Health and Safety. Initially, overall results indicated a significant relationship between obesity and absenteeism but when controlling for the two mediating variables (physical and mental health), the relation between obesity and absenteeism was no longer significant. Limitations to this study include self-reported measures such as height and weight, absenteeism, as well as physical and mental health.

Absenteeism related to illness has been shown to predict mortality and future disability pension. Understanding all the economic costs of obesity, including lost productivity, is critical for policymakers working on obesity prevention at any level (Laaksonen et al., 2007; Andreyeva et al., 2014). As indicated above, no studies regarding obesity-related absenteeism in employees in South Africa has been conducted. Thus, there is an urgent need to determine the effect of obesity-related absenteeism in South African corporate and industrial employees.

3.10.2 Presenteeism

Productivity losses are described through both absenteeism and presenteeism. ***Presenteeism*** refers to employees who are at work, but working at a reduced productivity rate due to feeling unwell, or working in times of illness; which leads to accrued costs by employees (Andreyeva et al., 2014; Howard & Potter, 2014). This may be due to a physical or mental health condition, which is more common among obese workers (Yu et al., 2015). Whereas absenteeism can be easily and objectively measured; presenteeism is subjective and it is more complex to determine financial losses due to reduced productivity. Presenteeism has been measured using various methods, and findings have been inconsistent (Goetzel et al., 2010; Bustillos et al., 2015; Yu et al., 2015).

Bustillos et al. (2015) investigated worker productivity relative to BMI in a Canadian population, taking part in the Canadian Community Health Survey. A total of 56 971 participants were included in the final analysis. Data related to age, gender, education, income, physical activity and chronic diseases were considered for possible confounding factors. Presenteeism was determined from the following question: "does a long-term physical condition or mental condition or health problem reduce the amount or kind of activity you can do at work?". Participants were asked to choose one of three possible responses: 1) sometimes, 2) often, or 3) never. Participants were said to have presenteeism if they answered with "sometimes" or "often". Prevalence of presenteeism for each of the BMI categories was 10.1%, 12.7%, 18.3%, 18.1%, and 16.2% for normal weight, overweight, obese class I, obese class II, and obese class III, respectively. When controlling for confounding factors, significant differences were only observed between the normal weight and obese class II employees. A higher prevalence of presenteeism was observed in women (13.8%) compared to men (11.4%), employees with less than secondary education (16.6%) compared to employees with post-secondary graduation (11.85), and lower income status (15.7%) compared to higher income status (11.1%). Significantly, higher presenteeism was observed in employees with increasing levels of physically inactivity, with a prevalence of 9.8% in physically active employees compared to 14.5% in physically inactive employees. Employees reporting one or more chronic conditions also had significantly higher presenteeism (21.9%) compared to employees reporting no chronic conditions (3.9%). Final analysis of results showed a weak but positive association between BMI and worker productivity. In the unadjusted analysis, the odds of presenteeism were higher for overweight categories (OR=1.30) and all obesity categories (OR=2.00); however, in the adjusted analysis, overweight (OR=1.16) and obesity (OR=1.49) were weakly associated with presenteeism. The authors found a direct relationship between BMI and several health conditions, which may be a confounding factor to the effect of increased BMI on presenteeism.

Yu et al. (2015) investigated health risk factors, including weight, associated with presenteeism in the Chinese population. The population included 1506 employees working at a petrochemical corporation. Presenteeism was determined using a questionnaire, from the work performance measurement portion of the Health Risk Appraisal. The questionnaire asked employees to recall their work performance during the previous 4-week period. Employees were asked to rate their own, as well as their co-workers work performance on a scale from 0 to 10; with 0 indicating the worst and 10 the best work performance. The presenteeism score was calculated as the monthly self-assessment work performance score divided by the evaluation score for co-workers' work performance. Calculated values ranged from 0.25 to 2.0, with scores lower than 0.25 assigned a value of 0.25, and scores over 2.0 assigned a value of 2.0. The defining point was set as a score of 1.0, with presenteeism being judged to exist when the presenteeism score was <1.0, and not to exist when the presenteeism score was ≥ 1.0. Prevalence of presenteeism was compared across socio-demographic status and health risk status. It was found that presenteeism was significantly higher in men (16%) than women (13%) ($p<0.05$), in employees aged 20-35 years (20%) than those aged 36-59 years (10%) ($p<0.05$), in current cigarette smokers (18% vs. 13%; $p<0.05$), and in current alcohol drinkers (17% vs. 14%; $p<0.05$). Presenteeism was also observed to be higher in employees who were insufficiently active versus those who were active (17% vs. 10%; $p<0.05$). Life ($p<0.01$) and job ($p<0.05$) dissatisfaction were both significantly associated with higher prevalence of presenteeism. An increasing prevalence of presenteeism was observed with increased BMI and this association was found to be significant ($p<0.05$). Prevalence of presenteeism for normal weight, overweight, and obese employees was found to be 10%, 15%, and 19%, respectively. The prevalence of presenteeism also increased with increasing health risk grade; this association was found to be significant ($p<0.01$). Prevalence of presenteeism increased from 3% for low health risk (<2 risk factors), to 9% for moderate health risk (3-4 risk factors), and finally to 27% for high health risk (≥5 risk factors). These findings are further supported by Kolbe-Alexander et al. (2008).

The current study is using the WHO Health at Work Survey to measure presenteeism, which requires participants to rate their own performance on a scale of 0-10, with 0 and 10 being their worst and best performance, respectively. This method was also used by Kleinman et al. (2014) to measure productivity levels associated with obesity. Employees were divided up into the following BMI categories: < 27 kg/m^2; 27-29.9 kg/m^2, and ≥ 30 kg/m^2. Several studies have used a lower band of approximately 27 kg/m^2 for being overweight, particularly when studying individuals with comorbid conditions (Soteriades, Hauser, Kwawachi, Christiani, & Kales, 2008; Pai et al., 2009). The study consisted of a large cohort, with 39 969 employees in the lowest BMI category (< 27 kg/m^2), 14 281 in the overweight category, and 18801 in the obese category. The Health at Work Survey productivity scores were significantly lowest in the obese employees (8.23), but no significance was observed with the overweight (8.33) and normal weight (8.34) employees.

The above results are supported by Goetzel et al. (2010) who measured productivity using the eight-item work limitations questionnaire. The questionnaire asked employees to rate, for the previous two weeks, the degree to which they experienced limitations in four domains: 1) time management, 2) physical demands, 3) mental/interpersonal, and 4) output demands. Scores ranged from zero (limited none of the time) to 100 (limited all of the time). Results were analysed for 10 026 employees from various work sites involved in obesity management interventions, across the United States. Compared to normal weight employees, presenteeism rates for overweight employees were 10% higher (non-significant), and obese employees were 12% ($p<0.01$). Interestingly obese employees also had a significantly higher rate of doctors' visits ($p<0.01$) when compared to normal weight employees, however overweight employees were no different to normal weight employees.

Though difficult to measure, numerous authors suggest that the negative financial impact of presenteeism is greater than absenteeism (Goetzel et al., 2010; Bustillos et al., 2015; Yu et al., 2015). In South Africa, the prevalence of overweight and obesity with presenteeism-related productivity losses has not yet been investigated.

In addition to absenteeism and presenteeism, obesity may lead to an increase in disability, which refers to a short-and long-term absence from work due to a physical or mental incapability to meet occupational demands. Disability costs arise when illness-related long-term absence from the workplace leads to productivity losses or disability payments from insurance companies (Hammond & Levine, 2010; Lehnert et al., 2013). Premature mortality refers to years of life lost due to obesity (Hammond & Levine, 2010), and this further contributes to lost productivity costs (Lehnert et al., 2013). The current study however, will not be investigating disability costs associated with obesity.

3.10.3 Burden of Disease in South Africa

In South Africa thus far, only two studies have investigated the burden of disease, but as these studies were conducted over 10 years ago, they are outdated (Joubert et al., 2007; Kolbe-Alexander et al., 2008). The study conducted by Joubert et al. (2007) estimated the burden of disease attributable to excess body weight for the year 2000, and was not specific to employees in South Africa. Kolbe-Alexander et al. (2008) investigated absenteeism and presenteeism associated with various chronic disease risk factors in South African employees, however no comparisons across BMI groups were made.

Joubert et al. (2007) used the WHO Comparative Risk Assessment Study methodology to estimate the disease burden attributable to excess body weight. The population-attributable fraction (PAF) was determined by the prevalence of exposure to the risk factor in the population and the relative risk (RR) of disease occurrence given exposure. The study used BMI as a measure of excess body weight. Though the current study will not be reporting PAFs, the study conducted by Joubert et al. (2007) is the only study in South Africa which has investigated the burden of disease attributable to excess body weight. Therefore, it is important to report on the trends observed.

Type II diabetes mellitus had the highest PAF, with 94% of the burden in females and 75% in males attributable to BMI above 21 kg/m^2. The relative risk associated with 1 kg/m^2 increase in BMI for ischemic heart disease, hypertensive disease, and T2DM ranged 1.02-1.13, 1.07-1.11, and 1.18-1.47, respectively. Excess body weight accounted for 11579 male and 24924 female deaths; which constituted 4.2% of the total male and 10.1% of total female deaths in South Africa in 2000. Type II diabetes mellitus accounted for the highest number of deaths in females, followed by hypertension. The trend was different in males, with ischemic heart disease being the highest cause of death, followed by T2DM then hypertensive disease. In South Africa in 2000, excess body weight was ranked fifth in terms of causes of death.

An interesting trend observed in this study, which has not been observed in other countries, is the gender difference. Mean BMI in females is higher than males in South Africa, and compared to females in other countries. Furthermore, the prevalence of obesity in females (37.3%) is more than double that of males (15.7%) in South Africa, whereas in the United States and Malaysia the obesity trends are similar between genders. Of further concern in South Africa is that T2DM, cardiovascular conditions and selected cancers attributed to excess body weight are higher than the global estimate, particularly in women. The observed gender difference can possibly be attributed to a cultural factor, where among many black African women being overweight is perceived to be advantageous and associated with acceptance. An overweight body image is associated with dignity, respect, wealth, strength, happiness and health, as well as with being treated well by their husbands.

The aim of the study conducted by Kolbe-Alexander et al. (2008) was to determine the occurrence of risk factors among employees in the corporate sector, and their association with absenteeism and presenteeism. Data was collected from 1954 employees participating in wellness days that took place at 18 companies between January and June 2006. Prevalence of overweight employees was 32%; 16% were classified as obese, and only 44% were classified as being normal weight. When compared to data collected by the South African Demographic Health Survey for the general population in 2002, men in the study had a higher prevalence of being overweight and of obesity compared to the general male population, while women had a lower prevalence of being overweight and of obesity. A trend observed in employees screened as part of this study reported lower levels of physical activity than the general population. Further analysis of results indicated that higher levels of physical activity were associated with significantly fewer days away from work in the previous month. Even one day of physical activity per week was associated with significantly reduced absenteeism compared to employees who were inactive; further reductions were observed with 2 days of physical activity. Though this is not compared across BMI groups, the trend seen is significant to the treatment of obesity and to reducing the burden of disease. Increased physical activity associated with decreased risk of disease, greater levels of productivity and decreased absenteeism is an important observation in the combat against obesity within the corporate sector.

3.11 Socio-Ecological Model

In the current obesity epidemic, costs of obesity are rising; thus, policymakers, insurers, and employers have expressed a growing interest in methods of improving health while lowering costs (DeJoy et al., 2008; Baicker, Cutler, & Song, 2010). Researchers and organizations alike have used various models to design and implement programmes to prevent and combat obesity (Bakker & Demerouti, 2007; Zapka, Lemon, Estabrook, & Jolicoeur, 2007; Eisenmann et al., 2008). The most commonly used model is the socio-ecological model (SEM), introduced as a conceptual model in the 1970s by Urie Bronfenbrenner, and formalized as a theory in the 1980s (Zapka et al., 2007; DeJoy et al., 2008; Davidson, Jurkowski, & Lawson, 2013). The application of social and ecological theories and models, focuses on several goals: to explain the person-environment interaction, to improve people-environment interactions, and to improve environments so they support the expression of individuals' dispositions (Wilson et al., 2007; Eisenmann et al., 2008). Ecological frameworks state that human behaviours are influenced by complex interrelationships of individual characteristics and their social and normative contexts, physical environment factors, as well as policies (Zapka et al., 2007; Eisenmann et al., 2008; Davidson et al., 2013). The socio-ecological model is illustrated in Figure 3.2 below.

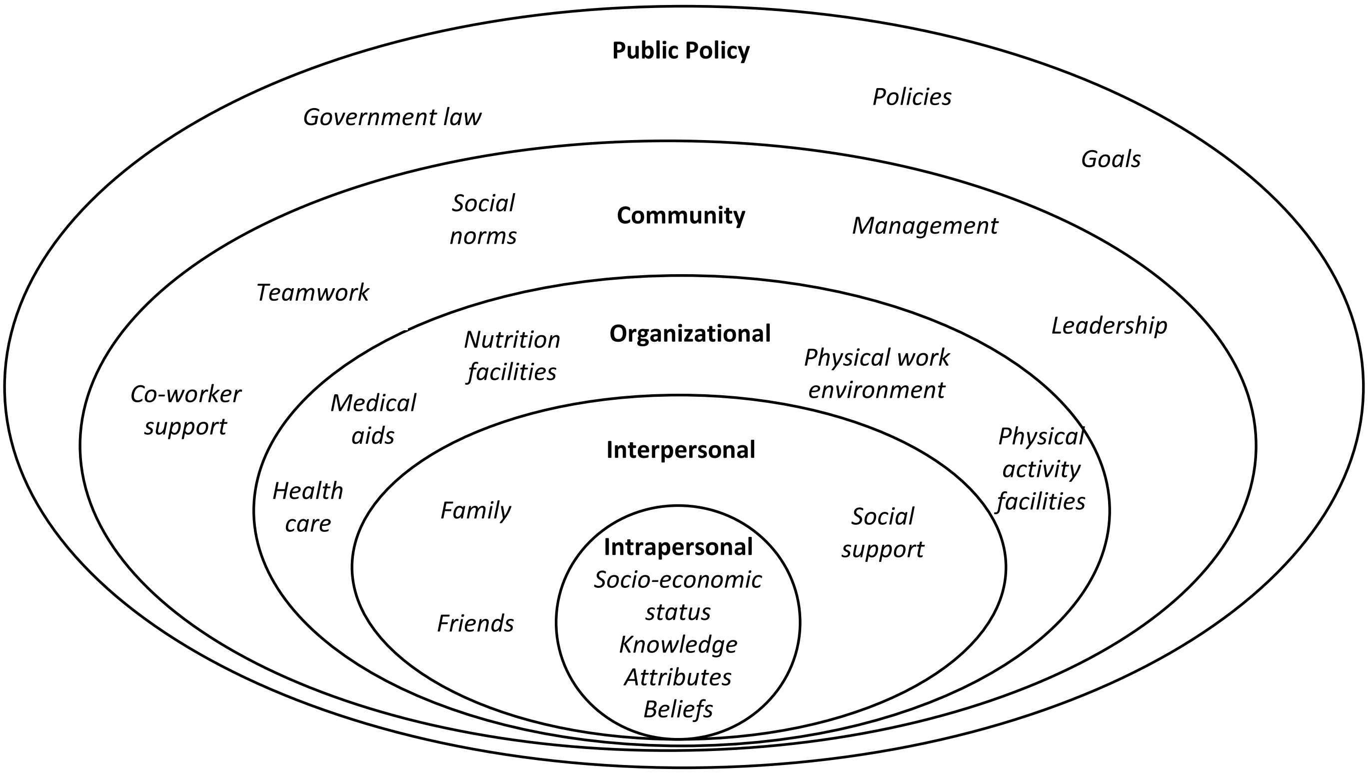

Figure 3.2 Socio-ecological model as described by Wilson et al. (2007), Zapka et al. (2007), and Eisenmann et al. (2008).

The model includes a series of concentric rings that describe the various personal, environment, and societal factors that influence dietary habits and physical activity habits. The model also proposes that there are multiple leverage points, illustrated by the concentric circles, that may be important in modifying nutrition, and physical activity behaviour. The proximal circles refer to the features of the micro-environment that affect physical activity and eating behaviour choices; while the distal circles refer to factors that can, directly or indirectly, shape attitudes, beliefs, and behaviours through the proximal circles. The above model has been adapted and applied by researchers and organizations in an attempt to combat obesity within the workplace (Zapka et al., 2007; Eisenmann et al., 2008; Davidson et al., 2013).

The inner circle describes the intrapersonal characteristics of individuals, such as knowledge, attitudes and beliefs, socio-economic status, life experience, perceptions, and preferences. Intervention objectives need to include understanding individuals' attitudes and beliefs, education on healthy behaviours, and supporting individual change and the changes needed in the environment to promote learning and change in behaviours (Zapke et al., 2007; Punnett, Cherniack, Henning, Morse, & Faghri, 2009).

The second circle describes relationships with family and friends, as well as social support. Intervention strategies need to be designed to foster social support related to physical activity and healthy eating, within existing social networks (work-based relationships) (Bakker & Demerouti, 2007; Zapke et al., 2007).

The third circle describes organizational characteristics, including the physical environment in which the employees work, as well as the resources available to employees. The physical work environment refers to staffing patterns, overtime, work scheduling, department procedures, task design, as well as physical job features such as workstation dimensions, heavy lifting, postures maintained, and repetitive tasks (Punnet et al., 2007; Zapke et al., 2007). Site characteristics also form part of the physical environment and refer to the arrangement of buildings, parking, safety and security, footpaths, signage on promoting physical activity, facilities for securing bicycles, stairs and elevators, and showers and changing facilities (DeJoy et al., 2008). Furthermore, the physical environment includes the food and physical activity environment; which incorporates aesthetic appearance, signage and pertinent information regarding healthy habits, location and options (Zapke et al., 2007; DeJoy et al., 2008). Resources include health care, health clinics and medical aid, as well as nutrition and recreation facilities.

The fourth circle represents the community within the workplace, shared expectations, standards or social norms, principles, teamwork and co-worker support. Media and social marketing play an important role in determining social norms, as well as for reinforcing healthy habits (Zapke et al., 2007). Community within the workplace also includes leadership and management, and the examples they set, and their support of health initiatives (Bakker & Demerouti, 2007; Punnet et al., 2009).

The fifth circle represents public policy, incorporating government laws and policies. This may include information regarding obesity trends and the burden of obesity, populations at risk, and national goals and prevention strategies. It also includes national organizations and professional associations, recommendations of recognized bodies, regulations that support health screening, clinical screening guidelines, and effective interventions. Policies and services related to physical activity and cafeteria services within the workplace may play a significant role in the adoption of healthy behaviours (Zapka et al., 2007). Policies could include the use of rewards or incentives for continued healthy behaviour, and for subsidizing medical aids and gym membership (Bakker & Demerouti, 2007; Zapke et al., 2007; Punnet et al., 2009; Sallis & Glanz, 2009).

As illustrated in the model above, policies, sociocultural, and structural environments may all contribute to the development of obesity. Within the workplace, levels of potential influence include the individual employee, the physical work environment, as well the organization itself. Interventions that target these multiple levels may be effective in combating obesity (Zapka et al., 2007; DeJoy et al., 2008; Hymel et al., 2011). There are numerous reasons as to why the workplace is an ideal setting for interventions targeting obesity and health-related behaviours; including the following:

1. The adult population spend a significant portion of their day at work.
2. Workplace programmes can reach segments of the population who may not have access to health information in other settings.
3. The work environment can be utilized to promote and provide access to healthy lifestyles; this includes manipulation of the physical environment to positively affect health behaviours.
4. The workplace creates a community where employees share a common purpose and expectations, social and organizational supports are readily available, and communication with employees is straightforward due to pre-established and well-organized communication channels.
5. Policies can be implemented to encourage positive health behaviours and participation in health programs via the use of financial and other forms of incentives (DeJoy et al., 2008; Hymel et al., 2011).

Numerous researchers and organizations have used adapted versions of the SEM to design intervention programms to counteract obesity (Bakker & Demerouti, 2007; Zapka et al., 2007; Eisenmann et al., 2008). Considering the SEM as well as the results of the study, the researcher will develop a health promotion model and adapt it to the South African context to suggest intervention strategies to combat obesity in corporate and industrial employees in South Africa. The model will be presented in chapter 7.

3.12 Significance of the Study

One researcher questioned whether it is possible to put a monetary value on health (Edington & Schultz, 2008). It could be argued that health is invaluable, and a price tag cannot be attached. However, for years researchers have attempted to quantify the economic value of health and loss of health due to obesity.

As adults spend a large portion of their time at work, the workplace has been identified as the ideal setting in which to reach a large proportion of the adult population, and positively influence the health risk profile of employees. In recent years, occupational health has shifted its focus to the health risk profiles of employees, non-communicable diseases, and the subsequent effect on individual health, as well as the economic costs to the companies. Findings from health risk assessments will provide companies with the health profile status of their employees, and may enable them to project future direct and indirect costs. This information is vital for the development and implementation of intervention strategies to prevent and reverse obesity and its adverse health effects. These interventions may result in subsequent reductions in absenteeism, reduce presenteeism, and ultimately lower the financial burden associated with obesity. Thus, being able to quantify the value of an employee's health to an organization will result in benefits to the employee as well as the organization.

As indicated, extensive research into obesity regarding prevalence, the association of various lifestyle and work-related factors, the association of various comorbidities, quality of life, productivity and economic burden, has been done. A large proportion of the research focused on the general population, with a smaller proportion conducted on employees within a work environment. Most of these studies were done in the United States, with a small portion of this research being done in other countries. In South Africa, research on obesity is substantially less, and the majority of research focusses on children and adolescents. Apart from the two studies referenced above, no other research has been done within the workplace in South Africa regarding obesity.

The contribution this study will make to the body of knowledge of obesity in South Africa includes:

- the prevalence of overweight employees and obesity in the employee population in South Africa,

- the lifestyle and work-related factors associated with obesity, such as physical activity habits, sedentary habits, dietary habits, sleeping patterns, alcohol consumption, smoking status, and work hours,
- the prevalence of comorbidities and risk factors associated with obesity,
- quality of life,
- the association of excess body weight with productivity, namely absenteeism and presenteeism,
- the contribution of absence frequency rates and associated costs to the economic burden of excess body weight in South Africa, and
- the development of a health promotion model, unique to SA, to address obesity in the workplace.

The current study is pioneering as it will provide information, for the first time, about overweight and obese employees. This will be vital for designing and implementing wellness intervention programmes to combat obesity in South Africa. Thus, this information will be used to design a model that can be used to prevent and reduce obesity and its associated costs in South Africa.

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CHAPTER FOUR

PILOT STUDY ARTICLE

Effect of Obesity on the Work Health-Related Behaviours and Quality of Life of South African Mining Employees: A Pilot Study

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Abstract

Background: Obesity rates have increased precipitously with a significant economic impact.

Aim: The aim of this study was to investigate the effect of obesity on the work health-related behaviours and quality of life (QOL) of employees of mining companies in South Africa.

Methods: Forty (40) subjects from three mining companies were assigned to three BMI categories: normal weight (18.5–24.9 kg/m^2; n = 10), overweight 25.0–29.9 kg/m^2; n = 15), and obese (≥30.0 kg/m^2; n = 15). Subjects wore a BodyMedia®FIT armband for seven consecutive days, and completed: 1) the WHO QOL; and 2) the WHO Health at Work survey.

Results: There were significant differences in calorie expenditure (p = 0.033), activity patterns (p = 0.017), and number of steps walked daily (p = 0.018) between the overweight and obese groups. Those of normal weight described being significantly (p = 0.041) more satisfied with their QOL and their leisure time activities and income (p = 0.017) than the

obese. Almost all the significant differences with regard to work health-related behaviours were between the overweight and obese groups.

Conclusion: Results provide preliminary support for targeting weight loss as obesity may adversely influence employees' work health-related behaviours and QOL.

Keywords: BodyMedia®FIT armband, Body mass index, Health-related behaviours, Lifestyle habits, Obesity, Physical activity patterns.

4.1. Introduction

Obesity rates are rising rapidly around the world and becoming a growing concern in public health, with people becoming ever more sedentary (Sartorius, Veerman, Manyema, Chola, & Hofman, 2015). Obesity affects 500 million people worldwide and this burden is projected to double by 2030 (Hill, Peters, Catenacci, & Wyatt, 2008; WHO, 2014). Within sub-Saharan Africa, the South African population shows the highest prevalence of obesity (Micklesfield, Lambert, Hume, Chantler, Pienaar, Dickie, & Goedecke, 2013), indicated to be nearly 54%, (WHO, 2015a).

Obesity is associated with increased morbidity and mortality (Hill et al., 2008; WHO, 2015b; James, 2005). Apart from the increased risk of developing a variety of medical conditions such as cardiovascular disease (Tibazarwa, Ntyintyane, Sliwa, Gerntholtz, Carrington, Wilkinson, & Stewart, 2009), metabolic syndrome, hypertension (van Zyl, van der Merwe, Walsh, Groenewald, & van Rooyen, 2012) and diabetes (Peer, 2012), obesity appears to adversely affect an individual's capacity to live a full and active life. Thus, it has become increasingly evident that the problems associated with obesity are not simply restricted to causing or exacerbating medical conditions; this state also appears to have a substantial effect on a person's functional capacity and QOL (de Zwaan, Petersen, Kaerber, Burgmer, Nolting, Legenbauer, & Herpertz, 2009; Taylor, Forhan, Vigod, McIntyre, & Morrison, 2013). Obesity has been associated with impaired QOL in a variety of domains, including physical functioning, adequate sleep, occupation, self-esteem, social relationships and home environment (de Zwaan et al., 2009; Li, O'Connor, Zhou, & Campbell, 2015). Additionally, obese individuals seem unconcerned about their health behaviours relating to their activity levels, number of steps taken daily, calorie expenditure and hours slept (Li et al., 2015; Gonnissen, Adam, Hursel, Rutters, Verhoef, & Westerterp-Plantenga, 2013; Dwyer, Hosmer, Hosmer, Venn, Blizzard, Granger, & Dunstan, 2007; Leibel, Rosenbaum, & Hirsch, 1995).

The QOL and health behaviours of employees of different weight working for South African mining companies, however, are unknown.

Of further concern is that the obesity epidemic directly impacts a nation's workforce, resulting in impaired productivity and increased expenditure on health care (Barkin, Heerman, Warren, & Rennhoff, 2010). Also, employees manifest different health behaviours at work, including poor dietary habits, poor control over stress levels, and decreased physical activity levels having a negative effect on their body composition. In this regard researchers indicate that employees' working conditions contribute to the above unhealthy behaviours (Miranda, Gore, Boyer, Nobrega, & Punnett, 2015). For example, obesity has been linked with night work, long working hours, sedentary work, psychosocial job strain, and job insecurity (Taylor et al., 2013; Miranda et al., 2015; Quist, Christensen, Christensen, Aust, Borg, & Bjorner, 2013; Escoto, French, Harnack, Toomey, Hannan, & Mitchell, 2010). Nonetheless, the literature is inconsistent on any of these putative associations. Among possible reasons both the lack of formal theoretical hypotheses and, somewhat in contrast, an incomplete set of risk factors are suggested (perhaps stemming from undue reliance on a priori models at this relatively early stage of accruing evidence) (Quist et al., 2013; Solovieva, Virtanen, & Viikari-Juntura, 2013). Many of these studies have analysed data from the general, working population abroad with no studies focusing on South African companies. To this end, the pilot study reported here investigated the impact of obesity on the QOL of mining employees and the status of their health at work. It formed part of a comprehensive study that aims to assess the impact of obesity and absence due to illness on economic costs incurred by South Africans at work.

4.2. Methods

This explorative-descriptive study used quantitative methods to describe and compare physical activity, sleep duration, calorie intake and expenditure, lifestyle habits, QOL and health of three select groups of employees.

4.2.1 Subjects

Forty (40) subjects between the ages of 24–49 years (mean age 35.9 ± 7.9 years) from three South African mining companies volunteered for the study. Information about the research project were made available through the company's intranet platform. Recruitment of subjects was limited to admin personnel, and included professionals, managers, and clerical and administrative support. They were assigned to one of three groups, each comprising both men and women, according to their body mass index (BMI) – normal weight subjects with a BMI of 18.5–24.9 kg/m^2 (n = 10), overweight subjects with a BMI of 25.0–29.9 kg/m^2 (n = 15) and the obese group with a BMI of ≥30.0 kg/m^2 (n = 15) (Thompson, Gordon, & Pescatello, 2014). The clinical characteristics of the subjects are displayed in Table 4.1. The study sample was not differentiated by ethnic background, even though ethnicity may have an influence on the development of obesity.

Table 4.1: Subject characteristics (M ± SD)

Variables	Normal weight (n = 10)	Overweight (n = 15)	Obese (n = 15)
Age (years)	34.7 ± 9.4	36.6 ± 7.5	36.8 ± 7.6
Height (cm)	172.3 ± 10.3	167.6 ± 11.7	165.3 ± 7.3
Weight (kg)	65.5 ± 12.2	76.6 ± 10.9	104.7 ± 29.0
BMI (kg/m^2)	22.2 ± 1.95	27.2 ± 1.63	36.0 ± 4.67

Note. M = mean; SD = standard deviation.

4.2.2 Measuring Instruments

The measurement criteria used (described in detail below) were body composition (height and body mass), physical activity (based on the results of using a BodyMedia®FIT accelerometer), QOL (WHO QOL questionnaire), and work health-related behaviours (WHO Health at Work survey questionnaire).

4.2.2.1 Body Composition Measurements

Weight was recorded on a calibrated Robusta Seca 813 scale (Teraoka, South Africa) according to a standardized protocol (Thompson et al. 2014). Measurements were taken to the nearest 0.1 kg. Height was measured in centimetres using a mobile stadiometer rod with a sliding ruler. Height and weight were used to calculate BMI (as weight/height^2 – kg/m^2) according to the protocol of Thompson et al. (2014).

4.2.2.2 BodyMedia®FIT Measurements

The BodyMedia®FIT armband was used to measure energy expenditure (including steps taken), physical activity, exercise intensity, and sleep efficiency (duration and quality) (BodyMedia, 2014). All thirty subjects wore the armband for seven days, for 23 hours a day. They were given a thorough explanation of the purpose of the study, and received specific instructions on the use of the armband. Subjects were instructed to wear it on the back of the left upper-arm (triceps), with the silver sensors in contact with the skin at all times. The armband was removed only while the wearer was bathing, showering or swimming as it is not waterproof. After the seven-day measurement period, all the armbands were collected, and the data were downloaded for analysis using BodyMedia® software on the computer.

4.2.2.3 Quality of Life Measurements

The WHO Quality of Life questionnaire (WHOQOL) was used to measure subjects' QOL in various respects, such as health status, effect of pain, life enjoyment and meaning, ability to concentrate, sleep and energy levels, self-esteem and bodily appearance, ability to perform activities of daily living, money and leisure, work environment, and personal relationships (Harper, 1998). When answering the questions subjects were asked to keep in mind their standards, hopes, pleasures, and concerns. The questions were answered in relation to the previous four (4) weeks of one's life. Subjects were required to answer the questions according to a Likert scale, with answer choices ranging from very poor/very dissatisfied/not at all/always to very good/very satisfied/an extreme amount/never.

4.2.2.4 Work Health-Related Behaviour Measurements

The WHO Health at Work survey involved a comprehensive questionnaire covering information such as diagnosed diseases and conditions, lifestyle habits such as smoking and alcohol consumption, ability to concentrate, feelings of fatigue, problems with sleep, accidents and injuries in the workplace, visits to medical professionals, working hours, absenteeism, productivity, and demographic information (Kessler, Barber, Beck, Berglund, Cleary, McKenas, & Wang, 2003). Questions were answered according to a Likert scale, with options ranging from no I don't have this condition/poor/nearly every day/all of the time to yes, I have this condition and I am currently receiving professional treatment/excellent/never/none of the time.

4.2.3 Statistical Analysis

The experimental data were analysed using the SPSS software program. For the analysis of the BodyMedia®FIT armband results the Kolmogorov-Smirnov test was performed to determine if the data were normally distributed ($p > 0.2$). As this proved to be the case, a parametric technique was used to analyse the data. A simple analysis of variance (ANOVA) was used to determine if there were significant differences between the three study groups (normal, overweight and obese). Significance was set as $p < 0.05$. Once significant differences were established, a Tukey's HSD test was conducted to determine between which specific groups the differences lay. For the analysis of the various questionnaires, Pearson's chi-squared test was used to determine whether there was a significant difference between the expected and the observed frequencies in one or more categories.

4.2.4 Validity and Reliability of Measuring Instruments

The validity and reliability of the data were ensured as follows:

Body mass and height were measured according to standardized methods (Thompson et al., 2014).

Valid and reliable questionnaires were used. Domain scores produced by the WHOQOL correlate highly (0.89 or above) with WHOQOL-100 domain scores (calculated on a four-domain structure). WHOQOL domain scores demonstrated good discriminant validity, content validity, internal consistency and test-retest reliability (Harper, 1998; Skevington, Lotfy, & O'Connell, 2004).

The WHO Health at Work survey has been used previously, and proved to be valid and reliable (Kessler et al., 2006).

The BodyMedia®FIT armband has been clinically proven accurately to measure physical activity levels and calories expended (de Cristofaro, Pietrobelli, Dragani, Malatesta, Arzeni, Luciani, & Battistini, 2005; Robertson, 2004).

4.3. Results

The work health-related behaviours of the subjects are displayed in table 4.2; table 4.3 explains where significant differences lie between groups. Significant differences were noted between the three groups for calorie expenditure ($p = 0.033$), amount of daily activity ($p = 0.037$), number of steps taken daily ($p = 0.017$), and hours slept per night ($p = 0.045$). No significant differences were seen in calorie intake ($p = 0.227$), sleep efficiency ($p = 0.266$), and hours spent lying down ($p = 0.216$), with average physical activity intensity approaching significance ($p = 0.095$).

Table 4.2: Work health-related behaviours of normal, overweight and obese subjects

Variables	Normal	Overweight	Obese	F	P
Calex (kCal)	2,599 ± 490	3,256 ± 839	2,514 ± 514	3.88	0.033*
Calin (kCal)	1,314 ± 425	1,596 ± 522	1,205 ± 491	1.57	0.227
Physical Activity (hours)	3.74 ± 0.91	3.93 ± 1.27	2.30 ± 1.57	4.77	0.037*
Steps (steps/day)	6,973 ± 1,412	8,322 ± 1,733	5,378 ± 2,602	4.68	0.017*
Pa int (METs)	1.79 ± 0.27	1.85 ± 0.29	1.58 ± 0.29	2.57	0.095
Sleep ef (%)	79.0 ± 6.55	80.3 ± 7.43	74.2 ± 10.3	1.39	0.266
Lying (hours)	9.17 ± 0.87	8.16 ± 1.64	8.35 ± 1.10	1.63	0.216
Sleep (hours)	7.21 ± 0.82	6.41 ± 0.69	6.18 ± 1.00	3.50	0.045*

Note. *p < 0.05; Calex = calorie expenditure; Calin = calorie intake; Activity = activity recorded; Steps = steps taken per day; Pa int = physical activity intensity; METs = metabolic equivalent; Sleep ef = sleep efficiency; Lying = number of hours lying down per day; Sleep = number of hours slept per day.

It is clear from table 4.3 that significant differences are only noted between the overweight and the obese groups with regard to calorie expenditure (p = 0.033), physical activity patterns (p = 0.037) and number of steps taken (p = 0.017). Overweight individuals reported being significantly more active and took more steps daily than obese individuals. The physical activity levels of the normal weight group were higher than those of the obese, and approached significance (p = 0.057). No significant differences were seen between the normal weight and overweight groups with regard to calorie expenditure, physical activity, and steps taken. Overweight subjects spent less time sleeping than those of normal weight, yet the sleep efficiency of the overweight group was greater than that of normal subjects (though not significantly different; Table 4.2). Table 4.3 indicates that those of normal weight recorded the most hours of sleep, with the obese group sleeping the least. Those of normal weight spent significantly (p = 0.045) more time sleeping, and demonstrated greater sleep efficiency than the obese.

Table 4.3: Significant differences specific to normal, overweight and obese subjects

Calex (kCal)	Normal (n = 10)	O/weight (n = 15)	Obese (n = 15)
Normal (M = 2599)			
O/weight (M = 3256)	0.103		
Obese (M = 2514)	0.944	0.033*	
Physical Activity (hours)			
Normal (M = 3.74)			
O/weight (M = 3.93)	0.963		
Obese (M = 2.29)	0.057	0.037*	
Steps (steps/day)			
Normal (M = 6973)			
O/weight (M = 8322)	0.461		
Obese (M = 5378)	0.231	0.017*	
Sleep (hours)			
Normal (M = 7.21)			
O/weight (M = 6.41)	0.213		
Obese (M = 6.18)	0.045*	0.835	

Note. O/weight = overweight; *$p < 0.05$.

The results of the WHO QOL questionnaire indicate some significant differences between the study groups (Table 4.4). All of the significant differences were found between the normal weight and obese subjects. The first significant difference was in the QOL ratings, for which normal weight subjects reported being significantly ($p = 0.041$) more satisfied with their QoL than the obese. Quality of life is also associated with perceived satisfaction with income and leisure activities as well as general contentment with life. The results showed a significant difference ($p = 0.025$) between normal weight and obese subjects in these respects. The largest significant difference ($p = 0.017$) was between normal weight and obese subjects with regard to their general satisfaction with life; those of normal weight reported being ‘very satisfied with life in general’ compared to the obese, who were only ‘satisfied with life’.

Table 4.4: WHO QOL questionnaire variables between normal, overweight and obese groups

WHO QOL variable	χ^2 value	df	p
Q1: Quality of life	13.13	6	0.041*
Q2: Satisfaction with health	10.60	6	0.101
Q3 & Q4: Effect of pain & medical treatment on quality of life	7.29	6	0.295
Q5 & Q6: Life enjoyment & meaning	6.68	4	0.154
Q7: Ability to concentrate	9.65	6	0.140
Q8 & 9: Safety & health of physical environment	6.28	4	0.179
Q10: Energy levels	8.57	6	0.199
Q11: Bodily appearance	6.40	6	0.380
Q12–Q14: Money & leisure	11.16	4	0.025*
Q15-Q25: Satisfaction with sleep, work, self, relationships, living space, health services & transport	8.14	2	0.017*
Q26: Negative feelings	7.22	6	0.301

Note. *$p < 0.05$.

Table 4.5 shows the results of the WHO Health at Work survey relating to subjects' diagnosed diseases/state of health, lifestyle habits such as smoking and alcohol consumption, ability to concentrate, feelings of fatigue, mental health symptoms, diagnosed chronic conditions, bothersome symptoms, and productivity. The section of the WHO Health at Work survey relating to concentration asked subjects if they had difficulty organizing matters for a work-related task, problems remembering appointments, delayed tasks requiring concentration, or if they fidgeted if they had to sit still for an extended period. There was a significant difference ($p = 0.032$) between the normal weight and obese groups with regard to problems with concentration; whereas the former reported rarely experiencing such problems, the obese had difficulty with their concentration more often. Although no other significant differences were found between the three groups with regard to the health at work survey, the difference between smoking habits of obese subjects compared to normal weight subjects approached significance ($p = 0.091$).

Table 4.5: WHO Health at Work survey variables for normal, overweight and obese groups

WHO Health at Work variable	Value	df	p
A1 & A2: Overall & mental health	6.06	8	0.640
A3: Diagnosed orthopedic & chronic conditions	7.96	6	0.241
A7: Diagnosed chronic conditions	6.04	8	0.643
A9: Smoking	10.92	6	0.091
A10: Drinking habits	11.68	8	0.166
A10a: Average number of drinks/day	4.51	4	0.341
A10b: Frequency of consuming >5 drinks/day	8.46	6	0.207
A11–A13: Irritability	1.22	2	0.542
A15: Concentration	16.87	8	0.032*
A16: Tiredness	11.22	8	0.190
A18: Bothersome abdominal symptoms	7.94	6	0.242
A20: Shortness of breath	1.81	2	0.404
A27: Bothersome symptoms	6.45	6	0.375
A28: Mental health symptoms	0.73	2	0.696
B12: Productivity	2.85	2	0.241

Note. *$p < 0.05$.

4.4. Discussion

The pilot study took place and to date no evidence is available on the impact of obesity on the work health-related behaviours, quality of life and health status at work of select employees from mining companies in South Africa. Our preliminary findings indicate that almost all the significant differences with regard to their work health-related behaviours, except for the number of hours slept, were between the overweight and obese groups. This was unexpected as it was postulated that the main differences would be between the normal weight and obese subjects. The fact that our study subjects were divided into three different groups on the basis of only BMI may have contributed to these surprising findings. BMI measures excess weight rather than body fatness and does not differentiate between bone, muscle and fat (Burkhauser & Cawley, 2008); thus, lean body mass was not considered. Muscle mass compared to overall body weight needs to be considered as a more reliable predictor of resting energy expenditure (Johnstone, Murison, Duncan, Rance, & Speakman, 2005; MacArdle, Katch, & Katch, 2010). It may be possible that some of the subjects placed in the overweight group were actually physically active individuals, with relatively large amounts of muscle mass, thus explaining the significant differences in the two components of physical activity (amount of daily activity and number of steps taken per day) of the study. Previous findings in this regard are inconsistent: Chan, Ryan, and Tudor-Locke (2004) indicated that BMI is not significantly related to changes in step number; Dwyer et al. (2007) found an inverse association between number of daily steps and obesity; and Li et al. (2015) reported differing patterns of physical activity exhibited by normal weight, overweight, and obese people which are consistent with their weight status – leaner people are more physically active.

When analysing total calorie expenditure, a significant difference was once again found between overweight and obese individuals, such that the former showed higher total calorie expenditure than the obese. Basic energy accounting, in terms of which individuals expend calories in three ways, namely basal metabolic rate (BMR), diet-induced thermogenesis as well as energy spent on daily physical activity, may explain the difference between the overweight and obese individuals (McArdle et al., 2010; Cutler, Glaeser, & Shapiro, 2003). BMR accounts for approximately 60% of total energy expenditure, and includes the metabolic cost of processes such as the maintenance of body systems and resting cardiopulmonary activity. The thermic effect of feeding accounts for approximately 10% of total energy expenditure, and refers to the calories expended in the digestion, transport, and assimilation of nutrients. Energy expended during physical activity represents approximately 30% of total energy output (McArdle et al., 2010). As indicated earlier, the overweight subjects in our study were significantly more physically active than the obese group, possibly with a greater muscle mass, and therefore they would have had a higher BMR due to their metabolically active musculature. In agreement with findings by other researchers, an elevated BMR, in conjunction with more physical activity performed, could explain the higher calorie expenditure of the overweight group compared to the normal weight and obese groups (Cutler et al., 2003).

Our study's finding that individuals of normal weight spent significantly more time sleeping, and enjoyed greater sleep efficiency, than the obese group was consistent with previous observations that less sleep may contribute to weight gain (Gonnisen et al., 2013; Nishitani, Sakakibara, & Akiyama, 2012), and that weight gain may lead to reduced sleep (Nishitania et al., 2012; Fogelholm, Kronholm, Kukkonen-Harjula, Partonen, Partinen, & Härmä, 2007).

A large body of evidence suggests that obesity has been associated with an impaired QoL in a variety of domains, such as physical functioning, self-esteem, health status, ability to enjoy life, social relationships, and sleep disorders (de Zwaan et al., 2009; Taylor et al., 2013), which support the findings of our study. However, Atlantis and Baker reported a weak relationship between obesity and QOL (Atlantis & Baker, 2008).

The significant difference between normal weight and obese subjects with regard to problems with concentration — such that obese subjects experienced difficulty with their concentration more often — are consistent with previous research (Barkin et al., 2010; Forhan, Law, Taylor, & Vrkljan, 2012). Also reflecting other reports, our study found that fewer normal weight subjects smoked than their obese counterparts (Miranda et al., 2015).

4.5. Conclusion

The preliminary results have added to the body of knowledge on the work health-related behaviours, QOL and health status at work of South African mining employees; more specifically and quite surprisingly, overweight subjects expended more calories and were physically more active than their obese counterparts. It was expected that any significant difference would be found between obese and normal weight individuals. However, with regard to the QOL and health status of our sample, our results correlate with previous findings that obese individuals also had a poorer perceived quality of life and concentration levels than those of normal weight.

The pilot study warrants further studies to confirm the impact obesity may have on employees' physical and mental health, functional capacity, and quality of life. Furthermore, the present pilot study suggests that these results needs to be acknowledged by those at school, at work generally, as well as in South Africa at large, to help combat obesity in the country.

Compliance with Ethical Standards

All procedures performed in studies involving human subjects were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Ethical clearance was obtained from the University and informed consent was obtained from all individual subjects included in the study.

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Competing Interests Statement

The authors declare that there are no competing or potential conflicts of interest.

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CHAPTER FIVE

METHODOLOGY

5.1 Introduction
5.2 Research Design
5.3 Study Population
5.3.1 Part A
5.3.2 Part B
5.4 Measurements Part A: Data from Medical Database
5.4.1 Body Composition Measurements
5.4.1.1 Height
5.4.1.2 Weight
5.4.1.3 Body Mass Index
5.4.2 Blood Glucose
5.4.3 Blood Pressure
5.4.4 Cholesterol
5.4.5 Prevalence Calculations
5.4.5.1 Prevalence of Overweight Inidividuals and Obesity
5.4.5.2 Prevalence of Comorbidities
5.4.5.3 Odds Ratio (OR) for Comorbidities
5.5 Measurements part B
5.5.1 Body Mass Index
5.5.2 Health at Work Survey
5.5.2.1 Comorbidities
5.5.2.2 Bothersome Symptoms
5.5.2.3 Smoking Status and Alcohol Consumption Habits
5.5.2.4 Problems with Concentration
5.5.2.5 Feelings of Fatigue
5.5.2.6 Sleep Problems
5.5.2.7 Shortness of Breath
5.5.2.8 Accidents and Injuries in the Workplace
5.5.2.9 Visits to Medical Professionals
5.5.2.10 Absenteeism
5.5.2.11 Presenteeism
5.5.2.12 Work Hours
5.5.3 Quality of Life
5.5.4 International Physical Activity Questionnaire (IPAQ)
5.5.5 Dietary Record

5.1 Introduction

The purpose of this study was to assess the work health-related profile of overweight and obese employees in South African industrial and corporate companies and to establish the cost implication of overweight and obese employees on these companies. Furthermore, the study developed a health promotion model, unique to SA, to address obesity in the workplace.

Chapter 5 describes the cross-sectional observational research design adopted, the background of participants, and the sampling techniques used. It further describes the process of data collection, including protocols and instruments used to obtain measurements, as well as ethical considerations.

5.2 Research Design

The study is a once-off cross-sectional observation study. Participants were part of a non-random population who voluntarily participated in the study. It is a field study in which the natural circumstances make peripheral variables hard to control, however, this is more likely to present relevant and useful findings.

5.3 Study Population

5.3.1 Part A: a total of 17 359 employees, including both males (n = 8561) and females (n = 8798), from a non-random availability population from various corporate and industrial companies in South Africa participated in the study. Their ages varied between 18-64 years (40.8 ± 11.0) and no differentiation was made between race groups. Participants were categorised into various groups, each comprising both men and women, according to their body mass index (BMI) – normal weight participants with a BMI of 18.5–24.9 kg/m^2 (n = 7338), overweight participants with a BMI of 25.0–29.9 kg/m^2 (n = 6323), obese class I with a BMI of 30.0-34.9 kg/m^2 (n = 2552), obese class II with a BMI of 35.0-39.9 kg/m^2 (n = 782), and obese class III with a BMI of ≥ 40 kg/m^2 (n = 364).

5.3.2 Part B: refer to Figure 5.1 below showing the selection of participants. Seven hundred and sixty-six (766) employees agreed to participate in the study, however, only 199 employees returned the questionnaires. From this, 16 were excluded as they were not within the correct age range. A further 64 participants were excluded due to invalid responses within the questionnaires, and 2 more were excluded as they fell into the underweight BMI category; which is not investigated in this study.

A total of 117 participants met the selection criteria and were included in the final analysis. A response rate of 199 participants from 776 equates to a response rate of 25.6%, which is very poor. The poor response rate has been observed in numerous other studies (Kolbe-Alexander et al., 2008; Vioque, Weinbrenner, Castelló, Asensio, & de la Hera, 2008). Admittedly, the sample size is a limitation in this study; however, these participants are representative of the companies from which data was collected.

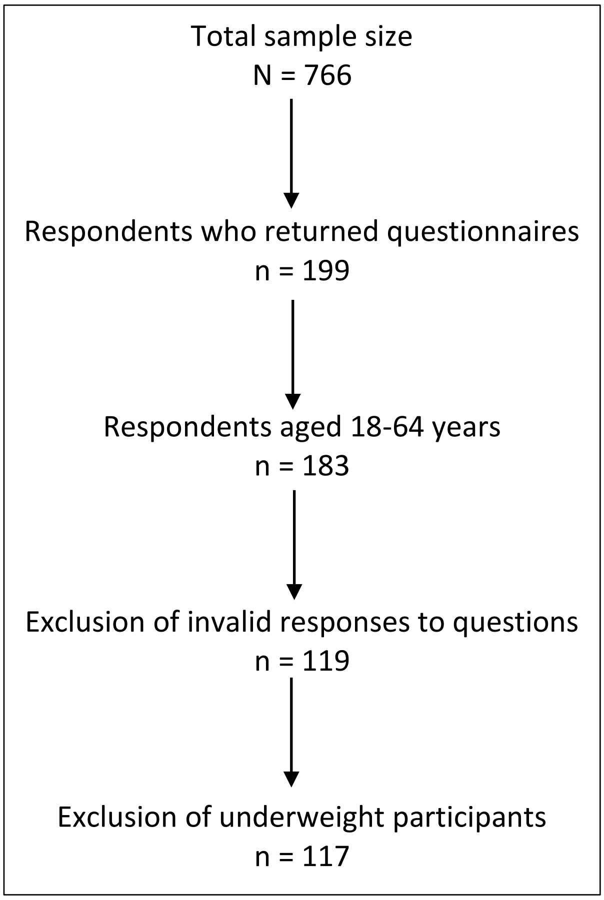

Figure 5.1 Flow chart showing the selection of participants.

A total of 117 employees, including both males (n = 56) and females (n = 61), from various corporate and industrial companies in South Africa voluntarily participated in the study. Their ages varied between 18-64 years (40.98 ± 0.70) and no differentiation was made between race groups. Participants were assigned to three groups, each comprising both men and women, according to their body mass index (BMI) – normal weight participants with a BMI of 18.5–24.9 kg/m^2 (n = 33), overweight participants with a BMI of 25.0–29.9 kg/m^2 (n = 35) and obese participants with a BMI of ≥30.0 kg/m^2 (n = 49).

5.4 Measurements Part A: Data from Medical Database

The company housing the medical database forwarded the unlinked data results and clinical measures to the researcher for data analysis.

5.4.1 Body Composition Measurements

5.4.1.1 Height

A Seca stadiometer was used to measure height according to the method described by Swain and Brawner (2014). Participants were required to remove their shoes and socks and stand with their feet together at the heels, with buttocks and scapulae touching the vertical board of the stadiometer. Participants were asked to spread their weight evenly over both feet and their head was oriented in the Frankfort Plane. Once this position was achieved the headboard of the stadiometer was pushed firmly down onto the Vertex (the highest point of the skull), compressing the hair as much as possible. The measurement was recorded in centimetres to the nearest 0.1cm

5.4.1.2 Weight

A Seca 813 scale (Teraoka, South Africa) was used to weigh the participants. Participants were weighed while standing still on the scale and facing forward; they were barefoot and wore minimal clothing. The measurement was recorded in kilograms, to the nearest 100 grams (Swain & Brawner, 2014).

5.4.1.3 Body Mass Index

Body mass index (BMI) was calculated to assess weight relative to height. The BMI was determined by using the following equation: weight (kg)/[height (m^2)], as stated by Thompson et al. (2014). These results are used to classify body mass categories (see table 5.1).

Table 5.1: Classification for BMI

CLASSIFICATION	BMI (kg/m^2)
Underweight	< 18.5
Normal	18.5-24.9
Overweight	25.0-29.9
Obesity class I	30.0-34.9
Obesity class II	35.0-39.9
Obesity class III	≥ 40

(Thompson et al., 2014)

5.4.2 Blood Glucose

Random capillary blood glucose was used to determine risk of diabetes. Capillary blood was obtained via fingerpick and measurements were performed using the Accu-Chec Performa Nano and the Accutrend GC (Roche Diagnostics, Switzerland). Random capillary blood glucose was classified according to the table below as stated by Oberlinner, Neumann, Ott and Zober (2007).

Table 5.2: Classification for random blood glucose

CLASSIFICATION	BLOOD GLUCOSE (mmol/L)
Hypoglycaemia	< 4.0
Normal	4.0-7.8
Impaired glucose tolerance	7.8-11.0
Diabetes	> 11.0

(Oberlinner et al., 2007)

5.4.3 Blood Pressure

Blood pressure was measured using an ALPK2 aneroid sphygmomanometer (Medical Centre Trading Corporation, Japan) and a Biocare professional stethoscope (Biocare Medical Systems, China). Participants were seated quietly for 5 minutes in a chair with back support, feet on the floor and their arms placed at the level of the heart. Two readings were taken 2 minutes apart (Thompson et al. 2014). Blood pressure was classified according to the table below as stated by Thompson et al. (2014)

Table 5.3: Classification for blood pressure

CLASSIFICATION	SYSTOLIC BLOOD PRESSURE (mm/Hg)	DIASTOLIC BLOOD PRESSURE (mmHg)
Normal	100-119	60-79
Prehypertension	120-139	80-89
Stage I hypertension	140-159	90-99
Stage II hypertension	≥ 160	≥ 100

(Thompson et al., 2014)

5.4.4 Cholesterol

Random capillary total cholesterol concentration was used to determine the risk of hypercholesterolemia. Capillary blood was obtained via fingerpick and measurements were performed using the Accu-Chec Performa Nano and the Accutrend GC (Roche Diagnostics, Switzerland). Total cholesterol was classified according to the table below as stated by Thompson et al. (2014).

Table 5.4: Classification for total cholesterol

CLASSIFICATION	TOTAL CHOLESTEROL (mmol/L)
Desirable	< 5.18
Borderline high	5.18-6.19
High	≥ 6.2

(Thompson et al., 2014)

5.4.5 Prevalence Calculations

Prevalence is a measure of disease frequency, and refers to the proportion of the population that has a disease at a particular time; thus, it is a measure of burden of disease on society (Bustillos, Vargas, & Gomero-Cuadra, 2015; Yu, Wang, & Yu, 2015). Prevalence can also be used to assess the frequency of behaviours or characteristics that might be risk factors for a disease. Prevalence is calculated according to the following equation as suggested by Bustillos et al (2015): prevalence = number of cases ÷ population size.

5.4.5.1 Prevalence of Overweight Individuals and Obesity

Prevalence of overweight individuals, and obesity amongst employees was calculated as follows, as suggested by Bustillos et al. (2015):

- Prevalence of overweight employees = number of overweight employees ÷ total population size
- Prevalence of obese class I employees = number of obese class I employees ÷ total population size
- Prevalence of obese class II employees = number of obese class II employees ÷ total population size

- Prevalence of obese class III employees = number of obese class III employees ÷ total population size

5.4.5.2 Prevalence of Comorbidities

Prevalence of disease for diabetes, hypertension and hypercholesterolemia was calculated for each BMI category, and compared across BMI categories. Prevalence was expressed both as a ratio and an absolute difference. Prevalence of disease was calculated as follows, as suggested by Bustillos et al. (2015):

- Prevalence of diabetes = number of cases of diabetes ÷ population size
- Prevalence of hypertension = number of cases of hypertension ÷ population size
- Prevalence of hypercholesterolemia = number of cases of hypercholesterolemia ÷ population size

5.4.5.3 Odds Ratio (OR) for Comorbidities

The ***odds ratio (OR)*** uses prevalence of a disease at a specific time, with no follow-up period, to measure the association between an exposure and an outcome (Howard & Potter, 2014; Bustillos et al., 2015). The OR represents the odds that an outcome will occur given a particular exposure, compared to the odds of the outcome occurring in the absence of that exposure. Odds ratio was calculated for diabetes, hypertension and hypercholesterolemia across BMI categories. The OR was calculated according to the example below, as suggested by Howard and Potter (2014):

Table 5.5 Odds ratio for comorbidities

	Diseased (E.g. diabetes, hypertension etc.)	**Non-diseased**	**Total**
Exposed (e.g. Ow, Ob)	7	10	**17**
Non-exposed (normal weight)	6	56	**62**
Total	**13**	**66**	**79**

OR = (7 ÷ 6) ÷ (10 ÷ 56) = 6.53 **or,** OR = (7 ÷ 10) ÷ (6 ÷ 56) = 6.53

Ow = Overweight; Ob = Obese

5.5 Measurements Part B

5.5.1 Body Mass Index

Body mass index (BMI) was included in the part B measurements according to the protocol of Thompson et al. (2014) as described under the part A measurements section. Furthermore, prevalence of being overweight, and obesity amongst employees was calculated, as explained in part A above. Prevalence was calculated separately for males and females.

5.5.2 Health at Work Survey

The WHO Health at Work survey (Appendix A) is a comprehensive questionnaire covering information regarding health status, work related conditions, and lifestyle habits (Kessler et al., 2003). The WHO health at Work survey has been previously validated by Kessler et al. (2003). The following data was analysed from information collected from the questionnaire: prevalence of comorbidities, smoking status, alcohol consumption habits (frequency and quantity), problems with concentration, feelings of fatigue, problems with sleep, shortness of breath, accidents and injuries in the workplace and associated days missed, bothersome symptoms, negative feelings, visits to medical professionals, absenteeism, and presenteeism. Furthermore, the following demographic information was captured: job type, work hours, age, gender, marital status, education level, and income level.

5.5.2.1 Comorbidities

Prevalence of disease across BMI categories was calculated for diabetes, hypertension, cardiovascular disease, and hypercholesterolemia. Furthermore, odds ratio (OR) was calculated for each comorbidity across BMI categories. Prevalence and OR was calculated according to the methods explained in part A above.

In addition to comorbidities, percentage of the study population by number of health risk factors for each BMI category was computed. Thus, prevalence of risk factors was determined according to classifications used in the study by Kolbe-Alexander et al. (2008). Participants were classified as ‘at risk’ for each of the risk factors as follows:

- Men equal to and older than 45 years of age and women equal to and older than 55 years,
- Classified as having ‘low’ physical activity levels according to the IPAQ,
- Reported smoking,

- Diagnosed hypertension, diabetes, hypercholesterolemia or cardiovascular heart disease,
- Taking medication for any one of the above-mentioned conditions.

5.5.2.2 Bothersome Symptoms

Bothersome symptoms across BMI categories was determined by the following question: "during the past 4 weeks, how much were you bothered by each of the following conditions?". Conditions included feeling dizzy, headaches, back or neck pain, pain in the arms, legs, joints (knees, hips etc.), muscle soreness, watery eyes, runny nose, or stuffy head, cough or sore throat, fever, chills, or other cold/flu symptoms, constipation, loose bowels or diarrhoea, and nausea, gas or indigestion. The participants were requested to rate their answers on a 5-point Likert scale ranging from "not at all" (1), to "a little" (2), to "some" (3), to "a lot" (4). Prevalence of bothersome symptoms was determined if the following responses were chosen: "a little", "some", or "a lot", as described in Bustillos et al. (2015).

5.5.2.3 Smoking Status and Alcohol Consumption Habits

Smoking status

Smoking status was determined by participants indicating whether they currently smoked, were an ex-smoker, only smoked a few times, or had never smoked. Prevalence of non-smokers was determined from employees who had never smoked, or only smoked a few times. Both prevalence ratio and OR were calculated for smoking status across BMI categories, as suggested by Bustillos et al. (2015):

Prevalence of smoking habits

- Prevalence of current smoker = number of current smokers ÷ population size
- Prevalence of non-smoker = number of non-smokers ÷ population size

Table 5.6: Odds ratio for smoking habits

	Smoker	**Non-smoker**	**Total**
Exposed (e.g. Ow, Ob)	7	10	**17**
Non-exposed (normal weight)	6	56	**62**
Total	**13**	**66**	**79**

OR = (7 ÷ 6) ÷ (10 ÷ 56) = 6.53 **or,** OR = (7 ÷ 10) ÷ (6 ÷ 56) = 6.53

Ow = Overweight; Ob = Obese

Alcohol consumption habits

Frequency of alcohol consumption was determined by responses to the following question "how often do you usually have at least one drink of alcohol?". Participants could select one of the following responses: 1) nearly every day, 2) several days per week, 3) 1-2 days a week, 4) 1-3 days a month, 5) less than once a month, 6) never. Quantity of alcohol consumption was determined by responses to the following question "on the days you drink, about how many drinks do you usually have per day?". Participants could select one of the following responses: 1) 1-2 drinks, 2) 3-4 drinks, 3) 5-10 drinks, 4) 10+ drinks. Participants were classified as either a current drinker or a non-drinker; current drinkers had a minimum of one drink in the previous month, while non-drinkers did not consume any alcohol in the previous month (Subady, Assanangkornchai, & Chongsuvivatwong, 2013; Katulanda, Ranasinghe, Rathnapala, Karunaratne, Sheriff, & Matthews, 2014). Both prevalence ratio and OR were calculated for alcohol consumption across BMI categories.

Prevalence of alcohol consumption habits

- Prevalence of alcohol consumption = number of current drinkers ÷ population size
- Prevalence was also calculated according to frequency and quantity.

Table 5.7: Odds ratio for alcohol consumption habits

	Current drinker	**Non-drinker**	**Total**
Exposed (e.g. Ow, Ob)	7	10	**17**
Non-exposed (normal weight)	6	56	**62**
Total	**13**	**66**	**79**

OR = (7 ÷ 6) ÷ (10 ÷ 56) = 6.53 **or,** OR = (7 ÷ 10) ÷ (6 ÷ 56) = 6.53

Ow = Overweight; Ob = Obese

5.5.2.4 Problems with Concentration

Prevalence of problems with concentration was determined from a cluster of questions regarding concentration, such as difficulties with organizing things and remembering appointments, procrastinating, and fidgeting. The participants were requested to rate their answers on a 5-point Likert scale ranging from “never” (1) to “rarely” (2), to “sometimes” (3), to “often” (4), to very often (5). Prevalence was determined if the following responses were chosen: “sometimes”, “often”, or “very often”; as described in Bustillos et al. (2015).

- Prevalence of problems with concentration = number of employees who answered with “sometimes”, “often”, or “very often ÷ population size

5.5.2.5 Feelings of Fatigue

Prevalence of fatigue was determined from the following two questions: 1) “How often did you become very tired, weak, or exhausted while performing minor every day physical tasks like working, shopping, housekeeping, and walking?”; 2) “How often did you become very tired, weak, or exhausted while performing minor every day mental tasks like reading, writing, and doing paperwork?”. The participants were requested to rate their answers on a 5-point Likert scale ranging from “never” (1) to “rarely” (2), to “sometimes” (3), to “often” (4), or “very often” (5). Prevalence was determined if the following responses were chosen: “sometimes”, “often”, or “very often”, as described in Bustillos et al. (2015).

- Prevalence of feelings of fatigue in physical tasks = number of employees with physical fatigue ÷ population size
- Prevalence of feelings of fatigue in mental tasks = number of employees with mental fatigue ÷ population size

5.5.2.6 Sleep Problems

Participants were classified as having poor sleep (poor quality) if they experienced any of the following four items on sleeping habits at least 5-8 weeks of the past year: 1) having trouble falling asleep; 2) waking up during the night and having trouble getting back to sleep; 3) waking up too early in the morning and being unable to get back to sleep; 4) feeling overly sleepy during the day (Roth, 2007; Bansil, Kuklina, Merritt & Yoon, 2011).

- Prevalence of sleep problems = number of employees with poor sleep quality ÷ population size

5.5.2.7 Shortness of Breath

Shortness of breath was self-reported, participants answered either "yes" or "no" to the following question: "have you been repeatedly short of breath over the past 12 months?". Prevalence ratio calculated for shortness of breath across BMI categories.

- Prevalence of shortness of breath = number of employees with shortness of breath ÷ population size

5.5.2.8 Accidents and Injuries in the Workplace

Accidents and injuries in the workplace was self-reported from the following question: "in the past 12 months, how many accidents or injuries did you have that required medical attention?". Specified injuries included broken or dislocated bones, sprain or strained muscle, cuts, scrapes or puncture wounds, head injury or concussion, bruise, contusion or internal bleeding, and burn or scald. Prevalence ratio was calculated for accidents and injuries in the workplace across BMI categories as stated in Pollack et al. (2007).

- Prevalence of accidents and injuries in the workplace = number of accidents or injuries ÷ population size

5.5.2.9 Visits to Medical Professionals

Frequency of visits to medical professionals in the previous 12 months were self-reported. Medical professional visits included visits to doctors, dentists/orthodontist, opticians/ophthalmologist, hospitals or clinics for routine check-ups or scheduled treatment/surgery; and visits to a doctor, emergency room, or clinic for urgent care treatment. Furthermore, visits to a psychologist, psychiatrist or other mental health professional was included. Prevalence ratio was calculated for visits to medical professionals across BMI categories, as well as for hospital stays. Furthermore, the number of visits due to excess body weight was computed across BMI categories.

- Prevalence of visits to medical professionals = number of visits to medical professionals ÷ population size
- Prevalence of hospital stays = number of hospital stays ÷ population size
- Excess number of visits to medical professionals

Excess number of visits to medical professionals due to obesity related health problems was determined by calculating the difference between average number of visits to medical professionals for normal weight and overweight, and normal weight and obese employees.

5.5.2.10 Absenteeism

Absenteeism was self-reported, with a four-week recall period; this method has been used by numerous authors (Frone, 2008; Andreyeva, Luedicke, & Wang, 2014; Howard & Potter, 2014). Participants were required to indicate the number of days they missed an entire workday, or part of a workday, because of problems with their physical or mental health. The mean number of days absent for each BMI category was computed. Furthermore, incident proportion (cumulative incidence), incidence rate, risk ratio, percent relative risk, and obesity attributable absenteeism costs were calculated as outlined below:

- Incidence proportion (cumulative incidence) and incidence rate

Incidence is a measure of the occurrence of new cases of disease (or some other outcome, such as absenteeism) during a span of time. ***Incidence proportion*** refers to the probability of developing disease over a stated period of time (in this case the probability of absenteeism), as such, it is an estimate of risk. It is calculated using the number of new cases within a specified period of time (e.g. 1 month) ÷ size of population initially at risk. ***Incidence rate*** is a measure of the number of new cases ('incidence') per unit of time ('rate'); time units can be expressed in days, months, or years. For example, incidence proportion could be 12 new cases per 1000 people over the period of a month; thus, incidence rate is 144 cases that would be expected for 1000 persons observed for 1 year. Andreyeva et al. (2014) used this method to indicate differences in absenteeism across BMI groups.

  - Incidence proportion (normal weight) = number of days absent ÷ population size
  - Incidence proportion (overweight) = number of days absent ÷ population size
  - Incidence proportion (obese) = number of days absent ÷ population size
  - Incidence rate (for all BMI groups): incidence proportion x12

- Risk ratio

Measures of disease frequency can be compared by calculating their ratio; this is frequently called relative risk. Relative risk is a method used to compare the risks for two groups, and gives an indication of strength of association. To calculate the ***risk ratio,*** cumulative incidence in the exposed group is divided by the cumulative incidence in an unexposed group. The risk ratio was calculated as indicated in the example below, as stated in Joubert et al. (2007).

Table 5.8: Risk ratio of absenteeism across BMI categories

BMI	Days Absent (Mean)	Days at work (Mean)	Total	Cumulative Incidence
Normal weight	0.39	29.61	30	0.39 ÷ 30 = 1.3%
Overweight	0.56	29.44	30	0.56 ÷ 30 = 1.86%
Obesity	1.33	28.67	30	1.33 ÷ 30 = 4.43%

In this case, the unexposed group is the normal weight employees, and the exposed group is both the overweight and obese employees.

- Risk ratio (RR) = cumulative incidence (exposed group) ÷ cumulative incidence (unexposed group)
- Between normal weight and overweight: RR = 1.86/1.3 = 1.43
- Between normal weight and obesity: RR = 4.43/1.3 = 3.41

- Percent relative risk

An alternate way to observe and interpret these comparisons is to calculate the ***percent relative effect***, i.e. the percent change in the exposed group; as proposed by Andreyeva et al. (2014). This calculation is based on the assumption that the unexposed group has 100% of the risk, and the exposed group is expressed relative to that. The calculation is as follows:

- % increase = (RR – 1) x 100
- % increase between normal weight and overweight = (RR – 1) x 100 = (1.43 – 1) x 100 = 43%
- % increase between normal weight and obesity = (RR – 1) x 100 = (3.41 – 1) x 100 = 241%

- Obesity-attributable absenteeism costs

Cost-of-illness studies use either a top-down approach or a bottom-up approach to calculate the burden of disease, as explained in chapter 3. The current study used the bottom-up approach to calculate obesity-attributable absenteeism costs. To calculate obesity-attributable absenteeism costs, the following formula was used as suggested by Andreyeva et al. (2014): 1) average annual earnings were estimated from demographic information, 2) the annual salary estimates were divided by 240 (250 week days minus average 10 vacation days) in order to obtain estimates of average earnings per day of work, 3) excess work days missed due to obesity related health problems was determined by calculating the difference between average predicted number of missed work days for normal weight and obese employees, 4) obesity-attributable absenteeism cost was calculated as the product of average daily earnings and the difference in missed work days between normal weight, overweight and obese employees, 5) total costs of absenteeism among obese employees was calculated by multiplying per employee cost of absenteeism by the population count of obese employees, 6) the final step calculated the percentage of obesity-attributable costs of absenteeism by estimating the total cost of absenteeism among all employed adults ages 18 and above and the cost of absenteeism among obese employees.

5.5.2.11 Presenteeism

The present study used the following method to determine the existence of presenteeism, as used in Yu et al. (2015). The Health at Work survey asked employees to recall their work performance during the past 4-week period. Employees were asked to rate their own, as well as their co-workers' work performance on a Likert scale from 0 to 10; with 0 indicating the worst and 10 the best work performance. The presenteeism score was calculated as the monthly self-assessment work performance score divided by the evaluation score for co-workers' work performance. Calculated values ranged from 0.25 to 2.0, with scores lower than 0.25 assigned a value of 0.25, and scores over 2.0 assigned a value of 2.0. The defining point was set as a score of 1.0, with presenteeism being judged to exist when the presenteeism score was < 1.0, and not to exist when the presenteeism score was ≥ 1.0. Both prevalence ratio and OR were calculated for presenteeism across BMI categories.

- Prevalence of presenteeism = number of employees with presenteeism ÷ population size
- Odds ratio for presenteeism

Table 5.9: Odds ratio for presenteeism

	Employees with presenteeism	Employees without presenteeism	Total
Exposed	7	10	**17**

(e.g. Ow, Ob)			
Non-exposed (normal weight)	6	56	**62**
Total	**13**	**66**	**79**

OR = (7 ÷ 6) ÷ (10 ÷ 56) = 6.53 **or,** OR = (7 ÷ 10) ÷ (6 ÷ 56) = 6.53

Ow = Overweight; Ob = Obese

5.5.2.12 Work Hours

Weekly work hours were self-reported, and were determined from the following question: "about how many hours altogether did you work in the past 7 days?". Many authors have found associations between long work hours, BMI and numerous health-related behaviours (Lallukka et al., 2008; Gu et al., 2012; Jang, Kim, Lee, Myong & Koo, 2013). While most authors agree that 40 hours per week is considered normal (Lallukka et al., 2008; Gu et al., 2012; Jang et al., 2013), there is a large variation in the classification of long work hours (Ko et al., 2007; Lallukka et al., 2008; Escoto et al., 2010; Di Milia, Vandelanotte, & Duncan, 2013; Jang et al., 2013). Lallukka et al. (2008) classify long work hours (LWH) as > 40 hrs per week; while Ko et al. (2007) and Di Milia et al. (2013) describe LWH as > 45 hrs and > 43 hrs, respectively. Escoto et al. (2010) indicated LWH as > 50 hrs, while Jang et al. (2013) indicated > 60 hrs. The current study classified normal work hours as 45 hrs per week; this is supported by Ko et al. (2007). Furthermore, it corresponds with normal working hours in South Africa which is set at 45 hrs according to the Department of Labour (www.labour.gov.za). Long work hours were classified as > 45 hrs per week, as supported by Ko et al. (2007).

5.5.3 Quality of Life

The WHO Quality of Life questionnaire (WHOQOL) (Appendix B) was used to assess the employees' quality of life (QOL); Harper (1998) has previously validated this questionnaire. Participants were asked to rate their overall quality of life, as well as their overall health, by rating their answers on a 5-point Likert scale ranging from "very poor/very dissatisfied" (1) to "poor/dissatisfied" (2), to neutral (3), to "good/satisfied", to "very good/very satisfied (5). Prevalence was determined according to the answers selected.

Furthermore, the WHOQOL asked questions relating to four domains: 1) physical health, 2) psychological health, 3) social relationships, 4) environmental QOL. Each question was answered using a five-point Likert scale. The four domains were calculated as the sum of seven items for physical, six items for psychological, three items for social, and eight items for environmental. Mean and standard deviation scores were compared across BMI groups, as stated by Krägeloh (2011). When answering the questions employees were asked to keep in mind their standards, hopes, pleasures, and concerns. The questions were answered in relation to the previous four (4) weeks of one's life. Associations between the various domains and BMI categories were determined.

5.5.4 International Physical Activity Questionnaire (IPAQ)

The IPAQ long form (Appendix C) used in this study to determine health-related physical activity, was developed as a surveillance instrument to measure multiple domains of physical activity. The IPAQ has been previously validated by Hagströmer, Oja, and Sjöström (2006), and is suitable for national population-based prevalence studies of participation in physical activity.

The IPAQ categorizes physical activity according to five domains, these include: 1) work related (occupational) physical activity, 2) transport, 3) household and garden chores, 4) leisure/recreation, and sports and exercise, 5) sedentary behaviour. Physical activity is recorded in terms of metabolic equivalents (METs) and metabolic equivalent minutes (MET minutes). Metabolic equivalents refer to the ratio of the metabolic rate during physical activity to the corresponding rate at rest. One MET unit is the energy cost while sitting quietly. A MET minute is calculated by multiplying a MET score by the time (in minutes) that the activity was performed. Walking is equivalent to light intensity physical activity at 3.3 METs, moderate physical activity corresponds to 4.0 METs, and vigorous physical activity measures 8.0 METs.

Total physical activity is categorized as either low, moderate or high. To fall into the moderate category, one of the following three criteria need to be met: 1) three or more days of vigorous activity of at least 20 minutes per day, 2) five or more days of moderate-intensity activity and/or walking for at least 30 minutes per day, or 3) five or more days of any combination of walking, moderate-intensity or vigorous-intensity activities achieving a minimum of at least 600 MET-minutes/week. To qualify for the high category, one of the following two criteria must be met: 1) vigorous-intensity activity on at least three days and accumulating at least 1500 MET-minutes/week, or 2) seven or more days of any combination of walking, moderate- or vigorous-intensity activities accumulating at least 3000 MET-minutes/week. If an individual does meet any of the requirements for the moderate or vigorous category, they would be classified as being physically inactive and placed in the low category (Samitz et al., 2011; Hallal et al., 2012).

The researcher adhered to the recommendations for data analysis as prescribed by the IPAQ Research Committee (IPAQ, 2005). The data was reported as a continuous score in MET-minutes per week (MET-min/wk), as well as time spent per week walking, and time spent performing moderate and vigorous physical activity. Furthermore, time spent sitting during the week, as well as on a weekend was reported. Data from the IPAQ was used to determine if any association existed between physical activity habits and BMI, as well as between sedentary habits and BMI. Furthermore, data from the IPAQ was used to determine if any of the following associations existed for the different BMI groups: 1) time spent sitting at work and time spent doing leisure time activities, 2) long work hours and physical activity habits.

5.5.5 Dietary Record

Participants were required to keep a food diary (Appendix D) to record all foods and fluids ingested for a period of three days, this included two weekdays and one weekend day. Participants were asked to record time of food/fluid intake, portion sizes, how the food was prepared, as well as details such as white or brown (bread/rice/pasta etc.), low fat (milk/cream/yoghurt etc.) etc. Fruit and vegetable items were 100% juice, fruit, lettuce salads, and other vegetables (all raw and cooked). Snacks included both sweet and savoury; sweet snacks included cakes, biscuits, chocolates, sweets, ice cream, donuts and sweet muffins. Savoury snacks were food items such as chips, popcorn, and fried chips. Sugar-sweetened beverages were defined as fruit drinks and soft drinks, both regular and diet. The use of the multiple pass 24-h dietary recall has been used by Ledoux, Hingle and Baranowski (2011), as well as French, Harnack, Toomey and Hannan (2007); and validated by Thompson and Byers (1994).

Data from the food diary was used to determine if any of the following associations existed between BMI and: 1) fruit and vegetable intake, 2) snacking, and 3) sugared drinks. Furthermore, the association of these habits, across BMI groups, and long work hours was investigated.

5.6 Data Collection and Testing Protocol

5.6.1 Permission to Conduct Research

The research proposal titled "The work health-related behaviours and economic costs of overweight and obese corporate and industrial employees: A South African study" was presented to the staff in the Department of Human Movement Science, as well as staff in the Faculty of Science and Agriculture at the University of Zululand. Thereafter, the proposal was submitted to the Faculty Research Committee and the Research Ethics Committee for approval. Further permission to conduct research at the various corporate and industrial companies was granted by the companies' Management teams.

5.6.2 Joint Planning with the Companies' Management Team

Part A: The principle researcher met with the product owner of the medical database company to explain the purpose of the study, as well as the data needed. The product owner granted permission for the principle researcher to use the data, provided the participants' personal details be removed. The medical database company forwarded the unlinked data results to the researcher for data analysis.

Part B: The principle researcher met with the clinic staff and HR director with each company to set up a structured plan as to how the company could accommodate the study; the HR director liaised the plan with the management team. Meetings were held with the clinic staff in order to explain the researcher's expectations of the participants, as well as the selection criteria. The HR director and the clinic sisters assisted in the recruitment of participants. The researcher attended wellness days at the various companies, where participants were encouraged by the HR director, clinic staff, and the researcher to take part in the study.

5.6.3 Meeting the Participants and Subsequent Testing

Part A: As participants' data was already captured within a database, no interaction with participants was required. Registered nurses who were fully trained in measuring height and weight, blood glucose, blood pressure and cholesterol performed the measurements.

Part B: Participants were informed of the study by the clinic staff via email a week before the wellness day, as well as on the morning of the wellness day. The researcher, and research assistants, were stationed at the wellness day to recruit participants. The purposes of the study and the participant rights were explained to the employees (details below in 5.7 Ethical considerations), as well as the measuring and testing procedures. The participants were then required to provide written consent for the study (Appendix G).

Once this preliminary process was completed, the participants were given the following four documents to complete: 1) WHO Health at Work Survey, 2) WHO Quality of Life Questionnaire, 3) International Physical Activity Questionnaire (IPAQ), 4) food diary. Participants were encouraged to complete the documents and submit them before leaving the venue, but they were also given the choice to complete them at a more convenient time. Participants were given the opportunity to submit the completed documents to the clinic staff, following which they were collected by the researcher. Participants who had not submitted documents were followed up on once a week to encourage participation in the study. Body composition measurement data for the employees was collected from the clinic sisters at the body composition measuring station.

5.7 Ethical Considerations

The University of Zululand, as well as the various companies from which data was collected granted ethical approval. The ethical clearance certificate number from the University of Zululand is UZREC 17110-030 (APPENDIX F).

5.8 Informed Consent

The participants were provided a verbal and written explanation of the purposes of the study, test procedures and the participant rights. The participant’s rights were explained according to the following guidelines: 1) the right to confidentiality, 2) the right to ask questions regarding the research, participation and ethics, 3) the right to freely withdraw at any time. The participants were provided with, and required to sign, a document of informed consent (Appendix G)

5.9 Statistical Analysis

Data analysis was done with the help of a qualified statistician based at the Durban University of Technology in order to ensure reliable and accurate analysis of all the relevant data as well as the correct interpretation thereof. IBM SPSS Statistics 24 was used to determine frequencies, associations and correlations. In the statistical analysis a 95% level of confidence ($p<0.05$) was applied as the minimum to interpret significant differences among sets of data. Descriptive statistics was used to determine frequencies and prevalence rates. A non-parametric chi-square test was used to determine significant associations between variables and each BMI category. The Mann-Whitney test was then used to determine significant differences between groups. A binary logistic regression was used to determine odds ratios.

5.10 Summary

In order to address the primary research question around the work health-related behaviours and economic costs of overweight and obese corporate and industrial employees in South Africa, a cross-sectional research design was planned and implemented with the assistance of the clinical staff at the various companies. Participation in the study was voluntary, and participants were assigned into the relevant BMI groups for comparisons. Participants were briefed about the purpose and process of the study, and informed consent was given. Data was analysed to evaluate prevalence, associations, and significance of any differences across the three BMI groups.

The following chapter reports on the results obtained to achieve the aims and objectives of this study.

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CHAPTER SIX

RESULTS AND DISCUSSION

6.1 Introduction

The present study investigated the work health-related profile of overweight and obese employees in South African industrial and corporate companies, and the cost implication of overweight and obese employees on these companies. The data was gathered from participants as part of a once-off cross-sectional observation study.

The variables assessed included BMI, blood glucose, blood cholesterol, and blood pressure, as well as health behaviours (including smoking, alcohol consumption, physical activity habits, dietary habits, and sleep), quality of life, and absenteeism and presenteeism. Furthermore, prevalence of being overweight and obesity amongst employees were assessed, as well as the prevalence of comorbidities associated with excess body weight. Comparisons of the above-mentioned variables were made across BMI categories, and reported on.

The presentation of the results is done by means of descriptive and inferential statistics. Descriptive statistics, including frequency distribution, means and standard deviations, and cross tabulation were used in order to describe and explain collected data. The Pearson Chi-square was used to determine where statistical significant differences between variable means were detected. Inferential statistical techniques were used to determine if associations existed between various parameters and BMI categories. Pearson correlation and Spearman's rho test was calculated to determine practical significance where statistical significant associations between variables were detected. A small practical significance is indicated with an absolute value of r>0.3, moderate practical significance with an absolute value of r>0.5 and large practical significance with an absolute value of r>0.8 (Gravetter & Wallnau, 2016).

Part A and part B of the study report on prevalence of overweight individuals and obesity amongst employees in South Africa, as well as the prevalence of comorbidities. Part B reports on lifestyle and work-related factors associated with excess body weight, quality of life, as well as absenteeism and presenteeism. The results are presented according to the objectives described in chapter 1.

6.2 Prevalence of Overweight and Obese Employees

6.2.1 Part A: Population Characteristics

Table 6.1 reports descriptive statistics for the population characteristics of the sample studied, including the prevalence of overweight and obesity amongst employees.

Table 6.1: Population characteristics by weight status among workers (N = 17359)

Men	**Normal weight < 25 kg/m² n = 2499**	**Overweight 25-29.9 kg/m² n = 3974**	**Obese class I 30- 34.9 kg/m² n = 1546**	**Obese class II 35-39.9 kg/m² n = 406**	**Obese class III ≥ 40 kg/m² n = 136**	**p-value <0.01**
Age (years), mean (SD)	37.73 (11.35)*	42.53 (10.56)*	43.45 (10.42)*	44.17 (10.20)*	43.60 (9.89)	<0.01#
Weight (kg), mean (SD)	73.06 (8.22)*	93.92 (14.74)*	101.44 (9.45)*	117.16 (11.34)*	138.97 (20.53)*	<0.01#
Height (m), mean (SD)	1.78 (0.08)*	1.78 (0.08)*	1.78 (0.07)*	1.78 (0.08)*	1.76 (0.12)*	<0.01
BMI - prevalence within study population (%)	29.2	46.4	18.1	4.7	1.6	
Smoker Non (%) Current (%)	90.5* 9.5	91.2* 8.8	91.8* 8.2	88.2* 11.8	93.8* 6.3	<0.01
Women	**Normal weight < 25 kg/m² n = 4839**	**Overweight 25-29.9 kg/m² n = 2349**	**Obese class I 30- 34.9 kg/m² n = 1006**	**Obese class II 35-39.9 kg/m² n = 376**	**Obese class III ≥ 40 kg/m² n = 228**	**p-value <0.01**
Age (years), mean (SD)	38.94 (11.06)*	42.46 (10.80)*	43.75 (10.92)*	42.61 (10.39)*	42.19 (11.11)*	<0.01#
Weight (kg), mean (SD)	59.69 (7.06)*	73.52 (7.20)*	85.64 (8.00)*	99.35 (9.55)*	116.38 (17.45)	<0.01#

Height (m), mean (SD)	1.65 (0.07)*	1.64 (0.07)*	1.63 (0.07)*	1.64 (0.07)*	1.62 (0.10)*	<0.01#
BMI - prevalence within study population (%)	55.0	26.7	11.4	4.3	2.6	
Smoker Non (%) Current (%)	94.7* 5.3	95.1* 4.9	94* 6	96.3* 3.7	95.6* 4.4	<0.01

*Significance computed by the non-parametric chi-square test
#Significance computed by the Mann-Whitney test

The study sample was initially set at 5000 employees; however, data was available for 17 359 employees. Employees were allocated into one of five BMI categories: normal weight (n = 7338), overweight (n = 6323), obese class I (n = 2555), obese class II (n = 782), and obese class III (n = 364). The employees' ages were between 18 and 64 years, with a mean age of 40.82 ± 11.05 years for the total sample. Prevalence rates of overweight and obese men were 46.4% and 24.4%, respectively, while prevalence rates for overweight and obese women were 26.7% and 18.3%, respectively. These prevalence rates differ substantially from national prevalence rates reported by the South African Demographic and Health Survey (SADHS) in 2016. Prevalence rates for overweight and obese men were reported to be 20.3% and 11.0%, respectively, while prevalence rates for obese women were reported to be 41%. Prevalence rates of overweight female employees were similar to that of the national prevalence rate reported by the SADHS (2016), which was 26.6%. Prevalence of smoking was lower in females than males across all BMI categories. Age was significantly associated with each BMI category for both males and females, except for males in the obese class III category. Weight was significantly associated with each BMI category for both males and females, except for females in the obese class III category. Height and being a non-smoker was significantly associated with each BMI category for both males and females. Significant differences between groups were observed for age and weight in males, as well as age, weight, and height in females. An increased age was observed with increased BMI, and an expected increase in weight was observed with increased BMI, for both males and females. Normal weight females were significantly taller compared to overweight and obese females, though it was only by 1cm.

6.2.2 Part B: Population Characteristics

Table 6.2 reports descriptive statistics for the population characteristics of the sample studied, including the prevalence of overweight and obesity amongst employees.

Table 6.2: Demographic characteristics and job characteristics by weight status among corporate and industrial workers (N = 117)

Men	**Normal weight < 25.0 kg/m² n = 14**	**Overweight 25.0-29.9 kg/m² n = 23**	**Obese ≥ 30.0 kg/m² n = 19**	**p-value <0.05**
Age (years), mean (SD)	36.69 (11.93)	41.91 (13.08)	46.11 (12.52)	<0.05#
Weight (kg), mean (SD)	77.73 (19.66)	82.70 (9.95)	102.83 (14.68)	<0.05#
Height (m), mean (SD)	1.78 (0.95)	1.72 (0.95)	1.72 (0.70)	NS
BMI - prevalence within study population (%)	25.0	41.1	33.9	
Women	**Normal weight < 25.0 kg/m² n = 19**	**Overweight 25.0-29.9 kg/m² n = 12**	**Obese ≥ 30.0 kg/m² n = 30**	**p-value <0.05**
Age (years), mean (SD)	35.95 (11.11)	41.85 (11.00)	40.40 (10.11)	NS
Weight (kg), mean (SD)	62.81 (7.75)	73.23 (5.55)	98.09 (23.82)	<0.05#
Height (m), mean (SD)	1.68 (6.60)	1.64 (0.70)	1.62 (0.86)	<0.05#
BMI - prevalence within study population (%)	31.1	19.7	49.2	
Men & women	**Normal weight < 25.0 kg/m² n = 19**	**Overweight 25.0-29.9 kg/m² n = 12**	**Obese ≥ 30.0 kg/m² n = 30**	**p-value <0.05**
Marital status				<0.05
Married/cohabiting (%)	42.4	57.1*	57.1*	
Separated (%)	3	0	0	
Divorced (%)	3	5.7	8.2	
Widowed (%)	0	0	4.1	
Never married (%)	51.5*	37.1	30.6	
Education				<0.05
8th grade or less (%)	15.2	5.7	2.0	
Some high school (%)	3	8.6	8.2	
High school graduate (%)	21.2	28.6*	24.5	
Some college/2-yr degree (%)	18.2	11.4	14.3	
4-year college degree (%)	15.2	25.7	24.5	
More than 4-year college degree (%)	27.3	20	26.5*	
Income				<0.05
< R30 000 (%)	42	35.3	27.6	
R30 000-R999 999 (%)	54.8*	55.9*	68.1*	
≥ R1 000 000 (%)	3.2	8.8	4.3	

Weekly work hours				<0.05#
≤ 45 hours (%)	54.5	62.9	77.6*	
> 45hours (%)	45.5	37.1	22.4	

*Significance computed by the non-parametric chi-square test
#Significance computed by the Mann-Whitney test

The study sample was initially set at 900 employees, however, only 117 employees volunteered to participate in the study. Employees were allocated into one of three BMI categories: normal weight (n = 33), overweight (n = 35), and obese (n = 49). The employees' ages ranged between 18 and 64 years, with a mean age of 40.61±11.85 years for the total sample. Prevalence rates of overweight and obese men were 41.8% and 34.5%, respectively, while prevalence rates for overweight and obese women were 19.4% and 48.4%, respectively. Normal weight employees were significantly associated (p=.000) with being never married, while overweight (p=.000) and obese (p=.000) employees were significantly associated with being married; this is supported by Amini et al. (2008). Level of education was significantly associated with both overweight (p=.001) and obese (p=0.15) employees, with the majority having a four-year degree or more. This is in contradiction to results found by Gu et al. (2014) and Luckhaupt, Cohen, Li and Calvert (2014) who found that higher levels of education were associated with a lower prevalence of obesity; however, Fernald (2007) found that greater educational attainment was significantly associated with higher BMI and a greater prevalence of overweight and obesity. Income was significantly associated with normal weight (p=.001), overweight (p=.000) and obese (p=.000) employees, with the majority of employees from each BMI category earning between R30 000 and R999 999. Luckhaupt et al. (2014) reported no significant association between BMI and monthly household income; however, Schmeiser (2009) and Neuman, Finlay, Smith and Subramaniam (2011) found that increased income was associated with increased BMI. Work hours was only significantly associated (p=.000) with obese employees, with most obese employees working less than 45 hours per week. Significant differences were only observed between groups for work hours (p=.029), with significantly more obese employees working less hours than normal weight and overweight employees. Gu et al. (2014) and Luckhaupt et al. (2014) observed Increasing prevalence of obesity with longer working hours, with working more than 40 hours per week being significantly associated with obesity. In South Africa, normal working hours is 45 hours per week, this is slightly longer than normal working hours reported in other countries; thus, this could be a contributing factor in the prevalence of obesity in South Africa (Lallukka et al., 2008; Gu et al., 2012; Jang, Kim, Lee, Myong, & Koo, 2013).

6.3 Comorbidities and Risk Factors Associated with Excess Body Weight

6.3.1 Part A: Descriptive Statistics

Descriptive statistics as well as the prevalence of comorbidities across BMI categories is presented in table 6.3. The comorbidities reported include diabetes, systolic and diastolic hypertension, and hypercholesterolemia.

Table 6.3: Prevalence of comorbidities by weight status among workers (N = 17359)

	Normal weight < 25 kg/m^2 n = 2499	**Overweight 25-29.9 kg/m^2 n = 3974**	**Obese class I 30- 34.9 kg/m^2 n = 1546**	**Obese class II 35-39.9 kg/m^2 n = 406**	**Obese class III ≥ 40 kg/m^2 n = 136**	**p-value <0.01**
Blood glucose (mmol/L), mean (SD)	5.24 (1.03)*	5.46 (1.22)*	5.67 (1.56)*	5.68 (1.46)*	5.91 (1.74)*	<0.01#
Systolic blood pressure (mmHg), mean (SD)	116.07 (13.44)*	124.82 (13.60)*	129.13 (14.70)*	132.05 (15.32)*	133.62 (16.80)*	<0.01#
Diastolic blood pressure (mmHg), mean (SD)	72.97 (9.72)*	78.10 (10.07)*	81.47 (10.09)*	82.71 (10.04*	83.76 (11.34)*	<0.01#
Total cholesterol (mmol/L), mean (SD)	4.88 (1.12)*	5.01 (1.16)*	5.03 (1.17)*	4.96 (1.07)*	4.89 (1.13)*	<0.01#
Diabetes (%)	0.2*	0.5*	1.2*	1.2*	1.6*	<0.01#
Systolic Hypertension (%)	3.5*	10.8*	19.5*	26.2*	28.2*	<0.01#
Diastolic Hypertension (%)	3.8*	10.8*	18.2*	20.6*	28.7*	<0.01#
Hypercholesterolemia (%)	12.5*	7.2*	7.3*	7.9*	5.0*	<0.01#

*Significance computed by the non-parametric chi-square test
#Significance computed by the Mann-Whitney test

A non-parametric chi-square test revealed that there was a significant association of BMI with each of the parameters tested, for both males and females. These parameters included mean values for blood glucose, systolic and diastolic blood pressure, and total cholesterol, as well as the prevalence of diabetes, systolic and diastolic hypertension, and hypercholesterolemia. A Mann-Whitney test revealed that significant differences were found between groups for each of the parameters tested. The prevalence of comorbidities associated with excess body weight in part A of the current study was much lower than that reported by other studies (Oghagbon, Okesina, & Biliaminu, 2008; de Zwaan et al., 2009; Keenan &

Rosendorf, 2011; Nguyen, Nguyen, Lane, & Wang, 2011; Félix-Redondo et al., 2013). Nguyen et al. (2011) reported prevalence of diabetes as 8%, 15%, and 23% for normal weight, overweight and obese individuals, respectively; with similar prevalence rates being reported by de Zwaan et al. (2009) and Félix-Redondo et al. (2013). Oghagbon et al. (2008) reported prevalence of high SBP and DBP in normal weight employees as 18.1% and 13.6%, respectively. Prevalence for high SBP and DBP in overweight employees was 28.4% and 22.4%, respectively, whereas prevalence of high SBP and DBP in obese employees was 37.8% and 29.7%, respectively. Keenan and Rosendorf (2011) reported slightly higher values of 25.8% for normal weight individuals, and 39.8% for obese individuals; which are supported by Félix-Redondo et al. (2013). Félix-Redondo et al. (2013) reported prevalence of hypercholesterolemia in men ranging from 37.1% for normal weight men, to 47.4% in overweight and 52.3% in obese men, with a similar trend observed in women; these results are further supported by de Zwaan et al. (2009).

The odds ratio of having diabetes, hypertension, and hypercholesterolemia for the respective BMI categories is presented in table 6.4.

Table 6.4: OR of diabetes, hypertension and hypercholesterolemia for BMI categories (N = 17 359)

BMI	**Diabetes**		**Systolic Hypertension**		**Diastolic Hypertension**		**Hypercholesterolemia**	
	OR	**p-value <0.05**	**OR**	**p-value <0.05**	**OR**	**p-value <0.05**	**OR**	**p-value <0.05**
> 25.0 kg/m^2	Ref		Ref		Ref		Ref	
25-29.9 kg/m^2	1.5	<0.05	3.3	<0.05	2.5	<0.05	1.3	<0.05
30.0-34.9 kg/m^2	3.4	<0.05	6.7	<0.05	4.8	<0.05	1.3	<0.05
35-39.9 kg/m^2	2.9	<0.05	9.8	<0.05	5.9	<0.05	1.1	NS
≥ 40 kg/m^2	3.1	<0.05	10.9	<0.05	10.2	<0.05	1.0	NS

A logistic regression was used to determine the odds of having a particular comorbidity for each BMI category. The odds of having diabetes, systolic hypertension, and diastolic hypertension were significantly increased with each BMI category; however, the odds of having hypercholesterolemia were only significantly increased for the overweight and obese class I category. The OR of having these comorbidities for the respective BMI categories is supported by (Barquera, 2007; Clougherty et al., 2009; de Zwaan et al., 2009; Félix-Redondo et al., 2013).

6.3.2 Part B: Descriptive Statistics

Descriptive statistics as well as the prevalence of comorbidities across BMI categories is presented in table 6.5. The comorbidities reported include diabetes, hypertension, cardiovascular disease, and hypercholesterolemia.

Table 6.5: Prevalence of comorbidities by weight status among workers (N = 117)

	Normal weight < 25 kg/m^2 n = 33	**Overweight** 25-29.9 kg/m^2 n = 35	**Obese** ≥ 30 kg/m^2 n = 49	**p-value** <0.05
Diabetes (%)	2 (6.3%)*	3 (8.6%)*	6 (12.2%)*	<0.05
Hypertension (%)	4 (12.1%)*	6 (17.1%)*	13 (26.5%)*	<0.05
Cardiovascular disease	0 (0.0%)*	0 (0%)*	3 (6.1%)*	<0.05
Hypercholesterolemia (%)	1 (3.0%)*	2 (5.9%)*	8 (16.3%)*	<0.05
Total number of conditions, mean (SD)	**0.21 (0.71)**	**0.31 (0.71)**	**0.61 (0.97)**	
Excess comorbidities	**Ref**	**0.10**	**0.40**	

*Significance computed by the non-parametric chi-square test
#Significance computed by the Mann-Whitney test

The prevalence of diabetes, hypertension, cardiovascular disease, and hypercholesterolemia increased with increasing BMI. Though the association between each of the tested variables was significantly associated with BMI, no significant differences were observed between groups; although significance was approached in hypercholesterolemia. Oberlinner, Neumann, Ott and Zober (2007), de Zwaan et al. (2009) and Félix-Redondo et al. (2013) found similar prevalence rates for diabetes. Reported prevalence of hypertension, CVD and hypercholesterolemia in the present study is much lower than that found in other studies (Oghagbon et al., 2008; Keenan & Rosendorf, 2011; Félix-Redondo et al., 2013). Keenan and Rosendorf (2011) reported prevalence of hypertension to be 25.8% for normal weight individuals, and 39.8% for obese individuals; this is further supported by Félix-Redondo et al. (2013). Félix-Redondo et al. (2013) reported prevalence of hypercholesterolemia in men ranging from 37.1% for normal weight men, to 47.4% in overweight and 52.3% in obese men, with a similar trend observed in women; these results are further supported by de Zwaan et al. (2009). Bogers et al. (2007) reported prevalence of CVD for normal weight, overweight, and obese individuals to be 3.3%, 5.4% and 7.3%, respectively. Furthermore, the total number of conditions reported in this study for each BMI category is also lower than that reported by Sullivan, Ghushchyan and Ben-Joseph (2008), who stated that normal weight, overweight, and obese individuals reported 1.58, 1.8, and 2.39 conditions, respectively.

The odds ratio of having diabetes, hypertension, cardiovascular disease, and hypercholesterolemia for the respective BMI categories is presented in table 6.6.

Table 6.6: OR of diabetes, hypertension, cardiovascular disease, and hypercholesterolemia for BMI categories (N = 117)

	Diabetes		Hypertension		CVD		Hypercholesterolemia	
BMI	**OR**	**p-value <0.05**	**OR**	**p-value <0.05**	**OR**	**p-value <0.05**	**OR**	**p-value <0.05**
> 25.0 kg/m^2	Ref		Ref		Ref		Ref	
25-29.9 kg/m^2	1.4	NS	1.5	NS	1.0	NS	2.0	NS
≥ 30 kg/m^2	2.09	NS	2.6	NS	2.08	NS	6.2	.092

A logistic regression was used to determine the odds of having a particular comorbidity for each BMI category. The odds of an overweight employee being diabetic is 1.4, and though not significant, is similar to the results found in part A above. Obese employees from part B had an OR of 2.09, which is slightly lower than that found in part A, in which the different classes of obesity had an OR ranging 2.9-3.4. Félix-Redondo et al. (2013) supports this result. Overweight and obese employees had an OR of hypertension of 1.5 and 2.6, respectively; which was not found to be significant. These OR values are substantially lower than that found in part A employees, where significance was observed; however, Clougherty et al. (2009) and Shihab et al. (2012) support these results. Though overweight employees from part B had an OR of 2.0 for hypercholesterolemia, which was higher than the OR of 1.3 for part A employees, this was not found to be significant. However, obese employees had an OR of 6.2 for hypercholesterolemia, which approached significance. The OR for hypercholesterolemia in the present study was higher than that found in other studies; which reported OR values ranging from 1.14-1.45 for overweight individuals and 1.22-1.93 for obese individuals (Barquera, 2007; de Zwaan et al., 2009; Félix-Redondo et al., 2013). The OR for CVD is similar to those found by Bogers et al. (2007) and Félix-Redondo et al. (2013).

The prevalence of bothersome symptoms across BMI categories is described in table 6.7. Bothersome symptoms include pain in various areas of the body, symptoms associated with colds/flu or allergies, and discomfort caused by the digestive system.

Table 6.7: Prevalence of bothersome symptoms associated with excess body weight (N = 117)

	Normal weight < 25 kg/m^2 n = 33	**Overweight 25-29.9 kg/m^2 n = 35**	**Obese ≥ 30 kg/m^2 n = 49**	**p-value <0.05**
Shortness of breath (%)	6.1	2.9*	18.4*	<0.05
Feeling dizzy (%)	42.4	38.2	39.6	NS
Headaches (%)	45.5	42.9	67.3*	<0.05#
Back or neck pain (%)	42.4	42.9	57.1	NS
Pain in your arms, legs, joints (knees, hips etc.) (%)	33.3	45.7	69.4*	<0.05#
Muscle soreness (%)	34.4	50.0	50.0	NS
Watery eyes, runny nose or stuffy nose (%)	36.4	25.7*	51	<0.05
Cough or sore throat (%)	30.3*	28.6*	42.6	<0.05
Fever, chills, or other cold/flu symptoms (%)	33.3	31.4*	41.7	<0.05
Constipation, loose bowels or diarrhoea (%)	25*	22.9*	49	<0.05#
Nausea, gas or indigestion (%)	18.2	31.4*	43.8	<0.05#

*Significance computed by the non-parametric chi-square test
#Significance computed by the Mann-Whitney test

A non-parametric chi-square test revealed that a cough or sore throat and constipation were significantly associated with normal weight employees, while shortness of breath, watery eyes, runny nose or stuffy nose, cough or sore throat, fever, chills, or other cold/flu symptoms, constipation, loose bowels or diarrhoea, and nausea, gas or indigestion were significantly associated with overweight employees. The association between being overweight and suffering from the above-mentioned symptoms is supported by Babb, Ranasinghe, Comeau, Semon and Schwartz (2008) and Peytremann-Bridevaux and Santos-Eggimann (2008). Furthermore, shortness of breath, headaches, and joint pain were significantly associated with obesity; this is supported by Peterlin, Rosso, Rapoport and Scher (2010), and Stone and Broderick (2012). The Mann-Whitney test revealed that significant differences were observed between BMI groups for headaches, pain in the limbs and joints, constipation, loose bowels or diarrhoea, and nausea, gas or indigestion. Obese employees had significantly greater prevalence of headaches and pain in the limbs and joints compared to normal weight and overweight employees, whereas normal weight and overweight employees had significantly greater prevalence of constipation, loose bowels or diarrhoea, and nausea, gas or indigestion as compared to obese employees.

Table 6.8 presents the distribution of the study population according to number of health risk factors and BMI.

Table 6.8: Percentage of study population by number of health risk factors (N = 117)

	Body Mass Index (kg/m^2)		
No. of health risk factors	**Normal weight < 25 kg/m^2 n = 33**	**Overweight 25-29.9 kg/m^2 n = 35**	**Obese ≥ 30 kg/m^2 n = 49**
0	66.6%	54.3%	40.8%
1	15.1%	25.7%	32.6%
2	12.1%	8.6%	18.4%
≥3	6.1%	11.4%	8.2%

The majority of normal weight employees had no health risk factors, while less than 50% of obese employees had no health risk factors. The prevalence of obese employees with one health risk factor was more than double that of normal weight employees. A decreasing trend was observed for prevalence of employees with no health risk factors, as one moved from the normal weight, to overweight, to the obese BMI category. Conversely, an increasing trend was observed for prevalence of employees with one health risk factor, with increased BMI. The prevalence of employees with two risk factors was lowest in overweight employees and highest in obese employees, whilst the prevalence of employees with three risk factors was lowest in normal weight employees, and highest in overweight employees. Tsai, Ahmed, Wendt, Bhojani and Donnelly (2008) reported only 11.6% of obese workers with no health risk factors, and 32.2% with three or more health risk factors.

Table 6.9 reports descriptive statistics for visits to medical professionals, hospital stays as well as accidents and injuries for each BMI category for the past year. Furthermore, excess number of visits to medical professionals by overweight and obese employees, as compared to normal weight employees, is reported.

Table 6.9: Prevalence of visits to medical professionals, hospital stay and accidents and injuries associated with excess body weight (N = 117)

	Normal weight < 25 kg/m^2 n = 33	**Overweight 25-29.9 kg/m^2 n = 35**	**Obese ≥ 30 kg/m^2 n = 49**	**p-value <0.05**
Visits to medical professionals, mean (SD)	2.85 (1.41)	2.77 (0.71)	3.75 (3.54)	NS
Visits to medical professionals (%)	94 (285%)	97 (277%)	180 (367%)	NS
Excess visits to medical professionals	Ref	-0.08	0.9	

Hospital stays (nights), mean (SD)	0.13 (0.42)	0.74 (4.22)	0.24 (1.30)	NS
Hospital stays (%)	4 (12.1)	6 (17.1%)	12 (24.5%)	NS
Accidents and injuries (%)	1 (3.03%)	2 (5.71%)	2 (4.08%)	NS

Overweight employees had the lowest prevalence in number of visits to medical professionals, whilst obese employees had the highest prevalence, though significance was not observed between groups. Sullivan et al. (2008) reported almost double the mean number of visits to medical professionals; whilst Goetzel et al. (2010) reported similar mean values to the present study. Furthermore, Goetzel et al. (2010) found significance between the normal weight and obese employees for number of visits to medical professionals. An increasing trend was observed for prevalence of hospital stays as well as accidents and injuries at work, with the highest prevalence observed in obese employees, though this was also not significant. Pollack and Cheskin (2007) found that excess body weight was associated with increased accidents and injuries at work, though this association was not found to be significant. Results from a study conducted by Vellinga, O'Donovan and de la Harpe (2008) support the association between excess body weight and increased number of days spent in hospital.

6.4 Lifestyle and Work-Related Factors Associated with Obesity (Part B)

6.4.1 Descriptive and Inferential Statistics of Lifestyle and Work-Related Factors

Prevalence of various lifestyle and work-related factors for males and females across BMI categories are reported in table 6.10. These include sedentary, physical, and dietary habits, as well as work hours and sleep.

Table 6.10: Lifestyle and work-related factors by weight status among corporate and industrial workers (N = 117)

	Males				Females			
	Normal weight < 25.0 kg/m^2 n = 14	**Over-weight 25.0-29.9 kg/m^2 n = 23**	**Obese ≥ 30.0 kg/m^2 n = 19**	**p-value <0.05**	**Normal weight < 25.0 kg/m^2 n = 19**	**Over-weight 25.0-29.9 kg/m^2 n = 12**	**Obese ≥ 30.0 kg/m^2 n = 30**	**p-value <0.05**
<u>Smoking status</u>								
Non (%)	92.3*	95.7*	94.7*	<0.05	90.0*	91.6*	96.7*	<0.05
Current (%)	7.7	4.3	5.3		10.0	8.3	3.3	
Alcohol consumption (%)	61.5*	60.8*	73.7*	<0.05	75.0*	33.3*	40.0*	<0.05#
<u>Alcohol: frequency</u>				NS				NS
Nearly every day (%)	7.7	0.0	5.3		0.0	8.3	0.0	
Several days per week (%)	15.4	0.0	10.5		5.0	0.0	3.3	

1-2 days per week (%)	15.4	21.6	31.6		20.0	8.3	16.7	
1-3 days per month (%)	15.4	30.6	0.0		25.0	0.0	10.0	
Less than once a month (%)	7.7	8.7	26.3		25.0	16.7	10.0	
Never (%)	38.4	39.1	26.3		25.0	66.7	60.0	
Alcohol: number of drinks per day				NS				NS
1-2 drinks (%)	14.3	57.1	57.1		86.7	75.0	50.0	
3-4 drinks (%)	57.1	28.6	28.6		6.6	25.0	33.3	
5-10 drinks (%)	14.3	14.3	14.3		6.7	0.0	16.7	
10+ drinks (%)	14.3	0.0	0.0		0.0	0.0	0.0	
Physical activity - walking				NS				
< 7 hours/week (%)	62.5	38.5	50.0		33.3	87.5*	68.8*	<0.05
> 7 hours/week (%)	37.5	61.5	50.0		66.7	12.5	31.2	
Physical activity – moderate				.080				
activity	28.6	42.8	0.0		0.0	25.0	30.4	
< 150 min/week (%)	42.9	7.2	33.3		20.0	12.5	21.7	
150-250 min/week (%)	28.5	50.0	66.7		80.0*	62.5	47.8	<0.05#
> 250 min/week (%)								
Physical activity - vigorous activity				NS				
< 75 min/week (%)	0.0	27.3	73.7		10.0	27.3	9.1	
> 75 min/week (%)	100	72.7	26.3		90.0*	72.7	90.9*	<0.05
Physical activity: total MET-min/week,				NS				NS
Low (%)	0.0	26.7	0.0		0.0	16.7	13.1	
Moderate (%)	33.3	40.0	46.2		41.2	50.0	30.4	
Vigorous (%)	66.7	33.3	53.8		58.8	33.3	56.5	
Time spent sitting (weekday)								
< 5 hours/week (%)	0.0	0.0	0.0		20.0	0.0	4.2	
5-20 hours/week (%)	33.3	13.3	12.5		20.0	25.0	12.5	
> 20 hours/week (%)	66.7	86.7*	87.5	<0.05	60.0	75.0	83.3*	<0.05
Time spent sitting (weekend)								
< 2 hours/week (%)	12.5	36.4	0.0		0.0	25.0	5.0	
2-8 hours/week (%)	25.0	54.5	11.1		15.4	25.0	45.0	
> 8-16 hours/week (%)	62.5	9.1	88.9*	<0.05	84.6*	50.0	50.0*	<0.05#
Dietary Habits								
> 5 servings FV daily (%)	0.0	16.7	0.0		6.3	0.0	10.7	
< 5 servings FV daily (%)	100.0	83.3	100.0		93.7	100.0	89.3	
Number snacks, mean (SD)	1.0 (0.0)	2.0 (0.0)*	3.0 (0.0)*	<0.05	1.0 (0.0)	2.0 (0.0)*	3.0 (0.0)	<0.05
Number SSB, mean (SD)	1.0 (0.0)	2.0 (0.0)*	3.0 (0.0)*	<0.05	1.0 (0.0)	2.0 (0.0)	3.0 (0.0)*	<0.05
Sleep problems								
Overall prevalence (%)	30.7	26.0*	35.2	<0.05	55.0	66.6	30*	<0.05
Getting to sleep (%)	7.7	8.7*	17.7*	<0.05	20.0	25.0*	10.0*	<0.05
Staying asleep (%)	7.7	13.0*	30.8*	<0.05	25.0*	16.7*	6.7*	<0.05
Waking too early (%)	23.1	8.7*	5.9*	<0.05	30.0	25.0	10.0*	<0.05
Feeling sleepy in the day (%)	15.4*	8.7*	23.5*	<0.05	30.0	25.0	10.0*	<0.05

SSB sugar-sweetened beverages
FV fruit and vegetables
*Significance computed by the non-parametric chi-square test
#Significance computed by the Mann-Whitney test

Table 6.10 reports the prevalence and associations of various lifestyle and work-related factors for males and females across BMI categories. A non-parametric chi-square test was used to determine associations between each variable and each BMI category; whereas the

Mann-Whitney test was used to determine whether significant differences existed between the BMI categories.

Being a non-smoker was significantly associated with each BMI category for both males and females, though no significant differences were observed between groups; this is consistent with results from part A. For both males and females, prevalence of smoking was highest in the normal weight employees, whilst obese females had the lowest prevalence of smoking; this is also consistent with results from part A. The trend observed in the present study is supported by studies conducted by Chang et al. (2012) and Cameron et al. (2012).

Obese males and females from all BMI categories were significantly associated with alcohol consumption, as opposed to abstinence from consuming alcohol. The Mann-Whitney test revealed significant differences between BMI categories, but only in females. Normal weight females had the highest prevalence of alcohol consumption, which was approximately double that of overweight and obese females. Obese males had a similar prevalence of alcohol consumption as normal weight females, while normal weight and overweight males' prevalence was only about 10% less than that of obese males. Quantity of alcohol consumption approached significance for both males ($p=.078$) and females ($p=.052$) across BMI categories. Of those males who consumed alcohol, approximately half of overweight and obese males only consumed 1-2 drinks on the days they drank, whereas approximately half of normal weight males consumed 3-4 drinks on the days they drank. Whilst the prevalence of alcohol consumption was highest in normal weight females, majority of normal weight females only consumed 1-2 drinks on the days they drank; this association was significant ($p=.000$). Three quarters of overweight female consumed 1-2 drinks, whereas one quarter consumed 3-4 drinks on the days they drank. Only 50% of obese females consumed 1-2 drinks, the other 50% consumed between 3 and 10 drinks on the days they drank. The present study's results regarding alcohol consumption habits are conflicting with published data. In support of the present study, Taris et al. (2011) found an association between alcohol consumption and BMI. In contrast to the present study's results, Chang et al. (2012) reported an increase in the prevalence of alcohol consumption with increasing BMI, and Cameron et al. (2012) found no association between BMI and alcohol consumption in men; however, obese women drank significantly less alcohol than normal weight and overweight women

Insufficient time spent walking in a week was significantly associated with overweight ($p=.034$) and obese females ($p=.007$), with differences between groups approaching significance (p=.087). Normal weight females had a significant association (p=.02) with sufficient moderate intensity exercise, with significant differences (p=.024) observed between BMI categories for females. Moderate intensity exercise for males only approached significance (p=.08), with majority of males from all BMI categories reporting sufficient moderate exercise. Sufficient vigorous exercise was significantly associated with normal weight (p=.011) and obese females (p=.007). Though no significance was observed amongst males, the majority of normal weight males reported sufficient vigorous exercise, whereas majority of obese males reported insufficient vigorous exercise. The majority of employees, from all BMI categories, met the requirements for minimal amount of exercise needed per week to maintain health. This requirement has been established by the ACSM, and is 150 minutes per week of moderate exercise, or 75 minutes per week of vigorous exercise (Thompson, Gordon & Pescatello, 2014). However, numerous authors have found that this is insufficient to prevent gain, and does not result in weight loss (Donnelly et al., 2009; Slentz, Houmard, & Kraus, 2009; Lee, Djoussé, Sesso, Wang, & Buring, 2010). These authors report that significant weight loss only occurs with more than 420 minutes of physical activity per week. Therefore, the overweight and obese employees may be meeting minimal requirements for health benefits, but it may not be sufficient for significant weight loss.

Weekday sitting was significantly associated with overweight males (p=.022) and obese females (p=.003), though no significance was observed between groups. The highest prevalence rates of sitting for more than 20 hours per week was observed in overweight and obese males and females. Weekend sitting was significantly associated with obese males (p=.020), normal weight females (p=.013) and obese females (p=.026). Significance between groups was observed in females, with the majority of normal weight females sitting for more than 8 hours on a weekend. The association between sitting and excess body weight is supported by Heinonen et al. (2013), Ryde, Brown, Peeters, Gilson and Brown (2013) and Lin, Courtney, Lombardi and Verma (2015).

Interestingly, fruit and vegetable (FV) intake was very poor for all employees across BMI categories. Current evidence of the association between FV intake and body weight changes is limited and not fully consistent; some authors reported that increased FV intake decreases weight gain, while others found no association between FV intake and BMI (Vioque, Weinbrenner, Castelló, Asensio & Hera, 2008; Buijsse et al., 2009; Henrique Bandoni, Bombem, Marchioni & Jaime, 2010; Ledoux, Hingle & Baranowski, 2011). An increasing trend was observed for the number of snacks eaten on a daily basis, with increasing BMI. Significant associations for increased number of snacks were observed with overweight (p=.005) and obese males (p=.029), as well as overweight females (p=.021). Differences between groups approached significance (p=.075) in males. A similar trend was observed for number of sugar-sweetened beverages (SSB) consumed on a daily basis. Increased consumption of SSB was associated with increased BMI, and was significant for overweight (p=.000) and obese males (p=.029), as well as obese females (p=.006). No significant differences were observed between BMI categories. The association between increased snacking and SSB consumption and BMI is supported by Ko et al. (2007), Di Milia and Mummery (2009), as well as Escoto et al. (2010).

Increased problems with getting to sleep was significantly associated with obese men (p=.008), and normal weight (p=.007) and obese females (p=.000); overweight females only approached significance (p=.083). Increased problems with staying asleep was significantly associated with overweight (p=.000) and obese males (p=.029), as well as normal weight (p=.025), overweight (p=.021) and obese females (p=.000). Waking up too early was significantly associated with obese females (p=.000), and feeling sleepy during the day was significantly associated with normal weight (p=.013) and obese males (p=.029), as well as obese females (p=.000). Though obese males, normal weight and overweight females seemed to have the highest prevalence of sleep problems, no significance was observed between groups. Literature reporting on the association between sleeping patterns and excess body weight is inconsistent. While some studies report associations between excess body weight problems with sleep, others report no association (Chaput, Després, Bouchard, & Tremblay, 2008; Marshall, Glozier, & Grunstein, 2008; Patel & Hu, 2008; Wu, Zhai, & Zhang, 2014).

Inferential statistics was used to compute the OR for smoking and alcohol for overweight and obese males and females, and is reported in table 6.11.

Table 6.11: OR of smoking and alcohol consumption across BMI categories (N = 117)

BMI	Sex	Smoking Status		Alcohol Consumption	
		OR	p-value <0.05	OR	p-value <0.05
> 25.0 kg/m^2	**Male**	Ref		Ref	
25-29.9 kg/m^2		1.8	NS	1.02	NS
≥ 30.0 kg/m^2		1.5	NS	0.5	NS
> 25.0 kg/m^2	**Female**	Ref		Ref	

25-29.9 kg/m^2		1.2	.099	6.0	<0.05
≥ 30.0 kg/m^2		3.2	NS	4.5	NS

When comparing the OR for smoking between genders and BMI categories, obese females had the highest OR for being a smoker, whilst overweight females had the lowest. The trend for smoking was opposite in males, with overweight males having a higher OR than obese males. Obese females had more than double the OR for smoking as compared to obese males. Chiolero, Jacot-Sadowski, Faeh, Paccaud, and Cornuz (2007) found that increased smoking was associated with increased BMI in both men and women, which is in partial support of the present study's results. The trend for alcohol consumption in males was similar to the trend for smoking, with overweight males having a higher OR than obese males. The trend was similar in females, with overweight females having a higher OR than obese females. Overall, overweight females had the highest OR for alcohol consumption, and this was observed to be significant. The author could not find studies reporting on OR values for alcohol consumption associated with BMI.

Table 6.12 presents the correlation between various lifestyle and work-related factors for each BMI category, including sedentary, physical, and dietary habits, as well as work hours and sleep.

Table 6.12: Correlation of lifestyle and work-related factors by weight status among corporate and industrial workers (N = 117)

Variables	**Normal weight < 25 kg/m^2 n = 33**		**Overweight 25-29.9 kg/m^2 n = 35**		**Obese ≥ 30 kg/m^2 n = 49**	
	r	**p**	**r**	**p**	**r**	**P**
Physical fatigue and mental fatigue	.510**	.002	.472**	.000	.596**	.001
Time spent sitting on a weekday and –						
− Time spent sitting on a weekend	-.101	.637	.174	.427	.622*	.000
− Time spent walking	-.196	.407	-.049	.833	-.341	.08
− Time spent performing moderate activity	.056	.804	-.240	.281	.047	.798
− Time spent performing vigorous activity	-.194	.489	-.405	.151	-.502*	.047
Time spent sitting on a weekend and –						
− Time spent walking	-.293	.211	-.441*	.046	-.222	.275
− Time spent performing moderate activity	.166	.462	-.139	.537	-.078	.670
− Time spent performing vigorous activity	-.537*	.039	.121	.680	-.330	.211

Poor sleep and – − Time spent walking − Time spent performing moderate activity − Time spent performing vigorous activity	 -.124 -.254 -.342	 .603 .255 .212	 -.105 .009 .211	 .652 .968 .448	 -.018 .052 .267	 .929 .778 .318
Hours worked and – − Time spent on leisure time walking − Time spent on moderate leisure time activity − Time spent on vigorous leisure time activity − Total MET-min/week for leisure time activities	 -.284 -.169 -.139 .185	 .347 .599 .651 .462	 -.149 -.222 -.349 -.277	 .596 .321 .358 .265	 -.488 .646 -.117 .056	 .091 .239 .747 .827
Time spent sitting on a weekday and – − Time spent on leisure time walking − Time spent on moderate leisure time activity − Time spent on vigorous leisure time activity − Total MET-min/week for leisure time activities	 .372 -.215 -.154 .149	 .210 .503 .616 .554	 -.235 .655 .306 .110	 .400 .231 .423 .663	 .259 -.302 .236 .030	 .392 .622 .511 .905
Time spent sitting on a weekend and – − Time spent on leisure time walking − Time spent on moderate leisure time activity − Time spent on vigorous leisure time activity − Total MET-min/week for leisure time activities	 -.047 -.638* -.049 -.327	 .880 .02 .875 .185	 .763** .154 .439 -.486*	 .002 .805 .277 .041	 -.099 .339 -.335 -.249	 .748 .577 .344 .320
Occupational physical activity and leisure time physical activity (MET-min/week)	.113	.728	-.337	.341	-.085	.782

Correlation r is practically significant at 0.05 if lrl > 0.30
*p is significant at p<0.05
**p is significant at p<0.01

The results in table 6.12 indicate statistical and practically significant differences (p<0.05; r>0.3) for physical fatigue and mental fatigue for normal weight, overweight and obese employees. Furthermore, an inverse association was observed between time spent sitting on a weekend and time spent performing vigorous activity, as well as time spent sitting on a weekend and time spent on moderate leisure time activity, for normal weight employees. Though practical significance was observed for normal weight employees for poor sleep and decreased vigorous activity, as well as time spent sitting on a weekday and time spent on leisure time walking; these differences were not statistically significant. These results are supported by Stamatakis, HIrani and Rennie (2008).

In overweight employees, increased time spent sitting on a weekend was statistical significantly associated with decreased time spent walking, as well as decreased time spent on leisure activities. Though not statistically significant, the following practical significances were observed: 1) increased time spent sitting during the week was associated with increased moderate and vigorous leisure time activity, 2) increased time spent working was associated with decreased vigorous activity, 3) increased occupational physical activity was associated with decreased leisure time physical activity. These results are supported by Hadgraft et al. (2015).

In obese employees, increased time spent sitting during the week was significantly ($p<0.05$; $r>0.3$) associated with increased time spent sitting on a weekend. Practical and statistical significance was furthermore observed between increased sitting time during the week and decreased vigorous activity. Increased sitting time during the week was inversely associated with walking; however, this only approached statistical significance. Increased sitting time on the weekend was inversely associated with vigorous physical activity; however, this was not statistically significant. Practical significance was also observed between increased hours worked and decreased walking during leisure time. These results are supported by Hadgraft et al. (2015).

6.5 Quality of Life (Part B)

Table 6.13 presents the overall indicators of quality of life for each BMI category, including self-rated quality of life and self-rated health.

Table 6.13: Prevalence of QOL indicators by BMI category (N = 117)

Indicator	**BMI category**			
	Normal weight < 25 kg/m^2 n = 33	**Overweight 25-29.9 kg/m^2 n = 35**	**Obese ≥ 30 kg/m^2 n = 49**	**p-value <0.05**
	%	**%**	**%**	
Self-rated quality of life				
Very good, good	78.8*	80.0*	71.4*	<0.05
Neither good nor poor	15.2	17.1	22.4	
Poor or very poor	6.1	6.1	6.1	
Self-rated health				
Very satisfied or satisfied	81.8*	74.3*	57.1*	$<0.05^{\#}$
Neither satisfied nor dissatisfied	12.1	22.9	18.4	
Dissatisfied or very dissatisfied	6.1	2.9	24.5	

*Significance computed by the non-parametric chi-square test

#Significance computed by the Mann-Whitney test

The non-parametric chi-square test found a significant association between self-rated quality of life and self-rated health for normal weight, overweight, and obese employees. However, the Mann-Whitney test only found a significance difference (p=0.15) between groups for self-rated health. The majority of normal weight employees, as compared to just over 50% of obese employees, were very satisfied or satisfied with their health. Less than 10% of normal weight employees were dissatisfied or very dissatisfied with their health, whilst a quarter of obese employees were dissatisfied or very dissatisfied. Three-quarters of overweight employees were very satisfied or satisfied with their health, whilst almost a quarter were neither satisfied nor dissatisfied. No significant differences between groups were observed for self-rated QOL. Numerous studies found no significant differences between normal weight individuals and overweight individuals; however, significance was found between normal weight and obese individuals (Fjeldstad, Fjeldstad, Acree, Nickel, & Garner, 2008; de Zwaan et al., 2009; Backholer, Wong, Freak-Poli, Walls, & Peeters, 2012).

Table 6.14 reports descriptive statistics for various quality of life domains for each BMI category. These domains include physical health, psychological health, social relationships and environmental quality of life.

Table 6.14: Comparison of quality of life domains across BMI categories (N = 117)

	Normal weight < 25 kg/m^2 n = 33	**Overweight 25-29.9 kg/m^2 n = 35**	**Obese ≥ 30 kg/m^2 n = 49**	**p-value <0.05**
Physical health, mean (SD)	29.21 (3.19)	27.63 (3.71)	26.69 (4.25)	<0.05#
Psychological health, mean (SD)	23.76 (3.07)	22.60 (3.65)	22.31 (3.10)*	<0.05#
Social relationships, mean (SD)	12.30 (2.11)	11.40 (1.91)*	11.24 (1.92)*	<0.05#
Environmental quality of life, mean (SD)	29.74 (3.9)	29.11 (4.5)	28.14 (5.0)	<0.05#

*Significance computed by the non-parametric chi-square test
#Significance computed by the Mann-Whitney test

The non-parametric chi-square test indicated a significant association (p=.041) between social relationships and overweight employees, and significance was approached (p=.081) for physical health. Furthermore, psychological health (p=.039) and social relationships (p=.000) were significant for obese employees. The Mann-Whitney test found significance differences between BMI groups for all the domains tested. In all domains, normal weight employees had higher mean scores for the various quality of life domains, as compared to overweight and obese employees. These results are supported by Hitt, McMillen, Thornton-Neaves, Koch and Cosby (2007), Fjeldstad et al. (2008), Backholer et al. (2012) and de Zwaan et al. (2009).

Table 6.15 presents the correlation between various quality of life indicators across the BMI categories. These indicators include enjoyment and meaningfulness of life, ability to function daily, satisfaction with sleep, personal relationships and capacity to work, as well as physical pain and medical treatment.

Table 6.15: Correlations of various QOL indicators and BMI (N = 117)

Variables	Normal weight < 25 kg/m^2 n = 33		Overweight 25-29.9 kg/m^2 n = 35		Obese ≥ 30 kg/m^2 n = 49	
	r	p	r	p	r	p
Enjoyment of life and meaningfulness of life	.662**	.000	.691**	.000	.472**	.001
Ability to perform ADLs and enjoyment of life	.358*	.04	-0.002	.99	.470**	.001
Satisfaction with personal relationships and enjoyment of life	.436*	.01	.315	.06	.382**	.007
Physical pain and –						
− Need for medical treatment to function	.658**	.000	.650**	.000	.600**	.000
− Ability to perform ADLs	.152	.39	.204	.24	.287*	.04
Ability to perform ADLs and capacity to work	.219	.22	.511**	.002	.435**	.002
Sleep satisfaction and –						
− Sufficient energy	.199	.26	.246	.15	.492**	.000
− Ability to concentrate	.542**	.001	.481**	.003	.369**	.01
− Negative feelings	.279	.116	.443**	.009	.401**	.005
Sufficient energy and –						
− Ability to concentrate	.320	.07	.193	.26	.478**	.001
− Ability to perform ADLs	.078	.66	.180	.30	.385**	.006
Ability to concentrate and capacity to work	.456**	.008	.448**	.007	.259	.07

ADLs – activities of daily living
Correlation r is practically significant at 0.05 if lrl > 0.30
*p is significant at p<0.05
**p is significant at p<0.01

The results in table 6.15 indicate statistically and practically significant differences (p<0.05; r>0.3) for enjoyment of life and meaningfulness of life for normal weight, overweight and obese employees. Furthermore, a statistically and practically significant difference was observed for physical pain and need for medical treatment to function for employees from all

BMI categories. This association is supported by Fjeldstad et al. (2008), as well as Stone and Broderick (2012). In normal weight and obese employees, the ability to perform ADLs was associated with enjoyment of life; while in overweight and obese employees, the ability to perform ADLs was associated with capacity to work. In obese employees, increased physical pain was associated with decreased ability to perform ADLs. Normal weight and obese employees had greater enjoyment of life if they had greater satisfaction with personal relationships; however, this association only approached statistical significance in overweight employees. Similar results were found by Hitt et al. (2007), Backholer et al. (2012) and Pataky et al. (2014).

Normal weight and overweight employees had increased ability to concentrate with increased sleep satisfaction, and this was furthermore associated with increased capacity to work. The association between sleep satisfaction and ability to concentrate was also observed in obese employees; however, the association between increased concentration and increased capacity to work only approached significance. Decreased sleep satisfaction was associated with increased negative feelings in overweight and obese employees; however, in obese employees increased sleep satisfaction was associated with both sufficient energy and ability to concentrate. Furthermore, sufficient energy was associated with both ability to concentrate and ability to perform ADLs in obese employees only. These results are supported by Banks and Dinges (2007), Kobayashi, Takahashi, Deshpande, Shimbo and Fukui (2012) and Campbell et al. (2015). There were no other statistically significant differences for the various quality of life indicators across BMI categories.

6.6 Absenteeism and Presenteeism, and the Economic Burden of Obesity (Part B)

The prevalence of presenteeism across BMI categories is reported in table 6.16.

Table 6.16: Prevalence of presenteeism associated with excess body weight (N = 117)

	Normal weight < 25 kg/m^2 n = 33	**Overweight 25-29.9 kg/m^2 n = 35**	**Obese ≥ 30 kg/m^2 n = 49**	**p-value <0.05**
Presenteeism (%)	6.3%	17.1%*	18.8%*	<0.05

*Significance computed by the non-parametric chi-square test
#Significance computed by the Mann-Whitney test

The prevalence of presenteeism increased with increasing BMI, with the highest prevalence observed in obese employees. Non-parametric chi-square revealed that presenteeism was significantly associated with both overweight and obese employees. Though no significance was observed between groups, obese employees had three times the prevalence of presenteeism as compared to normal weight employees. The prevalence of presenteeism amongst overweight employees was only slightly less than that observed in obese employees. Goetzel et al. (2010) and Yu, Wang and Yu (2015) found similar presenteeism prevalence rates amongst overweight and obese employees. Bustillos, Vargas and Gomero-Cuadra (2015) found similar presenteeism prevalence rates amongst obese workers, however, reported lower prevalence (12.7%) amongst overweight workers compared to the present study.

Inferential statistics was used to compute the OR for presenteeism for overweight and obese employees, and is reported in table 6.17.

Table 6.17: OR of presenteeism for BMI categories (N = 117)

BMI	Presenteeism	
	OR	p-value <0.05
< 25.0 kg/m^2	Ref	
25-29.9 kg/m^2	3.125	NS
≥ 30.0 kg/m^2	3.461	NS

Obese employees had the highest OR for presenteeism, with the OR for overweight employees being only slightly less. Though no significance was observed between groups, obese employees were almost four times as likely to have presenteeism as compared to normal weight employees. Goetzel et al. (2010) and Yu et al. (2015) found similar OR values for presenteeism, whilst Bustillos et al. (2015) reported lower OR values for both overweight (1.30) and obese (2.00) employees compared to the present study. Descriptive statistics for absenteeism rates for each BMI category is reported in table 6.18.

Table 6.18: Comparison of absenteeism rates across BMI categories (N = 117)

	Normal weight < 25 kg/m^2 n = 33	Overweight 25-29.9 kg/m^2 n = 35	Obese ≥ 30 kg/m^2 n = 49	p-value <0.05
Days absent, mean (SD)	0.39 (0.0)	0.56 (0.0)	1.33 (0.0)	NS

*Significance computed by the non-parametric chi-square test
#Significance computed by the Mann-Whitney test

Table 6.18 reflects the average number of days employees are absent from work each month due to illness, for each of the different BMI categories. An increasing trend is observed from normal weight employees to obese employees, though this is not significant. Normal weight employees have almost half a day absent each month due to illness, whilst obese employees have nearly one and half days absent each month; which is three times more than what normal weight employees are. Overweight employees have just over half a day absent each month due to illness, which is more similar to normal weight employees than obese employees. Tsai et al. (2008) and Andreyeva, Luedicke and Wang (2014) found similar absenteeism rates for normal weight and overweight employees, with no significance between the two groups. However, these studies reported that obese employees were absent significantly more than normal weight employees were, though the mean value reported was lower than that found in the present study. A study conducted by Frone (2008) found no significance across BMI categories for absenteeism rates.

Inferential statistics was used to compute the incidence proportion, incidence rate, as well as risk ratio for absenteeism across the BMI categories; this is reported in table 6.19.

Table 6.19: Incidence proportion, incidence rate and risk ratio for absenteeism across BMI categories (N = 117)

BMI	Incidence Proportion	Incidence Rate (person-year)	Risk Ratio
Normal weight > 25.0 kg/m^2	0.39	4.68	Ref
Overweight 25-29.9 kg/m^2	0.57	6.84	1.43
Obese ≥ 30 kg/m^2	1.32	15.84	3.41

In the present study, the incidence proportion reflects the average number of days employees are absent from work in one month, whilst the incidence rate reflects absence frequency rates for the period of 12 months. The risk ratio indicates that overweight employees are nearly one and half times more likely to be absent from work as compared to normal weight employees, whilst obese employees are nearly three and a half times more likely to be absent. This equates to a percentage increase of 43% for overweight employees, and 241% for obese employees, as compared to normal weight employees. As absenteeism has not been reported in this manner by other authors, comparisons were not able to be made.

Table 6.20 reports excess number of workdays lost per year due to excess body weight, for the study cohort.

Table 6.20: Excess workdays lost due to excess body weight (N = 117)

Weight group	Workdays lost (per employee per year)	Excess workdays lost	% total study population (n = 117)	Total absence days (per year)	Total excess workdays lost (per year)
Normal	4.68	Ref	28.20 (33)	154.44	Ref
Overweight	6.84	2.16	29.91 (35)	239.4	75.6
Obese	15.84	11.16	41.88 (49)	776.16	546.84
Combined	-	-	100.0% (117)	1170	622.44

Table 6.20 computes the excess workdays lost by overweight and obese employees due to illness, by comparing absence frequency to normal weight employees. For the present study cohort, overweight employees lost an excess of 75.6 days in one year, whereas obese employees lost an excess of 546.84 days in one year. Excess workdays lost by overweight and obese employees reported in the present study are higher than that reported by Tsai et al. (2008) and Andreyeva et al. (2014).

The total cost of absenteeism per year due to excess body weight is described as obesity-attributable absenteeism costs, and is presented in table 6.21.

Table 6.21: Obesity-attributable absenteeism costs (N = 117)

Weight group	Total excess workdays lost (per year)	Average cost per employee per day (R)	Total cost of absenteeism per year (R)
Overweight	75.6	416.66 - 624.99	31 499.49 – 47 249.24
Obese	546.84	625.00 - 833.32	341 775.00 – 455 692.70

Table 6.21 computes the total cost of absenteeism of overweight and obese employees for the study cohort, for the period of one year. Average cost per employee per day was slightly less for overweight employees compared to obese employees. Overweight employees cost their respective companies in the range of R30 000 to R50 000 for the period of one year, and obese employees incurred a cost in the range of approximately R340 000 to R450 000. Together, overweight and obese employees incurred a cost of nearly half a million rand for the period of one year. These costs are calculated specifically for the study cohort, and would be substantially greater when calculated for the entire working population of South Africa.

Though these results cannot be compared to costs incurred in other countries, companies in South Africa can apply these findings within the context of the company to compute possible costs incurred by overweight and obese employees.

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CHAPTER SEVEN

SUMMARY, CONCLUSION, LIMITATIONS AND RECOMMENDATIONS

7.1 Summary

Obesity has long been recognized as a global burden of disease and the concern associated with obesity stems from the negative impact that obesity has on health and wellness, as well as on the economy (Borak, 2011). The trend of increasing prevalence of obesity is not only a public health concern, but employers have noticed the rising rates of obesity among their employees in the workplace (Luckhaupt, Cohen, Li, & Calvert, 2014; Nobrega et al., 2016). A number of health behaviours have been investigated for their association with excess body weight (Ko et al., 2007; Sallis & Glanz, 2009; Hu & Malik, 2010; Taris et al., 2011). These health behaviours include sedentary habits at work, dietary habits such as snacking, fruit and vegetable consumption, and the consumption of snacks and sugar-sweetened beverages, smoking, alcohol consumption, and sleeping patterns. Excess body weight and adverse health behaviours have been associated with the development, and exacerbation of obesity comorbidities (Sullivan, Ghushchyan, & Ben-Joseph, 2008; Goetzel et al., 2010). Evidence suggests that excess body weight and disease comorbidities have a negative influence on the various aspects of quality of life (Kruger, Bowles, Jones, Ainsworth, & Kohl, 2007; Taylor, Forhan, Vigod, McIntyre, & Morrison, 2013). These domains include physical, mental, social, and environmental quality of life. Furthermore, excess body weight has been associated with reduced productivity in the workplace, including absenteeism from work, and presenteeism at work (Lehnert, Sonntag, Konnopka, Riedel-Heller, & König, 2013; Andreyeva, Luedicke, & Wang, 2014). Monetary losses from reduced productivity form part of the burden of disease associated with excess body weight, and are known as obesity-attributable costs (Andreyeva et al., 2014). Though extensive research has been conducted in America and a few other countries, research that has been conducted in South Africa is outdated and very limited.

The overall aim of this study was to assess the work health-related profile of overweight and obese employees, to establish the cost implication of these employees in South African industrial and corporate companies, and to develop a health promotion model to address overweight individuals and obesity in the workplace.

In line with the above overall aim, the questions that this research endeavours to answer is to ascertain the prevalence of being overweight, and obesity, in corporate and industrial employees in South Africa, as well as the prevalence of comorbidities and risk factors in these employees. Moreover, the study explored the lifestyle and work-related factors associated with overweight and obese corporate and industrial employees, including physical activity and sedentary habits, dietary habits, sleeping patterns, alcohol consumption, smoking status, and work hours. The study also investigated the quality of life of overweight and obese corporate and industrial employees, compared to normal weight counterparts. Furthermore, the study investigated the association of excess body weight with productivity, namely absenteeism and presenteeism, as well as the absence frequency rates and associated costs. Answers to these questions should provide important information regarding the work health-related behaviours and economic costs of overweight and obese corporate and industrial employees in South Africa; and furthermore contribute to the development of a workable health promotion model, unique to SA, to address obesity in the workplace.

Due to the above-mentioned research questions, the objectives of the study were the following:

1. To establish the prevalence of overweight individuals and obesity in corporate and industrial employees in South Africa.

2. To establish the prevalence of comorbidities and risk factors associated with overweight and obese corporate and industrial employees compared to normal weight employees.

3. To establish the lifestyle and work-related factors associated with overweight and obese corporate and industrial employees, such as physical activity habits and sedentary habits, dietary habits, sleeping patterns, alcohol consumption, smoking status, and work hours.

4. To ascertain the quality of life of overweight and obese corporate and industrial employees compared to normal weight employees.

5. To establish the association of excess body weight with productivity, namely absenteeism and presenteeism in corporate and industrial employees.

6. To determine the contribution of overweight- and obesity-related absence frequency rates and associated costs to the economic burden of excess body weight in corporate and industrial South African employees.

7. To develop a health promotion model, unique to SA, to address obesity in the workplace.

Chapter 1 provided the introduction to the research study, problem statement, the objectives and research questions.

Chapter 2 provided evidence for prevalence rates of being overweight, and obesity, within the general population, validity and accuracy of BMI as a measurement of excess body weight, physiological changes that occur within the body due to excess body weight and the associated health concerns, and factors contributing to the development of obesity.

Chapter 3 provided evidence for the prevalence rates of overweight and obese employees within the workplace, lifestyle habits and work-related factors associated with overweight and obese employees, prevalence of comorbidities in overweight and obese employees, quality of life of overweight and obese employees, and cost of illness from reduced productivity associated with overweight and obese employees.

Chapter 4 was presented in the form a research article. The pilot study article titled, **"**Effect of Obesity on the Work Health-Related Behaviours and Quality of Life of South African Mining Employees: A Pilot Study" was published in the Global Journal of Health Sciences.

Chapter 5 described the methodology used in the present study. This chapter included the study design, information regarding the study participants, description of the measurements and test protocols used to collect the data, how the data was computed and analysed, as well as the ethical considerations.

The results of the study, as presented in **chapter 6**, are presented and discussed according to hypotheses of the study.

Chapter 7 presents a short summary and conclusion of the study, followed by recommendations for possible further research. Included in the recommendations is a health promotion model, unique to SA, aimed at addressing obesity in the workplace.

7.2 Conclusions

The conclusions of this research are presented according to the hypotheses of this study as presented in chapter 1:

1. The prevalence of overweight individuals, and obesity, in corporate and industrial employees in South Africa can be compiled from this study.

Statistical analysis of the data comprised descriptive summary statistics (mean and standard deviations). Due to the larger sample size, prevalence rates of being overweight and obesity will be more accurate for data from part A. From the descriptive data, prevalence rates of overweight and obese men were 46.4% and 24.4%, respectively, while prevalence rates for overweight and obese women were 26.7% and 18.3%, respectively. Hypothesis 1 can therefore be accepted.

2. Obese and overweight employees will have more obesity-related comorbidities and health risk factors than that of normal weight employees.

Statistical analysis of the data comprised descriptive summary statistics (mean and standard deviations), non-parametric chi-square test to measure significant associations between variables and each BMI category, as well as the Mann-Whitney test to establish statistical significances between different groups. Data from both parts A and B indicated increasing prevalence of comorbidities with increasing BMI. Diabetes, hypertension, cardiovascular disease, and hypercholesterolemia were all significantly ($p<0.05$) associated with BMI for both parts A and B. The Mann-Whitney test revealed that significant differences ($p<0.01$) were found between groups for each of the parameters tested in part A, whereas in part B no significant differences were observed between groups; although significance was approached in hypercholesterolemia ($p=.06$). Results from part B indicated that the majority of normal weight employees had no health risk factors, while less than 50% of obese employees had no health risk factors. The prevalence of obese employees with one health risk factor was more than double that of normal weight employees. A decreasing trend was observed for prevalence of employees with no health risk factors, as one moved from the normal weight, to overweight, to the obese BMI category. An increasing trend was observed for prevalence of employees with one health risk factor, with increased BMI. The prevalence of employees with two risk factors was lowest in overweight employees and highest in obese employees, whilst the prevalence of employees with three risk factors was lowest in normal weight employees, and highest in overweight employees. Hypothesis 2 can therefore be accepted.

3. Obese and overweight employees will have poorer lifestyle and work-related factors such as physical activity habits and sedentary habits, dietary habits, sleeping patterns, alcohol consumption, and smoking status, than that of normal weight employees.

Statistical analysis of the data comprised descriptive summary statistics (mean and standard deviations), non-parametric chi-square test to measure significant associations between variables and each BMI category, as well as the Mann-Whitney test to establish statistical significances between different groups.

Being a non-smoker was significantly associated ($p<0.05$) with each BMI category for both males and females, though no significant differences were observed between groups. For both males and females, prevalence of smoking was highest in the normal weight employees, whilst obese females had the lowest prevalence of smoking.

Significantly ($p=.016$) more normal weight females, as compared to overweight and obese females consumed alcohol, while the consumption of alcohol was similar for males from all BMI categories. Though the trend for quantity of alcohol consumed indicated that more overweight and obese females consumed 3-4 drinks on the days they consumed alcohol, as compared to normal weight females, a reversed trend was observed in males.

Overweight and obese females spent less time walking as compared to normal weight females, this approached significance (p=.087); whereas no differences were observed in males. Furthermore, a significant amount of normal weight females performed sufficient moderate intensity exercise, whilst a significant amount of overweight and obese females did not perform sufficient moderate intensity exercise (p=.024). The majority of males from all BMI categories reported sufficient moderate exercise. Sufficient vigorous exercise was significantly associated with normal weight (p=.011) and obese females (p=.007). Though no significance was observed amongst males, the majority of normal weight males reported sufficient vigorous exercise, whereas majority of obese males reported insufficient vigorous exercise.

Interestingly overweight and obese employees spent greater amounts of time sitting during the week than normal weight employees, however normal weight employees spent greater amounts of time sitting on the weekend as compared to overweight and obese employees. Weekday sitting was significantly associated with overweight males (p=.022) and obese females (p=.003), though no significance was observed between groups. Weekend sitting was significantly associated with obese males (p=.020), normal weight females (p=.013) and obese females (p=.026).

An increasing trend was observed for the number of snacks eaten on a daily basis, as well as number of SSB consumed, with increasing BMI. Significant associations ($p<0.05$) for increased number of snacks, as well as SSB were observed with overweight and obese males, as well as overweight females.

Obese males, normal weight and overweight females seemed to have the highest prevalence of sleep problems, though no significance was observed between groups. Normal weight, overweight, and obese males and females were all significantly associated ($p<0.05$) with at least one sleep problem.

Health behaviours that are not observed to be poorer in overweight and obese employees include smoking and alcohol consumption. Health behaviours that are prevalent in overweight and obese employees, but are also observed to some extent in normal weight employees include poor physical activity habits, increased sedentary habits, and problems with sleep. Overweight and obese employees very clearly had poorer dietary habits compared to normal weight employees. Thus, hypotheses 3 can be partially accepted.

4. Obese and overweight employees will have poorer quality of life scores compared to normal weight employees.

Statistical analysis of the data comprised descriptive summary statistics (mean and standard deviations), non-parametric chi-square test to measure significant associations between variables and each BMI category, as well as the Mann-Whitney test to establish statistical significances between different groups. A significant association ($p<0.05$) between self-rated quality of life and self-rated health for normal weight, overweight, and obese employees was observed. Normal weight employees were significantly ($p=.015$) more satisfied with their health than overweight and obese employees were. A significant association ($p=.041$) was observed between social relationships and overweight employees, and significance was approached ($p=.081$) for physical health. Furthermore, psychological health ($p=.039$) and social relationships ($p=.000$) were significant for obese employees. In all domains of QOL, normal weight employees had higher mean scores for the various quality of life domains, compared to overweight and obese employees. Hypothesis 4 can therefore be accepted.

5. Obese and overweight employees will have greater absence frequency rates (decreased productivity) than that of normal weight employees.

Statistical analysis of the data comprised descriptive summary statistics (mean and standard deviations), non-parametric chi-square test to measure significant associations between variables and each BMI category, as well as the Mann-Whitney test to establish statistical significances between different groups. The prevalence of presenteeism increased with increasing BMI, with presenteeism being significantly associated ($p<0.05$) with both overweight and obese employees. The prevalence of absenteeism increased with increasing BMI, and though significance was not observed between groups, the absence frequency rates was similar to that reported in other studies. Hypothesis 5 can therefore be accepted.

6. Obese and overweight employees will present a greater economic burden than that of normal weight employees.

Overweight employees cost their respective companies in the range of R30 000 to R50 000 for the period of one year, and obese employees incurred a cost in the range of approximately R340 000 to R450 000. Together, overweight and obese employees incurred a cost of nearly half a million rand. These costs are calculated specifically for the study cohort, and would be substantially greater when calculated for the entire working population of South Africa. Hypothesis 6 can therefore be accepted.

7. Based on the results of the study a health promotion model, that will be unique to SA, can be developed to address obesity in the workplace.

Results from the study provides important information regarding the health behaviours of corporate and industrial employees in South Africa. This information has been used in conjunction with the socio-ecological model (SEM) to develop a health promotion model that can be used to address overweight and obesity in the workplace. This model has been described in detail in chapter 7. Thus, hypothesis 7 can be accepted.

7.3 Limitations

The following limitations are acknowledged in the present study:

- The sample size of part B of the study was very small due to the poor response rate by employees. However, results from the study are supported by results found in other studies.
- Aspects of the data was self-reported, and collected with the use of questionnaires; which relies on honesty from the participants.
- Data was collected using a cross-sectional, observational design; thus, it can only be used to determine associations, and not causative effects.

7.4 Recommendations

From this study, it is clear that there is a specific need for further research on the following aspects to expand on the knowledge on the work health-related behaviours and economic costs of overweight and obese employees in South Africa.

- Research is needed to create a national database on employees in South Africa, regarding their physical activity, dietary, smoking, and alcohol consumption habits, as well as sleeping patterns. Furthermore, quality of life, absenteeism and presenteeism should be included. Demographic information, inclusive of body composition, also needs to be included in this database. Databases such as these are available in other countries; South Africa however, does not have such a database.

- A longitudinal study needs to be done to assess the changes in body composition of employees in South Africa, as well as the changes in the prevalence of associated comorbidities.
- Further research is needed to explore the causative factors associated with the development of obesity. These include sedentary, physical activity, dietary, smoking, and alcohol consumption habits, as well as sleeping patterns.
- Intervention studies need to be conducted to assess the efficacy of the health promotion model developed in the present study, and the effect this model will have on economic parameters such as presenteeism, absenteeism, health care costs, short and long-term disability, workers' compensation, and turnover.

7.5 Model

7.5.1 Introduction

Health promotion practices traditionally focused on individual change in health behaviours, such as exercise, diet, smoking, and alcohol consumption. These interventions have proven to be ineffective, and changes in health behaviour are not sustained (Grief & Miranda, 2010). Thus, attempts have been made to address environmental influences on health behaviours within the workplace. The World Health Organization's Ottawa Charter for Health Promotion stated that health promotion programmes aim to reduce the differences in current health status, and ensure equal opportunities and resources to all. It was further stated that people cannot achieve their fullest health potential unless they are able to take control of those things which determine their health (WHO, 1986). Health behaviours represent decisions based on intrinsic factors, such as knowledge, beliefs and motivation, as well as the physical and psychosocial environment. Thus, the health promotion model that has been developed is based on a multi-faceted approach, in order to address obesity in the workplace from the intrapersonal level through to the top level of public policy.

7.5.2 Objectives of the Health-Promotion Model (HPM)

The main objective of the HPM is to use a multi-faceted approach to address obesity in the workplace; thus, the objectives of the HPM are outlined according to the different levels of the HPM (figure 7.1).

<u>Intrapersonal and interpersonal:</u>

- To change the attitudes, perceptions and behaviours towards health, by improving employees' value placed on and satisfaction with active lifestyle and healthy diet.
- To empower employees towards healthy decision-making, by educating and improving awareness of healthy living.
- To support individual change.
- To improve employees' perception of the work environment as health-oriented and increase perceived interpersonal and organizational support for healthy habits.
- To increase healthy lifestyle habits, such as physical activity and healthy diet, and decrease unhealthy lifestyle habits such as smoking and alcohol consumption.

Organizational and community:

- To support changes needed in the environment.
- To provide accessibility of "health" to people in low socio-economic positions, for example exercise facilities, healthy food options, health care, and education.
- To establish a participatory infrastructure between employees and management for the purpose of involving employees in decision-making.

Public policy:

- To engage and maintain companies' management and trade union leaders' support for policy, physical, and social environment changes.
- To establish and maintain senior and middle management support for employee physical activity and healthy dietary choices at work and within their personal lives.
- To facilitate better work-family balance.

7.5.3 Implementation Strategy of the Health-Promotion Model

Phase one:

- Engage with company leadership to obtain buy-in.
- Develop a broad 3-5 year plan, as well as annual plans with detailed action plans for each specific activity, program or policy.

- Gather demographic data about the workforce, as well as baseline data on absenteeism, presenteeism and short- and long-term disability.
- Establish baseline health measurements, such as body composition, blood pressure, blood glucose and cholesterol etc.
- Identify current health behaviour practices.
- Evaluate attitudes and feelings towards making changes.
- Establish short-term and long-term goals that fits within employees' individual lifestyles.

Phase two:

- Make incremental changes with regards to policies and resources.
- Increase awareness of health.
- Individual consultation with dietician: provide shopping lists (with costing), meal plans, and recipes.
- Individual consultation with clinical exercise physiologists and/or fitness instructors: provide exercise plans and routines.
- Reinforce with incentives and rewards.

Phase three:

- Re-evaluate the 3 to 5 year plan and update it.
- Monitor changes over time.
- Reinforcement and maintenance of the change in behaviours outlined above.

7.5.4 Health-Promotion Model

Figure 7.1 below describes the health promotion model developed by the author, which has been adapted from Wilson et al. (2007), Zapka et al. (2007), and Eisenmann et al. (2008). Following that is a detailed explanation of the model, and how it may be applied within the workplace. Certain aspects are repeated at several levels and this lends to reinforcement of healthy habits, building an environment that supports healthy habits, and changing the socially acceptable norms within the workplace.

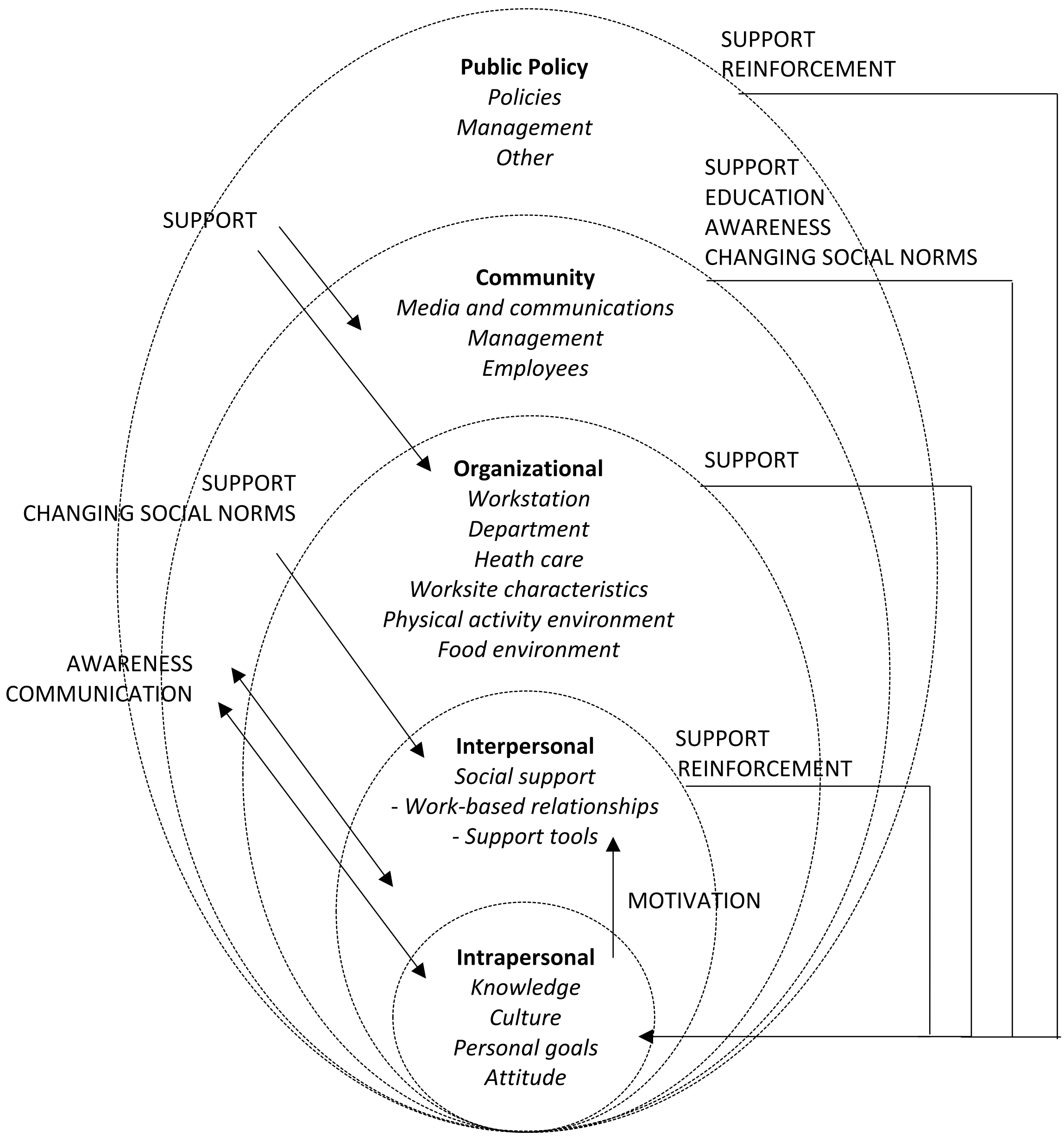

Figure 7.1 Health promotion model, adapted from Wilson et al. (2007), Zapka, Lemon, Estabrook and Jolicoeur, (2007), and Eisenmann et al. (2008).

7.5.4.1 Intrapersonal Level

- Knowledge

One of the key aspects for effective change in behaviour is education. Effective education is not just about teaching individuals' knowledge, but it needs to include understanding individuals' attitudes and beliefs, and applying the knowledge within each individual's lifestyle. Employees need to be educated on various health behaviours such as sedentary, physical activity, dietary, smoking, and alcohol consumption habits. Employees need not only to be educated, but also to be taught how to apply this knowledge to everyday life. This may include the following: 1) defining sedentary activities and how to limit time spent on sedentary activity, 2) defining active living, and how to increase incidental workday and personal time on physical activity, 3) determining what is purposeful exercise and how to fit it into daily schedules, 4) making healthy food choices, food preparation, and portion sizes, 5) providing weekly meal plans, recipes, shopping lists, and costing, 6) highlighting the negative effects of smoking and alcohol consumption on health, and methods used to decrease and stop these habits.

- Culture

In South Africa, specifically in the black culture, a large body mass has been perceived to be advantageous and associated with acceptance. An overweight body image is associated with dignity, respect, wealth, strength, happiness and health, as well as with being treated well by their husbands (Joubert et al., 2007). Thus, education regarding health behaviours needs to include these cultural aspects and perceived views.

- Personal goals

Annual kick off events can be organized to host workshops or seminars with the above-mentioned topics, as well as keynote motivational speakers. Measurements such as body composition, blood pressure, blood glucose and cholesterol could be included in this event to determine baseline measurements for setting goals, monitoring and tracking progress. Progress can be tracked with the use of pedometers, activity watches (e.g. Fitbit, Garmin), computer software and cell phone apps. Regular events could be held throughout the year for continued awareness, motivation, and monitoring of progress.

- Attitude

For sustainable change in the health behaviours of employees, a change of attitude and perception towards health and health behaviours is needed. The key to changing attitudes and perceptions of employees is to improve employees' value placed on and satisfaction with active lifestyles and healthy diets. This can be accomplished through the interaction of all the levels of the model, such as through education and improving awareness, support from co-workers and management, changes in the physical work environment to support individual change, and policies that provide incentives for change in the work environment as well as change in personal health behaviours.

7.5.4.2 Interpersonal Level

- Social support

This aspect of the model represents social support networks within one's life, such as family, friends, and *work-based relationships*. In order to reinforce behaviours and motivate continued health-conscious choices, individuals need accountability and support. Creating networks within existing work-based relationships is important for sustainable changes in health behaviour. Thus, regular group sessions, facilitated by a qualified individual, should be created. Various *support tools* can also be used for further support, such as WhatsApp groups, and the use of various cell phone apps. On-site self-paced weight management groups such as Weigh-less and Weight Watchers may also be effective.

The aim of the intrapersonal and interpersonal aspects of the model is to:

- Increase awareness of health behaviour and provide motivation,
- Decrease time spent on sedentary activities,
- Increase physical activity levels through daily incidental activity and increased purposeful exercise,
- Increase healthier food buying and fruit and vegetable intake,
- Initiate employees to work towards a healthy weight,
- Decrease adverse health behaviours such as smoking and alcohol consumption,
- Develop social support for motivation and accountability, and
- Empower employees towards healthy decision-making, by educating and improving awareness of healthy living.

7.5.4.3 Organizational Level

- Workstation

Changes to the workstation to improve health include the use of ergonomic desk equipment such as supportive chairs, ergonomically designed desks, and computer equipment set up at the correct distance and height for working. Furthermore, frequent breaks from screen time has also shown to decrease the risk of weight gain, reduce back and neck pain, improve mood, and improve cardiometabolic health (Swartz, Squires, & Strath, 2011; Pronk, Katz, Lowry, & Payfer, 2012; Bailey & Locke, 2015). Thus, software programs have been designed to pop up messages or freeze computer screens at specific time intervals to ensure employees take regular and active breaks throughout the day.

- Department

A full staff complement ensures fair distribution of workload amongst staff members, and may enable staff to complete their work within normal working hours; thus ensuring a more balanced work-family time, and more time for involvement in healthy behaviours. The availability of various fitness equipment, such as stationary bikes, resistance bands, and exercise balls within departments may further promote active breaks. Water coolers within departments may encourage the consumption of more water, and reduce the consumption of sugar-sweetened beverages. Furthermore, scales within bathrooms may assist with monitoring weight changes and adhering to healthy lifestyle choices.

- Health care

The workplace is often the only place in which people of low socio-economic status receive health care, and the availability of health care within the workplace promotes the use of health care to improve health. Thus, it is important for companies to provide employees with health care options. Health care may include regular clinic screenings within the companies occupational health clinic, regular health days sponsored by health and fitness partners (such as Discovery or Momentum Health), and offering medical aid options to employees.

- Physical activity environment

The availability of resources plays a large role in determining the behaviours of individuals. Thus, the availability of exercise facilities may significantly increase physical activity levels of employees. Exercise facilities could include the following: 1) fitness centre with weight training and cardiovascular equipment, 2) exercise classes, such as aerobics, kickboxing, Zumba etc., 3) sport-specific exercise areas, such as soccer, volleyball, cricket etc., 4) organized physical activities, such as a soccer or volleyball tournament, 5) on-site fitness instructor to provide employees with exercise programs and assist with correct technique of exercises, and 6) showers and change rooms to freshen up after an exercise session. Research has shown that aesthetic appearance is important, and the use of signage promoting and outlining the benefits of physical activity contributes towards the use of a facility (DeJoy et al., 2008).

- Worksite characteristics

Characteristics of a worksite also play a large role in promoting physical activity. For example, the location of stairs, whether closer to a door or the elevator, and access to stairs (through unlocked doors) may promote the use of stairs. Furthermore, signs indicating the location of stairs, and promoting the use of stairs may improve incidental workday activity. An additional worksite characteristic that may increase walking is the creation and maintenance of footpaths or trails through the worksite. Once again, the aesthetic appearance contributes towards the use of these footpaths. Furthermore, designing maps that indicate distance, time, and approximate steps of the footpaths within the worksite may further promote walking. In addition to walking, cycling is a physical activity that could be promoted. The provision of free bicycles and facilities to secure bicycles around the worksite could increase daily physical activity levels.

- Food environment

Positive changes in health are further increased if healthy dietary habits are followed in conjunction with physical activity. As mentioned above, resources available to staff will largely determine habits adopted. Research has shown that the availability of healthy food at a reasonable cost in a canteen promotes healthy dietary habits (Henrique Bandoni, Bombem, Marchioni, & Jaime, 2010; Norbrega et al., 2016). Canteens offering full and half portions may facilitate a reduction in portion size, and therefore a reduction in energy intake. Canteens offering healthy take-away options may prevent employees buying fast food on the way home, specifically on days that they may work late. Aesthetic appearance of canteens and the use of signage promoting health dietary habits has also shown to be effective (DeJoy et al., 2008). Nutrition labels on food sold will further increase awareness regarding healthiness of food eaten, and may affect food choice. To indicate healthiness of food, canteens could create colour-coded health tags as follows: 1) green for the healthiest food; unprocessed and in its most natural form, 2) orange for food that have gone through some form of processing, and 3) red for the healthiest foods, as they may be highly processed, energy dense, high in fat, or high in sodium. Guidelines could then be created for these foods, based on the food pyramid, indicating suggested portion sizes and servings per week. For employees who may need to work through lunch breaks, the availability of a mobile food cart selling healthy food or vending machines offering healthy snacks and beverages may prevent the consumption of unhealthy food and snacks. Worksites selling farm fresh products at a low cost will further promote the consumption of fresh fruit and vegetables.

The aim of the organizational aspect of the model is to:

- Encourage healthier postures and movements,
- Promote regular and active breaks to decrease sedentary activity and increase physical activity levels,
- Improve dietary habits,
- Reinforce awareness between choices and health,
- Lessen chronic, work-related injuries,
- Make health and fitness activities widely available to employees,
- Further encourage employees to work towards a healthy weight, and
- Gain active support from strategic health and fitness partners.

7.5.4.4. Community Level

- Media and communications

Media such as the internet, email networks, posters, and brochures can be used for marketing purposes, and creating communication channels within the workplace. Posters and brochures could be placed around the worksite promoting healthy dietary and physical activity habits. An interactive website devoted specifically to healthy habits within the workplace could be created, with videos, blogs, success stories and relevant information aimed at assisting employees practically apply their knowledge. Dietary information could include dietary guidelines, various meal plans, recipes, shopping lists, along with the costings for each. Information on tips for shopping for healthy food and portion control could also be included. Physical activity information could include details on the on-site facilities, walking/cycling routes and maps, as well as information on local parks and wildlife sanctuaries. Information on the recommended amount of exercise per week, types of exercises to do and tips on how to fit it into daily schedules could also be included. This platform could also be used to advertize and promote local events such as warrior races, charity walks etc. Media interviews could be held to recognize success stories, and the dedication of individuals. These interviews could be used to promote healthy habits within the workplace, and further reinforce changing health habits.

Regular interactive workshops or seminars by guest speakers or healthcare providers could be organized, targeting specific topics such as: 1) correct postures for sitting, standing, sleeping, lifting etc., 2) how often to take breaks from a prolonged sitting position, and what to do for active breaks, 3) hazards associated with a sedentary lifestyle, smoking and excessive alcohol intake, 4) preventing and managing being overweight, and obesity, and 5) how to identify signs and symptoms of various diseases and lifestyle changes needed to prevent or treat them.

- Management

Research has indicated that the involvement of management significantly improves buy-in from employees to health programmes (Kolbe-Alexander et al., 2008). Thus, regular messages from management supporting health promotion, and their involvement in wellness days and health talks may significantly increase the support from employees, and their participation in the wellness program. Furthermore, creating committees comprised of management and employees, and involving employees in decision making may further enhance the sense of support within the workplace.

- Employees

Creating shared expectations and a sense of community within employees in a workplace can be accomplished by getting employees to work together toward a specific goal and performing regular activities together such as walking, cycling or exercise classes. Creating ongoing competitions through the use of cell phone apps which measure and record physical activity will create camaraderie, healthy competitiveness, and encourage individuals to adhere to exercise routines. Providing employees with the option of individual consultation with a health educator, nutritionist, or fitness instructor provides further support and encouragement for maintaining healthy habits.

The aim of the community aspect of the model is as follows:

- To provide channels for communication, information distribution, and networking,
- To create shared expectations, team work and co-worker support,
- To continue building health awareness and reinforcement of healthy habits,
- To gain employee buy-in to support and promote the campaign, and
- To change accepted social norms.

7.5.4.5 Public Policy Level

- Policies

To strongly promote the change of behaviour towards more acceptable, healthy norms, a number of policies would need to be developed. These policies may be concerning the following: 1) overtime and work scheduling, 2) incentives and rewards for healthy food choices, healthy physical activity habits, and employees who demonstrate significant health improvements, 3) services within the canteen such as healthy food options and healthy food preparation, and 4) healthy food choices for business-related functions. Incentives could include prizes or rewards such as pedometers, activity watches, time off work, free healthy meals at the canteen, a month's gym membership etc.

- Management

Key to enhancing buy-in and support from management is the training of management staff on the importance of health to individuals and to the company. By setting performance objectives for management teams, such as incentives for the healthiest department, creates a ripple effect down the staffing ladder. This creates widespread reinforcement and promotion of healthy habits within the workplace.

- Other

Within company policies, provision can be made for the subsidizing of medical aids and/or gym membership. This indicates to employees that the company firmly supports staff and healthy habits. The sponsorship of sports teams within the company, as well as organized and sponsored sports days further indicates to employees the support of the company.

The aim of the public policy aspect of the model is to:

- Maintain working hours within guidelines to ensure more balanced work-family time,
- Promote adoption of healthy lifestyle habits,

- Gain support for employees by management, and
- Accept healthy attitudes by employees to change social norms towards a healthier environment.

The aim of the health promotion model as a whole is to: 1) improve health-related behaviour in the workplace, such as increased physical activity and improved dietary habits, 2) promote greater employee achievement, 3) decrease comorbidities and health care costs, 4) improve all aspects of quality of life, 5) decrease presenteeism and absenteeism, and 6) reduce work-related disability.

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APPENDIX A

Health at Work Survey

A. YOUR HEALTH

Please place an **X** in the box of the answer which appears most appropriate

		Excellent	Very good	Good	Fair	Poor
A1	In general, how would you rate your overall health now?					
A2	In general, how would you rate your overall mental health now?					

A3 Do you have any of the following conditions? If your answer is YES, mark whether you never, previously, or currently receive professional treatment. (Professional treatment is any treatment supervised by a health professional.) If you are unsure if you have a condition, please mark the NO response option.

		NO, I don't have this condition	YES, but I never received professional treatment	YES, I previously received (but don't currently receive) professional treatment		YES, and I currently receive professional treatment	
A3a	Arthritis?						
A3b	Chronic back/neck pain						
A3c	Migraine headaches?						
A3d	Other frequent or severe headaches?						
A3e	Any other chronic pain?						
A3f	High blood pressure?						
A3g	Congestive heart failure?						
A3h	Coronary heart disease?						
A3i	High blood cholesterol?						

A4 If you answered YES to arthritis (A3a), which of the following arthritis do you have?

Osteoarthritis	
Rheumatoid arthritis	

Osteoarthritis: caused by cartilage in joints wearing down until bones rub against each other & cause pain.
Rheuamtoid arthritis: rare auto-immune disease that causes inflammation of the tissues that line joints.
When a doctor tells you that you have arthritis, he means osteoarthritis unless he explicitly says otherwise.

A7 Do you have any of the following conditions? If your answer is YES, mark whether you never, previously, or currently receive professional treatment. (Professional treatment is any treatment supervised by a health professional.) If you are unsure if you have a condition, please mark the NO response option.

		NO, I don't have this condition	YES, but I never received professional treatment	YES, I previously received (but don't currently receive) professional treatment		YES, and I currently receive professional treatment	
A7a	An ulcer in your stomach or intestine?						
A7b	Either frequent diarrhea or frequent constipation?						
A7c	Frequent nausea, gas, or indigestion?						
A7d	Chronic heartburn or GERD?						
A7e	Seasonal allergies or hay fever?						
A7f	Asthma?						
A7g	Chronic bronchitis?						
A7g1	Emphysema?						
A7h	Chronic Obstructive Pulmonary Disease (COPD)?						
A7h1	Chronic Obstructive Airways Disease (COAD)?						
A7h2	Chronic Obstructive Lung Disease (COLD)?						
A7h3	Alpha one antitrypsin deficiency?						
A7i	Urinary or bladder problems?						
A7j	Diabetes?						
A7k	Chronic sleeping problems?						
A7l	Chronic fatigue or low energy?						
A7m	Osteoporosis?						
A7n	Multiple sclerosis?						
A7o	Skin cancer?						
A7p	Any other kind of cancer?						
A7q	Anxiety disorder?						
A7r	Depression?						
A7s	Any other emotional problem?						
A7t	Substance problems (drugs or alcohol)?						

A8 (Women only) Are you currently pregnant?

Yes	
No	
Not sure	
I am male	

A9 Do you smoke cigarettes?

Currently		
Ex-smoker		**GO TO A10**
Only smoked a few times		**GO TO A10**
Never		**GO TO A10**

a9.1. Have you ever in your life smoked cigarettes on a daily basis?

Yes		
No		**GO TO A9a**

A9.2. How many years, in total, did you smoke cigarettes on a daily basis?

YEARS SMOKING

a9.3. How many cigarettes did you smoke on an average day during the time in your life when you smoked most often?
(PLEASE ANSWER IN NUMBER OF CIAGRETTES RATHER THAN NUMBER OF PACKS. A PACK WOULD BE CONSIDERED 20 CIGARETTES)

NUMBER OF CIGARETTES PER DAY

A9a How many cigarettes do you currently smoke a day?

10 or less	
11 - 20	
21 - 30	
31 or more	

A9b How soon after you wake up do you smoke your first cigarette?

Within 5 minutes	
6 - 30 minutes	
31 - 60 minutes	
After 60 minutes	

A9c Which cigarette would you hate the most to give up?

First one in the morning	
All others	

A9d Do you find it difficult to refrain from smoking in places where it is forbidden, such as the library, theater, or doctor's office?

Yes	
No	

A9e Do you smoke more frequently during the first hours after waking than the rest of the day?

Yes	
No	

A9f Do you smoke when are so ill that you are in bed most of the day?

Yes
No

A10 How often do you usually have at least one drink of alcohol?

Nearly everyday		
Several days per week		
1 - 2 days a week		
1 - 3 days a month		
Less than once a month		
Never		**GO TO A11**

A10a On the days you drink, about how many drinks do you usually have per day?

1 - 2 drinks	
3 - 4 drinks	
5 - 10 drinks	
10+ drinks	

A10b How often do you drink 5 or more drinks per day?

Nearly everyday	
Several days per week	
1 - 2 days a week	
1 - 3 days a month	
Less than once a month	
Never	

A11 Some people have periods lasting several days or longer when they feel much more excited and full of energy than usual. Their minds go too fast. They talk a lot. They are very restless or unable to sit still or need very little sleep. They sometimes do things that are unusual for them, such as driving too fast or spending too much money. Have you ever in your life had a time like this lasting several days or longer?

Yes		**GO TO A13**
No		

A12 Have you ever had a time lasting several days or longer when most of the time you were so irritable or grouchy that you either stared arguments, shouted at people, or hit people?

Yes ☐
No ☐ **GO TO A15**

A13 People who have episodes like this often have changes in their thinking and behaviour at the same time, like being more talkative, needing very little sleep, being very restless, going on buying sprees, and behaving in ways they would normally think inappropriate. Did you ever have any of these changes during your episodes of being (IF A11 = YES: excited and full of energy/ IF A12 = YES: very irritable or grouchy)?

Yes ☐
No ☐ **GO TO A15**

A14 Think of an episode when you had the largest number of changes like these at the same time. During that episode, which of the following changes did you experience?

		Yes	No
A14a	Were you so irritable that you either started arguments, shouted at people, or hit people?		
A14b	Did you become so restless or fidgety that you paced up and down or couldn't stand still?		
A14c	Did you do anything else that wasn't usual for you-like talking about things you'd normally keep private, or acting in ways that you'd usually find embarrassing?		
A14d	Did you try to do things that were impossible to do, like taking on large amounts of work?		
A14e	Did you constantly keep changing your plans or activities?		
A14f	Did you find it hard to keep your mind on what you were doing?		
A14g	Did your thoughts seem to jump from one thing to another or race through your head so fast you couldn't keep track of them?		
A14h	Did you sleep far less than usual and still not get tires or sleepy?		
A14i	Did you spend so much more money than usual that it caused you to have financial trouble?		

CHECKPOINT: IF 0-1 OF A14a-A14i = YES GO TO A15
CHECKPOINT: IF A11 = YES GO TO A14.1. IF A12 = YES GO TO A14.2

A14.1 About how many weeks out of 52 in the past year did you have an episode of feeling much more excited, full of energy, or hyper than usual with some of the other problems that we just reviewed? You can use any number between 0 and 52 to answer.

NUMBER OF WEEKS (0 - 52) ☐

CHECKPOINT: GO TO A15

A14.2 About how many weeks out of 52 in the past year did you have an episode of being much more irritable than usual with some of the other problems that we just reviewed? You can use any number between 0 and 52 to answer.

NUMBER OF WEEKS (0 - 52) ☐

A15 The next questions are about problems you may have with attention or concentration.

		Never	Rarely	Sometimes	Often	Very Often
A15a	How often do you have trouble wrapping up the final details of a project, once the challenging parts have been done?					
A15b	How often do you have difficulty getting things in order when you have to do a task that requires organization?					
A15c	How often do you have problems remembering appointments or obligations?					
A15d	When you have a task that requires a lot of thought, how often do you avoid or delay getting started?					
A15e	How often do you fidget or squirm with your hands or feet when you have to sit down for a long time?					
A15f	How often do you feel overly active and compelled to do things, like you were driven by a motor?					

A16 The next questions are about how often you got tired over the past twelve months. How often did you become very tired, weak, or exhausted while performing each of the following kinds of activities?

		Never	Rarely	Sometimes	Often	Very Often
A16a	Minor everyday physical tasks like working, shopping, housekeeping, and walking?					
A16b	Minor everyday mental tasks like reading, writing, and doing paperwork?					

CHECKPOINT: If you checked "SOMETIMES," "OFTEN," or "VERY OFTEN" TO ONE OR BOTH OF A16a OR A16b, GO TO A17. OTHERWISE, GO TO A18.

A17 During the times you became very tired while performing minor everyday tasks, what would happen when you tried to rest or relax? Would you...

Fully regain your energy and strength?		**GO TO A18**
Still feel tired or weak?		

A17a When this problem was most severe over the past 12 months, how often did you get tired?

Nearly everyday	
Several days per week	
1 - 2 days a week	
1 - 3 days a month	
Less than once a month	

A17b How often were you too tired to carry out your daily activities?

Never
Rarely
Sometimes
Often
Very often

A18 During the past 12 months, have you had at least one week each month when you had frequent pain or discomfort in your stomach or lower abdomen that was relieved when you had a bowel movement?

No
Yes, but I never received any professional treatment.
Yes, I previously received (but don't currently receive) professional treatment
Yes, and I currently receive professional treatment.

A19 The next few questions are about problems with your sleep. During the past twelve months, how many weeks did you have problems...

WRITE ONE OF THE FOLLOWING ANSWERS IN THE BLOCKS PROVIDED:

0 WEEKS	1-2 Weeks	3-4 weeks	5-8 weeks
9-12 weeks	12-26 weeks	27-51weeks	52 weeks

A19a ...getting to sleep, when nearly every night it took you two hours or longer before you could fall asleep.
A19b ...staying asleep, when you woke up nearly every night and took an hour or more to get back to sleep?
A19c ...waking too early, when you woke up nearly every morning at least two hours earlier than you wanted to?
A19d ...feeling sleepy during the day?

A20 Have you been repeatedly short of breath over the past 12 months?

Yes
No **GO TO 23**

A21 For how many months out of 12 in the past year have you had bronchitis or chronic coughing with phlegm/sputum from your chest?

NUMBER OF MONTHS (0 - 12)

A22 How many years in your life have you had bronchitis or chronic coughing with phlegm/sputum from the chest that lasted three months or longer?

NUMBER OF YEARS

A23 About how many times in the past 12 months did you have an attack of anger when all of a sudden you lost control and broke or smashed something worht more than a few rands?

NUMBER OF TIMES (0 - 999) [ ]

A24 About how many times in the past 12 months did you have an attack of anger when all of a sudden you lost control and threatened, hit, or hurt someone?

NUMBER OF TIMES (0 - 999) [ ]

A25 In the past 12 months, how many accidents, injuries, or poisonings did you have that required medical attention?

NUMBER OF ACCIDENTS (0 - 999) [ ]

CHECKPOINT: IF NO ACCIDENTS IN A25, GO TO A26. OTHERWISE GO TO A25a

A25a About how many days of work did you miss in the past 12 months because of a work related accident, injury, or poisoning? (If less than 1 day, enter 0).

NUMBER OF DAYS (0 - 365) [ ]

A25b Which of the conditions on this list resulted from your most recent accident, injury, or poisoning? Please check all that apply.

Broken or dislocated bones [ ]
Sprain, strain, or pulled muscle [ ]
Cuts, scrapes, or puncture wounds [ ]
Head injury, concussion [ ]
Bruise, contusion, or internal bleeding [ ]
Burn, scald [ ]
Poisoning from chemicals, medicines, or drugs
Other, please describe: [ ]

A25c What caused that most recent accident, injury, or poisoning? Briefly describe what you were doing and what happened. (For example, fell down while playing basketball and sprained ankle).

A25d In what month did the most recent acciddent, injury, or poisoning occur?

Month [ ]

A26 In the past 12 months, how many work-related accidents did you have that either damaged company property, led to a work delay, or otherwise had a financial cost to your company?

NUMBER OF ACCIDENTS (0 - 999) [ ]

CHECKPOINT: IF NO ACCIDENTS IN A26, GO TO A27. OTHERWISE GO TO A26a

A26a What is your best estimate of the financial loss to your company caused by your accident(s) over the past 12 months?

RAND AMOUNT R

A27 During the past 4 weeks (28 days), how much were you bothered by each of the following conditions?

		Not at all	A little	Some	A lot
A27a	Feeling dizzy				
A27b	Feeling tired or having low energy				
A27c	Trouble sleeping				
A27d	Headaches				
A27e	Back or neck pain				
A27f	Pain in your arms, legs, joints (knees, hips, etc.)				
A27g	Muscle soreness				
A27h	Watery eyes, runny nose, or stuffy head				
A27i	Cough or sore throat				
A27j	Fever, chills, or other cold/flu symptoms				
A27k	Constipation, loose bowels or diarrhea				
A27l	Nausea, gas, or indigestion				

A28 During the past 4 weeks (28 days), how much of the time did you feel...

		All of the time	Most of the time	Some of the time	A little of the time	None of the time
A28a	...so sad nothing could cheer you up?					
A28b	...nervous?					
A28c	...restless or fidgety?					
A28d	...hopeless?					
A28e	...that everything was an effort?					
A28f	...worthless?					
A28g	...unable to relax?					
A28h	...impatient or irritable?					

A29 How many times did you see each of the following types of professionals in the **past 12 months**? Include only visits regarding your **own health**, not visits when you took someone else to be examined.

E.g.: If you visited the dentist 2 times in the past year and an optician once, your answer to A29c would be 3

		Number of times 0 - 365
A29a	A doctor, hospital, or clinic for a routine physical check-up or gynecological exam (not counting pregnancy related care)	
A29b	(Women only) A doctor, hospital, or clinic for pregnancy related care (male = 0)	
A29c	A dentist or optician for a routine check-up or exam	
A29d	A doctor, emergency room, or clinic for urgent care treatment (for example, because of new symptoms, an accident, or something else unexpected)	
A29e	A doctor, hospital, clinic, orthodontist, or opthalmologist for scheduled treatment or surgery	
A29f	A psychiatrist, psychologist, or other mental health professional	

A30 How many nights did you stay in a hospital during the past 12 months (not including nights associated with childbirth)?

NUMBER OF NIGHTS (0 - 365) [ ]

A30a (Women only) How many nights did you stay in a hospital during the past 12 months for nights associated with childbirth? (If male, enter 0)

NUMBER OF NIGHTS (0 - 365) [ ]

A31 What is the name of your health plan(s)?

[ ]

B. YOUR WORK

B1 Please choose the category that best describes your main job. If none of the categories fits you exactly, please respond with the closest category to your experience. (Select only one).

Executive, administrator, or senior manager (e.g. CEO, sales VP, plant manager)	
Professional (e.g. engineer, accountant, systems analyst)	
Techinical support (e.g. lab technician, legal assistant, computor programmer)	
Sales (e.g. sales representative, stickbroker, retail sales)	
Clerical and administrative support (e.g. secretary, billing clerk, office supervisor)	
Service occupation (e.g. security officer, food service worker, janitor)	
Precision production and crafts worker (e.g. mechanic, carpenter, machinist)	
Chemical/production operator (e.g. shift supervisors and hourly employees)	
Laborer (e.g. truck driver, construction worker)	

B2 Is your work schedule best described as a regular schedule (roughly the same hours every day), a rotating schedule (e.g. working a day shift some days and a night shift other days), or an irregular schedule (e.g. unpredictable hours controlled by situations or workload)?

Regular schedule		**GO TO B4**
Rotating schedule		
Irregular schedule		

B3 What percentage of your total work hours in an avergae week are in each of the following times of day? (the sum should add up to 100%)

	%
Morning (6:00AM - 12:00PM)	
Afternoon (12:00PM - 6:00PM)	
Evening (6:00PM - 12:00AM)	
Nights (12:00AM - 6:00AM)	
Total	100

CHECKPOINT: GO TO B6 IF RESPONDANT ANSWERED B3

B4 What time do you usually begin work? (SPECIFY AM OR PM)

B5 What time do you usually end work?(SPECIFY AM OR PM)

B6 How many people do you personally supervise on your job? (if more than 97, enter 97)

NUMBER OF PEOPLE (0 - 97)

B7 About how many hours altogether did you work in the past 7 days? (if more than 97, enter 97)

NUMBER OF HOURS (0 - 97)

B8 How many hours does your employer expect you to work in a typical 7-day week? (If it varies, estimate the average. If more than 97, enter 97.)

NUMBER OF HOURS (0 - 97)

B9 Now please think of your work experiences over the past 4 weeks (28 days). In the spaces provided below, write the number of days you spent in each of the following work situations.

In the past 4 weeks (28 days), how many days did you...

		Number of days (0 - 28)
B9a	...miss an entire work day because of problems with your physical or mental health? (Please include only days missed for your own health, not someone else's health.)	
B9b	...miss an entire work day for any other reason (including vacation)?	
B9c	...miss part of a work day because of problems with your physical or mental health? (Please do not include entire work days missed. Please include only days missed for your own health, not someone else's health.)	
B9d	...miss part of a work day for any other reason (including vacation)? (Please do not include entire work days missed.)	
B9e	...come in early, go home late, or work on your day off?	

CHECKPOINT: IF YOU HAVE NOT MISSED AN ENTIRE DAY OR A PARTIAL DAY (ANSWERED 0 FOR ALL QUESTIONS IN B9 SERIES) GO TO B10. OTHERWISE GO TO B9f

B9 Think of (all) the (insert exact number of days if possible) days in the past 4 weeks (28 days) when you missed either a full day or a partial day of work. Count partial days as whole days.

How many of these (insert exact number if possible) days did you...

		Number of days (0 - 28)
B9f	...not receive pay?	
B9g	...get paid as part of regular salary?	
B9h	...use earned sick leave (while receiving regular pay)?	
B9i	...use earned vacation time (while receiving regular pay)?	
B9j	...get paid as short-term or long-term disability?	
B9k	...get paid as a result of an injury at work?	

B10 About how many hours altogether did you work in the past 4 weeks (28 days)? (see examples below)

NUMBER OF HOURS IN THE PAST 4 WEEKS (28 DAYS) ☐

Examples for calculating hours worked in the past 4 weeks
40 hours per week for 4 weeks = 160 hours
35 hours per week for the past 4 weeks = 140 hours
40 hours per week for the past 4 weeks with 28-hour days missed = 144 hours
40 hours per week for the past 4 weeks with 34-hour partial days missed = 148 hours
35 hours per week for the past 4 weeks with 34-hour partial days missed = 112 hours

B10a In the past 4 weeks (28 days), did you have any special work success or achievment?

Yes ☐
No ☐ **GO TO B11a**

B10b If you answered YES to the above question, please describe what happened.

B11a In the past 4 weeks (28 days), did you have any special work failure?

Yes ☐
No ☐ **GO TO B12**

B11b If you answered YES to the above question, please describe what happened.

B12 The next questions are about the time you spent during your hours at work in the past 4 weeks (28 days). Select the one response for each questions that comes closest to your experience.

		All of the time	Most of the time	Some of the time	A little of the time	None of the time
B12a	How often was your performance higher than most workers on your job?					
B12b	How often was your performance lower than most workers on your job?					
B12c	How often did you do no work at times when you were supposed to be working?					
B12d	How often did you find yourself not working as carefully as you should?					
B12e	How often was the quality of your work lower than it should have been?					
B12f	How often did you not concentrate enough on your work?					
B12g	How often did health problems limit the kind or amount of work you could do?					

B13 On a scale from 0 to 10 where 0 is the worst job performance anyone could have at your job and 10 is the performance of a top worker, how would you rate the usual performance of most workers in a job similar to yours? (please fill in the number below)

[ ] 0 = worst 10 = top performer

B14 Using the same 0 - 10 scale, how would you rate your usual job performance over the past year or two? (please fill in the number below)

[ ] 0 = worst 10 = top performer

B15 Using the same 0 - 10 scale, how would you rate your overall job performance on the days you worked during the past 4 weeks (28 days)? (please fill in the number below)

[ ] 0 = worst 10 = top performer

B16 How would you compare your overall job performance on the days you worked during the past 4 weeks (28 days) with the performance of most other workers who have a similar type of job? (Select only one.)

- You were a lot better than other workers [ ]
- You were somewhat better than other workers [ ]
- You were a little better than other workers [ ]
- You were about average [ ]
- You were a little worse than other workers [ ]
- You were somewhat worse than other workers [ ]
- You were a lot worse than other workers. [ ]

C. DEMOGRAPHICS

C1 How old are you?

YEARS OLD (0 - 99) [ ]

C2 Are you make or female? (Place an **X** in the appropriate box)

- Male [ ]
- Female [ ]

C3 What is your current marital status? (Place an **X** in the appropriate box)

- Married or cohabiting [ ]
- Seperated [ ]
- Divorced [ ]
- Widowed [ ]
- Never married [ ]

C4 How many children do you have? (Place an **X** in the appropriate box)

- None [ ]
- One [ ]
- Two [ ]
- Three [ ]
- Four or more [ ]

C5 What is the highest grade or level of school that you have completed? (Place an **X** in the appropriate box)

- 8th grade or less [ ]
- Some high school, but did not graduate [ ]
- High school graduate [ ]
- Some college or 2 year degree [ ]
- 4 year college graduate [ ]
- more than 4 year college degree [ ]

C6 What is your height? (in meters)

[ ] m

C7 How much do you weigh?

[ ] kg

C8 Are you salaried or are you paid hourly? ("salaried" means that you're paid the same amount each week or month no matter how many hours you work. "Hourly" means that you're paid a different amount each week or month depending on how many hours you work.)

Salaried		GO TO C8.1
Paid hourly		GO TO C8.2

C8.1 What is your annual income from your job, before taxes?

R1 - R999		R11000 - R11999		R30000 - R34999	
R1000 - R1999		R12000 - R12999		R35000 - R39999	
R2000 - R2999		R13000 - R13999		R40000 - R44999	
R3000 - R3999		R14000 - R14999		R45000 - R49999	
R4000 - R4999		R15000 - R15999		R50000 - R74999	
R5000 - R5999		R16000 - R16999		R75000 - R99999	
R6000 - R6999		R17000 - R17999		R100000 - R149999	
R7000 - R7999		R18000 - R18999		R150000 - R199999	
R8000 - R8999		R19000 - R19999		R200000 - R299000	
R9000 - R9999		R20000 - R24999		R300000 - R499999	
R10000 - R10999		R25000 - R29000		R500000 - R999999	
				R1000000 or more	

C8.2 How much are you paid per hour, before taxes?

R5.00 - R8.00		R22.01 - R24.00		R45.01 - R50.00	
R8.01 - R10.00		R24.01 - R26.00		R50.01 - R55.00	
R10.01 - R12.00		R26.01 - R29.00		R55.01 - R60.00	
R12.01 - R14.00		R29.01 - R32.00		R60.01 - R70.00	
R14.01 - R16.00		R32.01 - R35.00		R70.01 - R80.00	
R16.01 - 18.00		R35.01 - R38.00		R80.01 - R90.00	
R18.01 - R20.00		R38.01 - R41.00		R90.01 - R100.00	
R20.01 - R22.00		R41.01 - R45.00		More than R100	

That completes the survey. Thanks very much for your participation.

APPENDIX B

World Health Organization Quality of Life Questionnaire

The following questionnaire is **three pages** long.

The following questions ask how you feel about your quality of life, health, or other areas of your life. **Please choose the answer that appears most appropriate.** If you are unsure about which response to give to a question, the first response you think of is often the best one.

Please keep in mind your standards, hopes, pleasures and concerns. We ask that you think about your life **in the last four weeks.**

Please **BOLD** the answer that appears most appropriate.

		Very poor	Poor	Neither poor nor good	Good	Very good
1	How would your rate your quality of life?	1	2	3	4	5

		Very dissatisfied	Dissatisfied	Neither satisfied nor dissatisfied	Satisfied	Very satisfied
2	How satisfied are you with your health?	1	2	3	4	5

The following questions ask about **how much** you have experienced certain things in the last four weeks. Please **BOLD** the answer that appears most appropriate.

		Not at all	A little	A moderate amount	Very much	An extreme amount
3	To what extent do you feel that physical pain prevents you from doing what you need to do?	5	4	3	2	1
4	How much do you need any medical treatment to function in your daily life?	5	4	3	2	1
5	How much do you enjoy life?	1	2	3	4	5
6	To what extent do you feel your life to be meaningful?	1	2	3	4	5

		Not at all	A little	A moderate amount	Very much	Extremely
7	How well are you able to concentrate?	1	2	3	4	5
8	How safe do you feel in your daily life?	1	2	3	4	5
9	How healthy is your physical environment?	1	2	3	4	5

The following questions ask about how completely you experience or were able to do certain things in the last four weeks. Please **BOLD** the answer that appears most appropriate.

		Not at all	A little	Moderately	Mostly	Completely
10	Do you have enough energy for everyday life?	1	2	3	4	5
11	Are you able to accept your bodily appearance?	1	2	3	4	5
12	Have you enough money to meet your needs?	1	2	3	4	5
13	How available to you is the information that you need in your day-to-day life?	1	2	3	4	5
14	To what extent do you have the opportunity for leisure activities?	1	2	3	4	5

		Very poor	Poor	Neither poor nor good	Good	Very good
15	How well are you able to get around?	1	2	3	4	5

		Very dissatisfied	Dissatisfied	Neither satisfied nor dissatisfied	Satisfied	Very satisfied
16	How satisfied are you with your sleep?	1	2	3	4	5
17	How satisfied are you with your ability to perform your daily living activities?	1	2	3	4	5
18	How satisfied are you with your capacity for work?	1	2	3	4	5
19	How satisfied are you with yourself?	1	2	3	4	5
20	How satisfied are you with your personal relationships?	1	2	3	4	5
21	How satisfied are you with your sex life?	1	2	3	4	5
22	How satisfied are you with the support you get from your friends?	1	2	3	4	5
23	How satisfied are you with the conditions of your living space?	1	2	3	4	5
24	How satisfied are you with your access to health services?	1	2	3	4	5
25	How satisfied are you with your transport?	1	2	3	4	5

The following questions ask about **how often** you have felt or experienced certain things in the last four weeks. Please **BOLD** the answer that appears most appropriate.

		Never	Seldom	Quite often	Very often	Always
26	How often do you have negative feelings such as blue mood, despair, anxiety, or depression?	5	4	3	2	1

THANK YOU FOR YOUR TIME AND HONESTY WITH THIS QUESTIONNAIRE!

Please save questionnaire and return it by either:

Post: Shereen Currie
P.O.Box 10727
Meerensee
3901

Email: curries@unizulu.ac.za

APPENDIX C

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

The following questions will ask about the time you spent being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

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

PART 1: JOB-RELATED PHYSICAL ACTIVITY

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

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

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

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

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

☐ days per week
☐ No vigorous job-related physical activity **SKIP TO QUESTION 4**

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

☐ hours per day
☐ minutes per day

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

☐ days per week
☐ No moderate job-related physical activity **SKIP TO QUESTION 6**

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

	hours per day
	minutes per day

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

	days per week	
	No job-related walking	**Skip to PART 2: TRANSPORTATION**

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

	hours per day
	minutes per day

PART 2: TRANSPORTATION PHYSICAL ACTIVITY

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

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

	days per week	
	No days traveling in a motor vehicle	**Skip to question 10**

9 How much time did you usually spend on one of those days traveling ina train, bus, car, taxi or other kind of motor vehicle?

	hours per day
	minutes per day

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

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

	days per week	
	No bicycling from place to place	**Skip to question 12**

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

	hours per day
	minutes per day

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

[ ]	days per week	
[ ]	No walking from place to place	**SKIP TO PART 3: HOUSEWORK, HOUSE MAINTENANCE, AND CARING FOR FAMILY**

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

[ ]	hours per day
[ ]	minutes per day

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

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

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

[ ]	days per week	
[ ]	No vigorous activity in garden or yard	**Skip to question 16**

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

[ ]	hours per day
[ ]	minutes per day

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

[ ]	days per week	
[ ]	No moderate activity in garden or yard	**Skip to question 18**

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

[ ]	hours per day
[ ]	minutes per day

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

[ ]	days per week	
[ ]	No moderate activity inside home	**SKIP TO PART 4: RECREATION, SPORT AND LEISURE TIME PHYSICAL ACTIVITY**

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

	hours per day
	minutes per day

PART4: RECREATION, SPORT, AND LEISURE-TIME PHYSICAL ACTIVITY

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

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

	days per week	
	No walking in leisure time	**Skip to question 22**

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

	hours per day
	minutes per day

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

	days per week	
	No vigorous activity in leisure time	**Skip to question 24**

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

	hours per day
	minutes per day

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

	days per week	
	No moderate activity in leisure time	**SKIP TO PART 5: TIME SPENT SITTING**

25 How much time did you usually spend on one of those days doing moderate physical activities in your leisure time?

	hours per day
	minutes per day

PART 5: TIME SPENT SITTING

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

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

	hours per day
	minutes per day

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

	hours per day
	minutes per day

THIS IS THE END OF THE QUESTIONNAIRE, THANK YOU FOR PARTICIPATING

APPENDIX D

3-Day Food Diary

Name: ____

All the info you provide will be treated as confidential.

Please read the instructions carefully before you start and provide as much detail as possible!

If you have any questions, you can contact me via email curries@unizulu.ac.za

General instructions:

1. Don't change your eating habits while logging your food record. The goal is to identify your *usual* eating patterns.
2. Be honest. You will not be judged based on your choices and for research purposes we require accurate information.
3. Write down EVERYTHING you eat and drink during these 3 days (1 day on the weekend, 2 week days)
4. Be specific. Don't forget extras such as mayonnaise, butter, cheese, etc. Take note of the following:
    - Bread – indicate if it is white, brown, whole wheat, etc. (also indicate in detail what you have with your bread)
    - Milk – indicate if it is full cream, low fat/2%, fat free, coffee creamer, etc.
    - Apples – indicate if it is green or red
    - Sugar – indicate if it is brown or white
    - Pies – indicate meat, eg chicken, beef, etc.
    - Chicken: breast, thigh, leg, with skin or without skin etc.
    - Sometimes brand names such as Coke or Coke Zero are useful!
5. Estimate portions as accurately as possible. This can be in grams, cups, spoons or handfuls.
6. Do it now! Don't rely on your memory at the end of the day. Keep a small notebook with you if needed and copy your intake to your log at the end of the day if you do not want to carry these papers with you!
7. Look at the example on the following page (back of this page)

TIME	FOOD/DRINK Amount
9am	2 slices of white bread with margarine 1 cup of tea with 2 heaped teaspoons of brown sugar and 1 heaped teaspoon of Cremora Maize meal porridge, 1 full bowl with 2 heaped teaspoons of brown sugar and 1 teaspoon of brown vinegar
1pm	Rice – 2 heaped serving spoons of white rice Roast chicken – chicken leg quarter with skin and 1 serving spoon of gravy 1 read apple Tropika juice, orange, 500ml Salad – 1 boiled potato, 1 boiled egg and 1heaped tablespoon mayonnaise
4pm etc	Pie – chicken mushroom etc

Please answer the following questions:

1. Are you taking any vitamin and/or mineral supplements? (prescribed or over the counter)

Yes No

2. If yes, provide details on the supplements you are taking? (type and dosage)

____

____

____

____

____

____

DAY 1: Date	Day:
Time	**FOOD/DRINK** **Amount and preparation**

How many glasses of water did you drink today? ____

DAY 2: Date	Day:
Time	**FOOD/DRINK** **Amount and preparation**

How many glasses of water did you drink today? ____

DAY 3: Date	Day:
Time	**FOOD/DRINK** **Amount and preparation**

How many glasses of water did you drink today? ____

____

APPENDIX E

Global Journal of Health Science

Effect of Obesity on the Work Health-Related Behaviors and Quality of Life of South African Mining Employees: A Pilot Study

Shereen C. Currie, Michelle Smit, Mondli Linda, Jeanne Grace

Abstract

BACKGROUND: Obesity rates have increased precipitously with a significant economic impact. **Aim:** The aim of this study was to investigate the effect of obesity on the work health-related behaviors and quality of life (QoL) of employees of mining companies in South Africa.

METHODS: Forty (40) subjects from three mining companies were assigned to three BMI categories: normal weight (18.5–24.9 kg/m^2; n = 10), overweight 25.0–29.9 kg/m^2; n = 15), and obese (≥30.0 kg/m^2; n = 15). Subjects wore a BodyMedia®FIT armband for seven consecutive days, and completed: 1) the WHO QoL; and 2) the WHO Health at Work survey.

RESULTS: There were significant differences in calorie expenditure (p = 0.033), activity patterns (p = 0.017), and number of steps walked daily (p = 0.018) between the overweight and obese groups. Those of normal weight reported being significantly (p = 0.041) more satisfied with their QoL and their leisure time activities and income (p = 0.017) than the obese. Almost all the significant differences with regard to work health-related behaviors were between the overweight and obese groups.

CONCLUSION: Results provide preliminary support for targeting weight loss as obesity may adversely influence employees' work health-related behaviors and QoL.

Full Text:

PDF

DOI: https://doi.org/10.5539/gjhs.v9n12p122

Jeanne Grace

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APPENDIX F

UNIVERSITY RESEARCH ETHICS COMMITTEE
(Reg No: UZREC 171110-30)

UNIVERSITY OF ZULULAND
Website: http://www.unizulu.ac.za

Private Bag X1001
KwaDlangezwa 3886

Tel: 035 902 6887
Fax: 035 902 6222
Email: ManqeleS@unizulu.ac.za

ETHICAL CLEARANCE CERTIFICATE

Certificate Number	**UZREC 171110-030 PGD 2013/49**						
Project Title	**The impact of obesity and illness absence on economic costs in corporate/industrial workers: A South African study**						
Principal Researcher/ Investigator	SC Currie						
Supervisor and Co-supervisor	Prof. J Grace						
Department	Biokinetics & Sport Science						
Nature of Project	Honours/4th Year		Master's		Doctoral	x	Departmental

The University of Zululand's Research Ethics Committee (UZREC) hereby gives ethical approval in respect of the undertakings contained in the above-mentioned project proposal and the documents listed on page 2 of this Certificate. Special conditions, if any, are also listed on page 2.

The Researcher may therefore commence with the research as from the date of this Certificate, using the reference number indicated above, but may not conduct any data collection using research instruments that are yet to be approved.

Please note that the UZREC must be informed immediately of

- Any material change in the conditions or undertakings mentioned in the documents that were presented to the UZREC
- Any material breaches of ethical undertakings or events that impact upon the ethical conduct of the research

The Principal Researcher must report to the UZREC in the prescribe format, where applicable, annually and at the end of the project, in respect of ethical compliance.

The table below indicates which documents the UZREC considered in granting this Certificate and which documents, if any, still require ethical clearance. (Please note that this is not a closed list and should new instruments be developed, these may also require approval.)

Documents	Considered	To be submitted	Not required
Faculty Research Ethics Committee recommendation	X		
Animal Research Ethics Committee recommendation			X
Health Research Ethics Committee recommendation			X
Ethical clearance application form	X		
Project registration proposal	X		
Informed consent from participants	X		
Informed consent from parent/guardian			X
Permission for access to sites/information/participants	X		
Permission to use documents/copyright clearance			X
Data collection/survey instrument/questionnaire			X
Data collection instrument in appropriate language (IsiZulu)	X		
Other data collection instruments		Only if used	

Special conditions: Documents marked "To be submitted" must be presented for ethical clearance before any data collection can commence.

The UZREC retains the right to

- Withdraw or amend this Certificate if
    - Any unethical principles or practices are revealed or suspected
    - Relevant information has been withheld or misrepresented
    - Regulatory changes of whatsoever nature so require
    - The conditions contained in this Certificate have not been adhered to
- Request access to any information or data at any time during the course or after completion of the project

The UZREC wishes the researcher well in conducting the research.

Professor Rob Midgley
Deputy Vice-Chancellor, Research and Innovation
Chairperson: University Research Ethics Committee
28 January 2014

CHAIRPERSON
UNIVERSITY OF ZULULAND RESEARCH
ETHICS COMMITTEE (UZREC)
REG NO. UZREC 171110-30
28 -01- 2014
RESEARCH & INNOVATION OFFICE

APPENDIX G

Informed Consent Form

Shereen Currie is a registered Biokineticist who is doing her Doctorate Degree at the University of Zululand, and has requested my participation in her study. The title of the research is: The impact of obesity and illness absence on economic costs in corporate/industrial workers: a South African study.

1. I have been informed that the purpose of this research study is to determine the economic impact of obesity, and obesity-related diseases in South Africa.
2. My participation in this study will involve the following:
    - Signing a consent form (this form).
    - Filling out four questionnaires.
    - Wearing the BodyMedia® FIT Armband for one week.
    - Recording my food intake in the food logbook.
3. I understand that none of these requirements will be fatiguing; and there are no risks involved.
4. I understand that the results of the study may be published but that my name or identity will not be revealed. All my data will be kept confidential, and a participant code will be assigned to me.
5. I have been informed that I will not be compensated for my participation.
6. I have been informed that any questions I may have concerning the research or my participation in it, before or after my consent, will be answered by Dr. Jeanne Grace (gracej@ukzn.ac.za) thesis advisor, University of KwaZulu Natal, Department of Health Sciences.
7. Should I have any ethics related questions I may contact Dr. Vivier (035 902 6641), chair of the Research Faculty & Higher Degree Committee or Prof. Sibaya (035 902 6634), Vice Rector of the University of Zululand.
8. I have read the above information. The nature, demands, risks and benefits of the project have been explained to me. I knowingly assume the risks involved and understand that I may withdraw my consent and discontinue my participation at any time without penalty or loss of benefit to myself. In signing this consent form, I am not waiving any legal claims, rights or remedies. A copy of this consent form will be given to me. I voluntarily sign to form part of this research project.

Participant's Signature		**Witness' Signature**	
Participant's Name		**Witness's Name**	
Date		**Date**	

9. I, Shereen Currie, certify that I have explained to the above individual the nature and purpose, the potential benefits and possible risks associated with participation in this research study and have answered any questions that have been raised.

Signature		**Date**	

Please don't hesitate to contact me if you have any queries:

Cell: 083 380 6304
Email: curries@unizulu.ac.za