Physical activity, sedentary behaviour and body composition: associations with workplace performance among call centre employees.

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Supervisor:

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DECLARATION

I, Adam Stein (0610020V), declare that this dissertation report is my own, unaided work. It is being submitted for the Degree of MSc, through the MRC/WITS Developmental Pathways for Health Research Unit, Department of Paediatrics, School of Clinical Medicine, Faculty of Health Sciences, University of Witwatersrand, Johannesburg, South Africa. It has not been submitted before for any degree or Submission for examination at any other University.

Adam Stein____________ (Signature of candidate)

13 day of 05 2019 in Johannesburg

PREAMBLE

Ever since I completed my school career in 2005, I have been dedicated to chronic disease management, wellness and corporate health. I completed my BSc degree in Human Physiology and Human Movement Science (University of Johannesburg) and went on to complete my honours degree in Biokinetics (University of Johannesburg). My internship and subsequent 2 years was spent treating patients at the Centre for Diabetes and Endocrinology (CDE). At the CDE, I was exposed to the direct consequences of poor health, inactivity and unhealthy diet, with the high prevalence of chronic disease seen within the South African population. In the following years, I have been highly involved in corporate wellness, performing medical checks at multiple companies, testing for non-communicable diseases and providing advice to individuals in order to improve their health.

In 2015, I started my corporate career at Discovery Health, where I was introduced to a different aspect of healthcare – one involving corporate pressures and deadlines. This sparked my interest to see how health could have an impact on one’s workplace performance. I am highly intrigued by the results of my study, which show that health does have an impact in the workplace. I look forward to continued research and possible interventions in this field in order to make an impact on health in South Africa.

ABSTRACT

Background: The demands of the corporate workplace have resulted in detrimental behaviour changes due to the competitive nature of large corporate companies, and the need for high output to reach expected target. Corporate employees who have office bound, sedentary jobs are at greatest risk, as the combination of increased sitting time with a lack of structured physical activity greatly increases the risk of obesity and associated diseases. Additionally, statistics from Occupational Care South Africa and Statistics South Africa show that South Africa has been plummeting R16-billion a year due to absenteeism. Wellness interventions could reduce this enormous figure.

Objectives: The objectives of this study were twofold: 1- To describe the associations between lifestyle factors: sedentary behaviour, physical activity, and body composition on sickness absenteeism; and 2 – To describe the associations between these same lifestyle factors and workplace performance.

Methods: Discovery Health conducted their annual wellness event with the attendance of 5223 employees from all departments. This study used data from the Discovery Health call-centre staff (n=1237) who were assessed via a self-reported lifestyle questionnaire. The data were collected includes physical activity (frequency and duration), sedentary behaviour (min/day), age (years), sex, BMI (weight/height^2 (kg/m^2)) and waist circumference (cm). Employee performance was assessed using two measures: Member Based Rating score (MBR), which provides an average score according to customer surveys; and First Call Resolution (FCR), which assesses the proportion of clients' queries that are successfully resolved during the first call. Sickness absenteeism was collected over a 12 month period.

Results: Sedentary time and female sex were significantly and positively associated with sickness absenteeism ($p<0.01$). When deconstructing sedentary time into TV time, computer time and meeting time; neither TV time nor meeting time were significantly associated with sickness absenteeism ($p=0.70$ and $p=0.90$, respectively). However, computer time was significantly and positively associated with sickness absenteeism ($\beta=0.01$, $p<0.01$). Exercise frequency, BMI and waist circumference had no significant impact on sickness absenteeism. FCR score demonstrates a positive and negative association with age and BMI respectively.

Conclusion: The major finding of the study was that a sedentary lifestyle had a significant association with sickness absenteeism amongst call centre employees, regardless of physical activity outside of the working environment. Additionally, body composition played a negative role in workplace performance as those who had an elevated BMI (specifically those who were obese) had poorer FCR scores. This gives an indication that body mass may have an impact on working abilities and efficiency.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

GLOSSARY

Definitions

- Physical activity: Activities that raise energy expenditure levels above that of resting. In the case of this study, physical activity is making reference to structured exercise
- Sedentary behaviour: This includes any form of activity that does not increase energy expenditure above that of resting
- Sedentary time: Total time spent pursuing sedentary behaviour
- Sickness absenteeism: The term 'sickness absenteeism' refers to instances when an employee does not attend work due to an illness
- Metabolic syndrome: A cluster of biochemical and physiological abnormalities associated with the development of cardiovascular disease and type 2 diabetes

Acronyms

- BMI: Body mass index
- MBR score: Member based rating
- FCR score: First call resolution
- PA: Physical activity (see above)
- MVPA: moderate to vigorous intensity physical activity
- ST: Sedentary time (see above)
- NCD: Non-communicable disease
- WHO: World Health Organization
- MET: Metabolic Equivalent of Task

1.0 INTRODUCTION

1.1. Background

The World Health Organization (WHO) has stated that increased sitting time, insufficient physical activity and sub-optimal body composition are all contributing to the global disease burden (1). This is made evident by increases in obesity, type 2 diabetes, hypertension, stroke, and other non-communicable diseases (NCDs), which all result in higher mortality at younger ages (1-3). The global rise in sitting time and physical inactivity is caused in part by changes in transport convenience, work roles and technological advancements (4).

South Africa is one of many countries that is undergoing rapid socioeconomic advances and urbanisation, exacerbating the increasing prevalence of obesity and related NCD's within the population (5). South Africa has a higher rate of obesity than any other African country (6). Evidence shows that individuals who are overweight or obese are at greater risk of developing NCDs such as diabetes, hyperlipidaemia, hypertension, and stroke (7). Obesity and its associated complications increase the risk of cardiovascular disease and premature death at all ages (3).These findings are consistent throughout multiple studies which show that physical inactivity, sedentary behaviour, and obesity increase the risk of metabolic disease through their effects on cardiovascular health (8).

While much of the research available shows the impact lifestyle factors have on health, it is also important to examine the link between health, workplace performance and sickness absenteeism to understand the broader impact lifestyle factors can have on an individual's day to day life (9-10). The competitive nature of large corporations, and the pursuit of ambitious corporate targets, creates a behavioural change in employees that increases their burden of disease (11). Corporate employees who have office bound, sedentary jobs are at greatest risk of obesity and associated diseases, owing to the combination of increased sitting time and a lack of structured physical activity (12). This is particularly concerning because an increasingly significant percentage of the world's population is seated or standing in one position for most of the day (13).

With the understanding that health does in fact have an impact on workplace performance and sickness absenteeism, many companies are incorporating onsite wellness programs for their employees. By doing this, these companies are hoping to attenuate the health decline of their employees by improving lifestyle behaviours such as physical inactivity (9). Research is showing that the inclusion of workplace health programs improves workplace performance and reduces sickness absenteeism (9).

1.2. Definitions and guidelines for physical activity, sedentary behaviour and sickness absenteeism.

1.2.1. Sickness absenteeism

The term ‘sickness absenteeism’ refers to instances when an employee does not attend work due to an illness (14).

1.2.2. Physical activity

Physical activity is defined by the WHO as “any bodily movement produced by skeletal muscles that requires energy expenditure” (15). Metabolic Equivalent of Task (MET) is an index of energy expenditure, commonly used to describe intensity levels of different physical activities (15). Light physical activity (LPA) is defined as activity of less than 4.5 METs, including activities such a walking, yard work and fishing (16). Moderate physical activity (MPA) is activity between 4.5 METs and 7.5 METs, such as brisk walks, swimming and cycling (16). Vigorous physical activity (VPA), where energy expenditure is above 7.5 METs, includes activities such as running and ball sports (16).

The WHO recommends 150 minutes per week of moderate to vigorous activity (MVPA) (17). Reaching this quota of physical activity can bring about improvements in health by reducing blood pressure, improving blood glucose control, increasing HDL levels, and combating obesity (18-19). Physical inactivity refers to insufficient physical activity, whereby WHO guidelines are not being followed. Not following these recommended guidelines increases the risks of “heart disease, diabetes, hypertension and some cancers” (17).

1.2.3. Sedentary behaviour

In recent years there has been an increase in interest and research into sedentary behaviour and its effects on human physiology (20). Researchers have attempted to develop a global understanding and common language when referring to sedentary behaviour (20). The term sedentary behaviour is defined as "any waking behaviour characterised by an energy expenditure ≤1.5 metabolic equivalents (METs), while in a sitting, reclining or lying posture" (21). Examples are sitting while using electrical devices such as watching TV, using tablets, and computer time.

In order to prevent the health risks associated with sedentary behaviour, one should not be sedentary for more than eight hours per day. Sedentary time exceeding eleven hours per day is strongly predictive of negative health implications (22).

The prevalence of metabolic syndrome is rising, and research has demonstrated that increases in sedentary behaviour and obesity are linked to metabolic diseases such as diabetes and hypertension (23).

1.2.4. The difference between physical inactivity and sedentary behaviour

It is important to differentiate between physical inactivity and sedentary behaviour, because these are independent risk factors for negative health outcomes (24). Furthermore, any individual has the ability to follow one guideline (e.g. be highly physically active) and simultaneously fail to follow the other guideline (e.g. have a highly sedentary lifestyle). For example, on a typical day, an individual may be highly sedentary i.e. drive to work, sit in meetings and drive home. He/she can go for a moderate, 30 minute run every evening thereby following the WHO guidelines for physical activity (150 minutes exercise per week at a moderate to vigorous intensity). Conversely, another individual who does not run in the evenings, but does walk to/from work as well as limits his time seated during the day, could follow the recommended guidelines of being sedentary for less than 8 hours per day, but not follow WHO guidelines of exercising 150 minutes/week at a moderate to vigorous intensity. These scenarios illustrate how an individual can comply with physical activity guidelines, and still fail to comply with sedentary behaviour guidelines, and vice-versa. Both physical inactivity and sedentary behaviour are independently detrimental to health (24).

1.3. Literature review

This literature review focuses on lifestyle factors that may affect workplace performance and sickness absenteeism in office workers. These lifestyle factors are: levels of physical activity, levels of sedentary behaviour, and proxies of body composition - specifically body mass index (BMI) and waist circumference.

1.3.1. Physical activity levels globally and in South Africa

Physical inactivity has a major impact on mortality and morbidity rates - it is the fourth leading risk factor for death worldwide, and is responsible for 6% of all NCDs (25). Roughly 3.2 million people die annually due to physical inactivity related causes, and those who are inactive have a 20% to 30% increased chance of developing cardiovascular diseases such as heart attack and strokes (17). The trend of inactivity is seen mainly in higher income earning countries. However, it is also becoming prevalent amongst low to middle income countries such as South Africa, specifically in females (17).

Additionally, with the ongoing economic development and growth within South Africa, rural areas are becoming increasingly urbanised (23). In these areas, diets are becoming more westernised, and physical activity levels are decreasing due to the increased accessibility of public transport (26). As a result, obesity prevalence is increasing (27).

In 1998, the South African Demographic and Health Survey measured physical activity in the country using a self-reported questionnaire. The findings from the survey where that 48% of men and 52% of women were inactive (n=10159) (26). Since this time, more analyses regarding physical activity levels in South Africa have been completed. According to the WHO-WHS Report conducted in 2005, South Africa is ranked the 3rd most physically inactive country among thirty-eight participating developing countries.

Currently, there is no more recent survey data on physical activity levels in South Africa. However, in 2014, the South African National Health and Nutrition Examination Survey (SAHANES) reviewed fitness levels of South African men and woman as a proxy of physical activity. Fitness levels decreased with increasing age, with 18-24 year olds being the fittest age group (65.9% physically fit) (14). Females were considerably less fit than males - only 42% were physically fit, compared to over 62% of males (25).

1.3.2. Sedentary behaviour levels globally and in South Africa

The prevalence of sedentary behaviour amongst the adult population in South Africa is not well known, however, there are multiple studies completed with children and adolescents in South Africa (28).

A 2000 study, estimating the prevalence of inactivity amongst a group of South Africans, produced alarming results (29). This study used data from the 2003 World Health Survey. The sample population (n = 200) was split equally between men and women, and was stratified by age in years: 15-29, 30-44, 45-60, 60-69, 70-79, and 80+ years. The study did not measure sedentary behaviour directly, but rather recorded daily movement and physical activity. This does not appropriately capture the required patterns of sedentary behaviour but it does give an indication of physical activity patterns in this sample group. The cohort of this study was divided into 3 categories: 1) those who were highly sedentary i.e. “inactive: ‘doing no or very little activity at work, at home, for transport or during discretionary time”; 2) those who did not follow the recommended WHO guidelines of physical activity i.e. “insufficiently active: ‘doing some physical activity but less than 150 minutes of moderate-intensity physical activity or 60 minutes of vigorous-intensity physical activity a week accumulated across work, home, transport or discretionary domains’”; and 3) those who met the recommended guidelines of physical activity i.e. “sufficiently active – unexposed: ‘at least 150 minutes of moderate-intensity physical activity, or 60 minutes of vigorous-intensity physical activity a week, accumulated across work, home, transport or discretionary domains’, which approximately corresponds to current recommendations” (29). Even though this study mainly recorded levels of physical activity, an additional and important finding was that 43% of adult men and 49% of adult women were highly sedentary (29).

A 2011 WHO document reveals that 31% of adults do not follow recommended guidelines of movement, and the resultant mortality rate from this sedentary behaviour is up to 3.2 million deaths globally each year (30). The 2003, South Africa Demographic and Health Survey (SADHS) results showed that 25–37% of the South African population were reaching daily activity guidelines, but nearly half of the population were also too sedentary (31). A 2015 study by Skaal and Mathebedi reviewed the sedentary behaviour of South African government officials (n=340). They showed that 57.7% of government officials were too sedentary (30). Studies that investigate sedentary behaviour, have been carried out predominantly with children and adolescents (32-34). There is a great need for further research in the adult population, in order to get a more accurate understanding of the impact that sedentary behaviour is having in South Africa, specifically in the corporate South African setting due to the current limited literature.

1.3.3. Prevalence of obesity globally and in South Africa

The most commonly used index to classify body weight is Body Mass Index (BMI). BMI is calculated using the formula: weight divided by height squared i.e.

$\left. weight\ (kg) \middle/ height^2 (m^2) \right.$ (35).

Body mass index categorises people into one of four weight classes: underweight <18.5 kg/m^2, normal/healthy weight 18.5-24.9 kg/m^2, overweight 25.0-29.9 kg/m^2, and obese >30 kg/m^2 (36).

It has been estimated that 500 million of the world's population are obese, and this is predicted to increase to one billion by 2030 (31). In the South African context, the obesity epidemic is also rising (5). The rate of increase in the prevalence of obesity, is up to six time higher in the last seven years compared to the period spanning from 1980 to 2008 (5). Prevalence of obesity in male adolescents has increased from 6.3% in 2002, to 11% in 2008. Prevalence in female adolescents, increased from 24.3% to 29.0% over that same time period (37). A proportional relationship exists between socioeconomic class and obesity (38). Similarly, urban adolescents had higher rates of obesity when compared to those of rural adolescents (39).

Data from the South African National Health and Nutrition Examination Survey (SANHANES) shows that the prevalence of obesity is higher in South African women than in men, irrespective of the age group (25). Males had a mean BMI of 23.6 kg/m^2 vs females who had a mean BMI of (28.9 kg/m^2) (25).

Waist circumference is another common measure used to estimate central adiposity, and is related to cardiovascular health risk (39). Waist circumference is measured horizontally at the umbilical area (39). A waist circumference less than 94cm for men and less than 80cm for woman is considered healthy (40). Similar to obesity, South African woman are more likely to have unhealthily large waist circumferences than South African men, and they are therefore at a higher risk for cardiovascular disease (41).

1.3.4. Effects of obesity on health.

Obesity is a defined marker for metabolic syndrome (41). Metabolic syndrome is a clustering of health conditions that increases the risk of developing cardiovascular disease and diabetes (41). The most commonly acknowledged metabolic risk factors for metabolic syndrome besides obesity, are hypercholesterolemia, hypertension, and dysglycaemia (23).

Some mechanisms by which obesity causes metabolic disease have been described in the literature (42). Obese individuals are at increased risk of developing diabetes due to the high amount of accumulated adipose tissue, which releases various hormones and pro-inflammatory cytokines involved in insulin resistance (42). Adipose tissue also releases bioactive mediators that can lead to vascular dysfunction, thus increasing cardiovascular disease risk (43). Furthermore, obesity causes prothrombotic and proinflammatory states, thereby increasing overall health risks in these individuals (23). Studies also show that obesity is linked to multiple chronic diseases not normally discussed in connection with metabolic syndrome, such as certain cancers (44-46)

Obesity is a very well-researched area, probably owing to the role it plays in metabolic syndrome. Alberti et al (2009), reinforces that individuals with metabolic syndrome are at increased risk of developing cardiovascular diseases such as heart attacks and strokes (23). It must be noted that there are multiple additional factors such as age, sex and smoking status, that play a role in the development of cardiovascular disease (23).

1.3.5. Physical inactivity and sedentary behaviour as independent risk factors for poor health

The dangers linked to increased sedentary behaviour are highlighted in the study by Baddeley et al, entitled '*Sitting is the new smoking*' (38). Findings from this study show that sedentary behaviour can have a dire health impact, to the same or greater extent than smoking. This statement does not imply that sedentary behaviour has the same risks as smoking (e.g. lung cancer), but rather that the impact of sedentary behaviour on rates of mortality and morbidity can be equated to that of smoking (38). Studies have also shown that if an individual is too sedentary during the day, the beneficial effect of structured physical activity may not compensate for the negative physiological effects of the high sedentary time (47).

Multiple studies were identified that provide further evidence to support findings that sedentary behaviour and physical inactivity are independent risk factors for poor health outcomes. Duvivier et al (2017) analysed the impact of sedentary behaviour and physical inactivity in three groups: a highly sedentary group that did not partake in physical activity (group 1), a highly sedentary group in which participants performed one hour of physical activity daily (group 2), and a final group that was highly active during the day (i.e. following healthy sedentary behaviour guidelines) but did not partake in physical activity (group 3). This study showed that participants of the group 1 had the poorest blood glucose and insulin levels. Blood glucose control improved in both groups 1 and 2. However, group 2 did not see an improvement in insulin resistance. The only group whose members demonstrated an improvement in insulin resistance was group 3 ($p<0.001$) (48). A review of "inactivity physiology" by Hamilton et al (2008) clearly demonstrates that sedentary behaviour is strongly and independently associated with NCD's, and that the harmful health effects that are associated with sedentary behaviour are independent of physical activity (49). A 2016 Lancet physical activity series study reiterates these findings, by demonstrating that excessive sedentary behaviour produces detrimental cardiometabolic effects, even in individuals following the WHO guidelines of 150 MVPA per week (50). Those individuals who had high sedentary behaviour during the day, needed to achieve roughly 4 times the recommended WHO

guidelines of MVPA (approximately 600 min/week) in order to attenuate the harmful health risks associated with excessive levels of sedentary behaviour (50).
Sitting, in and of itself, is not unhealthy in small amounts, and the negative health effects such as cardiometabolic disease and diabetes only occur when individuals are consistently sedentary for long periods of time each day (24). When sedentary time is broken up regularly, and the total volume of sedentary behaviour is reduced and replaced with light intensity or ambulatory activities, the harmful cardiometabolic effects of sedentary behaviour are reduced (51). Further, the higher the intensity of the activity performed to interrupt the sedentary time, the greater the health benefit (51).

1.3.6 Effects of physical activity and sedentary behaviour in the workplace

Physical inactivity and sedentary behaviour have been associated with higher adiposity (52). Research has found that employees who are obese tend to cost their employers more than those who have a healthy body composition (52). This is largely driven by increased sickness and all-cause absenteeism, as well as a greater number of injuries in the workplace (52). Other studies that relate body composition to effects on workplace performance and sickness absenteeism, have found that overweight and obese individuals have a higher prevalence of sickness absenteeism and poorer workplace performance (52-53). There is a detrimental relationship between physical inactivity, sedentary behaviour, adiposity, and poor workplace performance that needs to be addressed. Recent studies show that even those who follow the recommended physical activity guidelines may still not be protected from the physiological damage resulting from a sedentary lifestyle (48). For example, office workers who are performing sufficient physical activity outside of the workplace, are still at risk from metabolic disease if they accumulate excessive sedentary time during the work day.

Due to the high levels of sedentary behaviour in corporate environments, there has been an increase in the adoption of workplace wellness programs, further supplementing a growing body of research that is investigating the economic benefits of a healthy work force (54). Studies are showing that a healthier work force translates into less sickness absenteeism, reduced healthcare costs and better workplace performance (54).

In studies where moderate physical activity was compared to workplace performance, positive effects on cognitive ability, alertness and stress reduction were shown with the increased levels of physical activity (55). However, there are conflicting views as to whether physical activity alone can contribute to work performance. In a 1989 study by North et al, authors described the “cardiovascular fitness hypothesis”. This hypothesis proposed that cardiovascular fitness, as assessed by VO2max, plays the most significant role in improvements in cognitive function (56). However, in a meta-regression study done in 2006, findings did not support the “cardiovascular fitness hypothesis” and mentioned that there are multiple factors that may affect the relationship between cognitive function and exercise, instead of cardiovascular fitness alone (57).

1.3.7. Physical activity, sedentary behaviour and the economy

In addition to the clear evidence, demonstrating the hazardous effects of physical inactivity on health, we are also improving our understanding of the financial and economic impacts of physical inactivity (8). Studies have shown that the more inactive a person is, the higher their likelihood of developing musculoskeletal or chronic disease, thereby increasing their sickness absenteeism and placing greater financial pressure on healthcare facilities and employers (8).

The effects of sedentary behaviour on sickness absenteeism and workplace performance in the South African setting is not well described, and results are inconsistent. However, high-quality studies conducted in North America have shown that billions of dollars are lost annually due to the impact of sickness absenteeism caused by poor lifestyle behaviours (58-59).

1.3.8. Financial impact of a healthy workforce

A study by Fabius et al, (2013) conducted in the United States, showed that companies that invested in their employees’ health via workplace health promotion programs, had better financial returns compared to companies that did not have health improvement programs (60). Conradie et al , (2016) repeated the study method of Fabius et al, (2013), except this time in South African corporate environments, where studies of this type have been limited. The findings were consistent with the US study, supporting the conclusion that South African companies with healthier workforces financially outperformed companies with less healthy workforces (61). Health measures included data such as eating habits, body mass index, motivation and stress levels.

A 2001 Canadian study reported actual financial losses that occurred due to lifestyle habits. Physical inactivity was estimated to cost the Canadian economy $5.3 billion per annum. Obesity was estimated to cost $4.3 billion per annum. Physical inactivity and obesity were therefore estimated to contribute 2.6% and 2.2% to the total Canadian healthcare budget respectively (59).

Finkelstein et al. (2010) are very clear regarding the impact that obesity has on the workplace, specifically in relation to sickness absenteeism. Their findings demonstrate that in a firm of 1000 employees, the cost of obesity adds up to approximately $285 000 per year. Of this amount, 30% is attributed to sickness absenteeism (62). The additional expense of substitute resource cover, to fill in for the obese class on their days absent, must also be taken into account (63).

1.3.9. Relationship between physical activity, sedentary behaviour and sickness absenteeism

There is limited data in the published literature, regarding the association between sedentary behaviour and sickness absenteeism. The literature that is available has focused primarily on physical activity rather than on sedentary behaviour, and occasionally assumed that high amounts of physical activity implies low levels of sedentary time.

van den Heuvel et al.(2005) attempted to investigate the relationship between leisure time sporting activity (not categorising those who follow the WHO physical activity guidelines or sedentary time guidelines) and sickness absenteeism, by focusing on participants who increased their daily physical activity by participating in sports (n=1228) (64). This study, when describing the effect of increased leisure time sporting activity shows results similar with the findings of this study, as those who increased MET's expenditure during the day were absent from work less frequently from sickness absenteeism (64). This published study did not categorise participants that either met the WHO guidelines of physical activity or who met the sedentary time guidelines. Therefore the conclusion cannot be drawn whether the study cohort decreased their sedentary time during the day by participating in sporting activity, whether following the PA guidelines caused the decrease is sickness absenteeism.

As described in section 1.3.5, sedentary behaviour and physical inactivity are independent risk factors, and being physically active does not necessarily prevent one from being sedentary. Despite a thorough review of the literature, no other studies have been identified that examine the effect of sedentary behaviour in isolation, and as defined by the WHO, on sickness absenteeism. There is also minimal published research regarding the effects of different kinds of sedentary behaviour on health.

The association between physical activity and sickness absenteeism was comprehensively described in a review by Amlani and Munir (2014), who assessed 37 studies on this topic (65). The main aspect scrutinised was the amount of physical activity performed and, in some cases, the intensity of the exercise. Ultimately, this review found that there was no clear association between physical activity and sickness absenteeism. The authors did, however, note that there were multiple methodological concerns, such as limited detail around physical activity, and the use of self-reported physical activity levels in the studies reviewed (52).

Another study compared participants who were currently or previously physically active, with participants who did not engage in physical activity (66). This study examined how the duration and frequency of sport engagement associated with sickness absenteeism, after adjusting for age, sex, alcohol consumption, and smoking (66). Findings demonstrate that there was minimal difference in the frequency of sickness absenteeism between the groups, however, the length of time that one was absent from work due to illness was substantially less in those who participate in sport (66). An interesting finding was that the group currently engaged in sporting activities were absent from work with greater frequency than the other groups, however in shorter bouts. The duration of bouts of sickness absenteeism, in those with no previous sport participation, was longer than that of the other groups – implying that recovery was faster in those who participated in physical activity (66). This study examined participants over a four year period, and demonstrated that those who were currently engaged in sport were absent due to illness for an average of 25 days less than those who were not currently participating in any sport, and up to 50 days less absent than employees who had never practiced any sport in their lifetime (66). It was also found that the beneficial effects of physical activity were greatest in those who had sedentary jobs.

A study by Spanos and Strigas (2018) investigated the relationship between physical activity, BMI and sickness absenteeism. This study found that physical activity levels were correlated with sickness absenteeism (R= -0.368) (63). Elaborating on these findings, other researchers examined whether the benefit of sporting activity outweighed the risk of injury, which could then be the cause of sickness absenteeism. The findings from this study reiterate those of Van Den Heuvel et al (2005) - those who engaged in sporting activity had similar frequencies of sickness absenteeism compared to those who did not, but they were absent for up to 23% less time (64). Interestingly, a study by Holtermann et al.(2012) found that employees performing physical activity at the workplace actually had increased sickness absenteeism when compared to employees who partake in leisure time physical activity (67). This suggests that interventions to increase leisure time physical activity should be prioritised.

Sedentary behaviour has been shown not to have a significant impact on sickness absenteeism, however, people who were more active during the day were found to have higher energy levels and be more productive (68). There is also data to show that increased sitting time has a negative effect on an individual's performance at work, and that high amounts of time spent sedentary results in more absenteeism due to sickness (68-69)

1.3.10. Relationship between obesity, sickness absenteeism and workplace performance

A review of the literature has revealed strong evidence that an elevated BMI has a significant impact on workplace sickness absenteeism. The study by Spanos and Strigas (2018) investigated the relationship between physical activity, BMI and sickness absenteeism. The key and most significant findings from this study show that an increased BMI correlates with an increased sickness absenteeism (R= 0.673) (63). In a 2008 study comparing health, psychosocial factors, and associations with sickness absenteeism, strong relationships between these factors were found (70). This study found that obesity had a significant impact on sickness absenteeism, in some cases doubling the amount of sick days taken. However, in this study, smoking and obesity were the main influencers of sickness absenteeism, and physical activity did not have a significant impact on total duration of sickness absenteeism (70).

The studies that have been conducted to test the prevalence of obesity in the workplace and its associations with workplace performance show conflicting results. Strong associations between high BMI and lower cognitive function have been found, irrespective of other health conditions (44)(71). However, a one-year long, randomised control trial - examining cognitive performance during and after interventions of physical inactivity and diet - found that, despite decreasing the prevalence of overweight individuals, the interventions were not able to produce sustained benefits on work performance (72).

1.3.11 What is missing in the current literature?

Improvements of employee health and wellness are essential to optimise staff performance and to reduce the duration and frequency of sickness absenteeism. However, research into the impact of physical activity, sedentary behaviour, and obesity on workplace performance and sickness absenteeism is very limited, especially in the South African setting. In particular, there is very little quality evidence (local or abroad) to describe the relationship between sedentary behaviour and workplace performance.

The increasing burden of physical inactivity and sedentary behaviour amongst South Africans has prompted the need for research which examines the impact that these lifestyle behaviours have on health and workplace performance (49). However, the associations between physical inactivity, sedentary behaviour and body composition, with workplace performance and sickness absenteeism in South Africa is not well understood.

1.4. Research objectives

The objectives of this study were twofold: 1- To describe the associations between these lifestyle factors: - sedentary behaviour, physical activity, and body composition (using BMI as a proxy) - on workplace sickness absenteeism and 2 – To describe the associations between these same lifestyle factors on workplace performance .

Figure 1 on the following page has been included to represent, visually, the relationships that may exist between individual factors, lifestyle factors, workplace factors and each of the two outcomes (sickness absenteeism and workplace performance). All of the variables that appear in red have been shown in previous studies to have an impact on the relevant outcomes, however, the present study does not have data to measure these exposures in this setting.

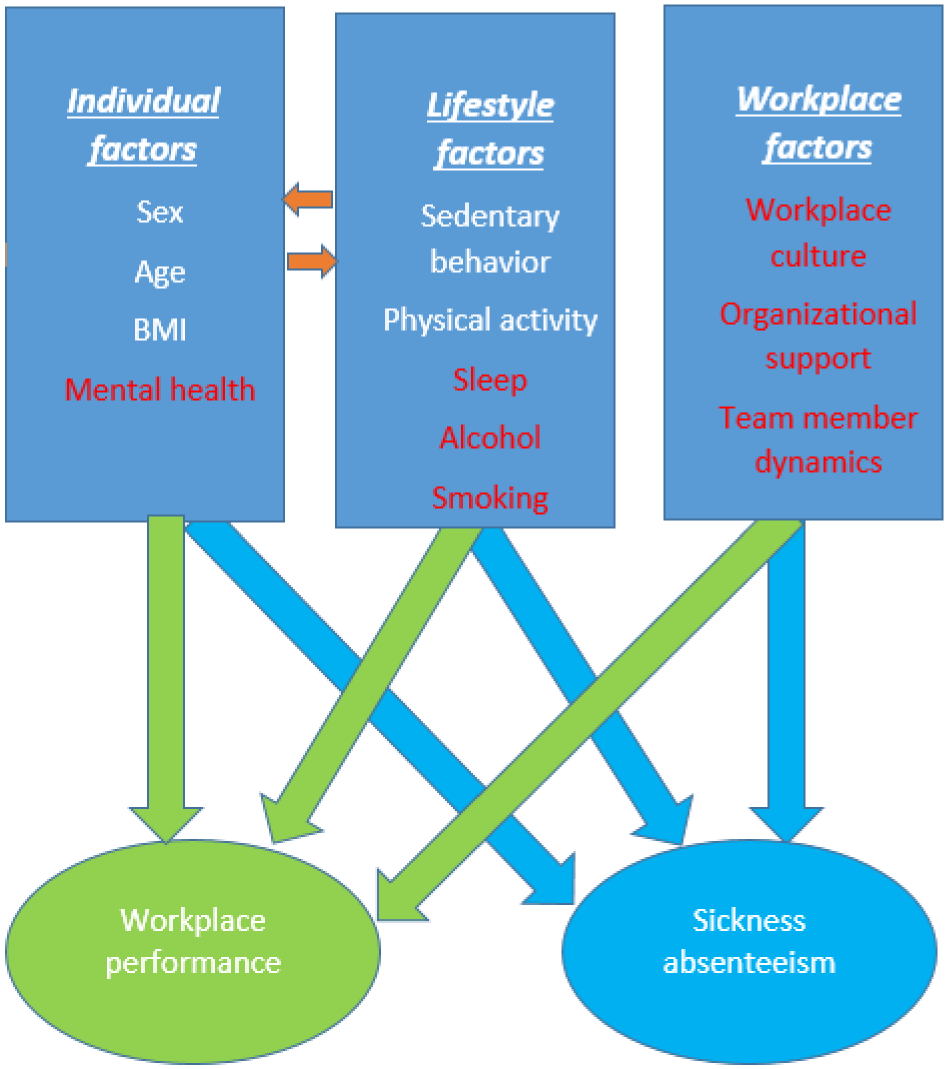


Figure 1: Relationship between individual factors, lifestyle factors, workplace factors with workplace performance and sickness absenteeism.

2.0. METHODS

2.1. Study population

The study population was comprised of call centre staff that were employed at Discovery Health offices based in Johannesburg, Pretoria, Port Elizabeth, Cape Town and Durban. All staff were encouraged to participate in one of the Vitality Wellness days. These were held from the 23rd of January to the 17th of February 2017 in these five major cities at the employees' respective offices.

In total, 5223 participants from all departments (including Health, Vitality, Insure and Invest), attended the 2017 wellness day. There were 3771 (73%) where from Johannesburg, 488 (9%) from Port Elizabeth, 417 (8%) from Durban, 334 (6%) from Cape Town and 213 (4%) from Pretoria. Of this total number, all 5223 (100%) completed all elements of the wellness day i.e. physical assessments and Vitality Health questionnaire.

A flow chart demonstrating inclusion and exclusion of participants, for various analyses in this study, is shown in Figure 2. This study chose to analyse only the results of call centre staff, because work performance metrics were available for this group.

A graphical breakdown of the number of participants included and excluded for each section of the study is shown in *Figure* 2.

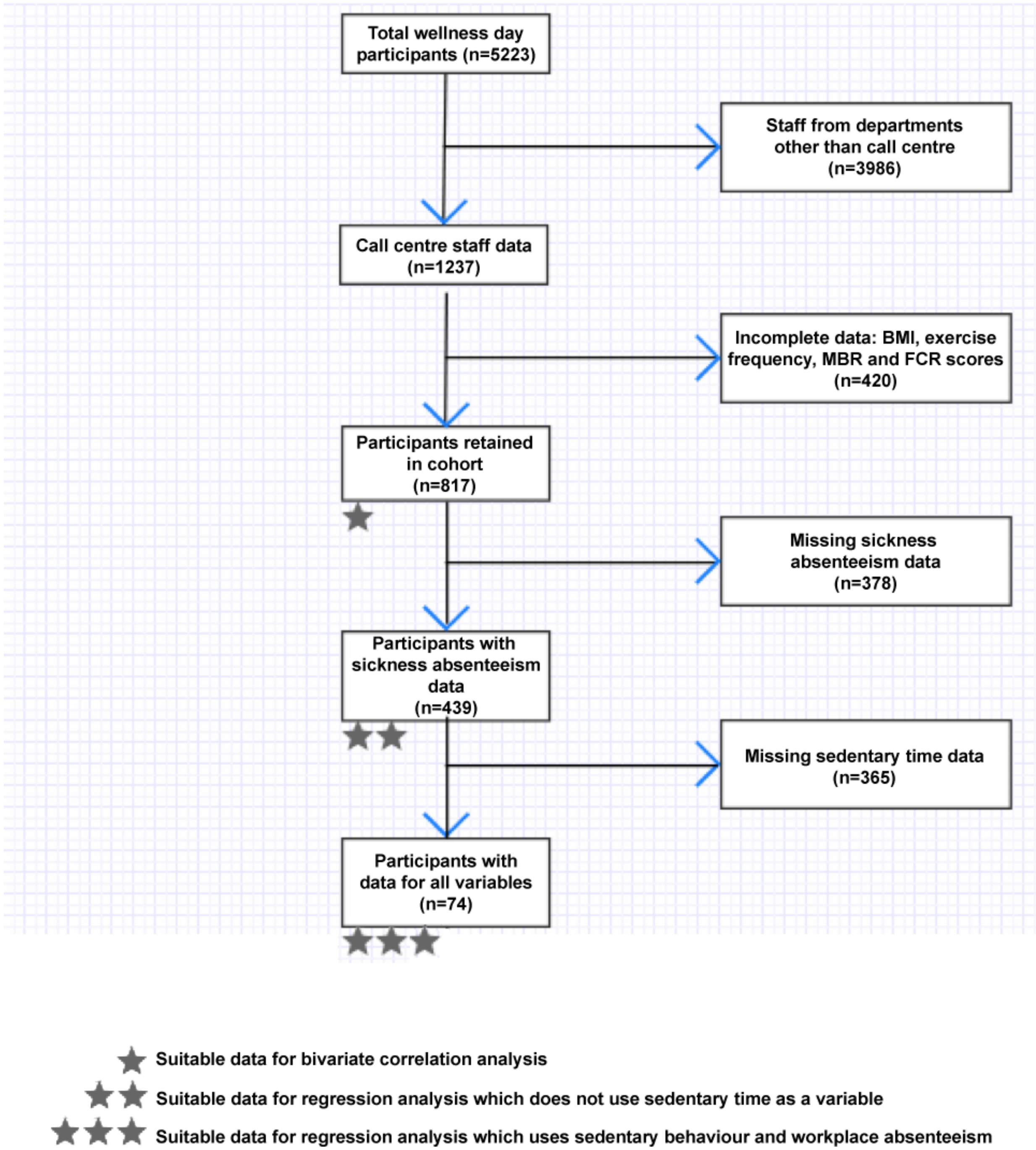


Figure 2: Flowchart demonstrating suitability of study participants for various stages of the study.

2.2 Anthropometry

All anthropometry measurements were conducted by a Wellness Specialist by Discovery Health according to standardised procedures (Appendix A). Wellness Specialists are Allied Healthcare professionals such as nurses and biokineticists. Participants removed any heavy clothing, as well as shoes and socks. Body weight was then measured to the nearest 0.1 kg using a digital measuring scale (Inbody 330, USA). Height was measured to the nearest 0.1 cm by a stadiometer (Charder HM200P Taiwan). Body mass index (BMI) was then calculated using the formula: $weight\ (kg) / height^2 (m^2)$ (35), Participants were categorised as underweight (<18.5 kg/m^2), normal weight (18.5-24.9 kg/m^2), overweight (25.0-29.9 kg/m^2), or obese (>30 kg/m^2) (36). Waist circumference was measured using a standard tape measure to the nearest 0.1 cm. Waist circumference was taken at the umbilical area, horizontally, while the participants were standing with their arms at their sides, their abdomen relaxed, and feet together (38). A waist circumference of >94 cm for men and >80 cm for woman was considered high (35).

2.3. Exercise frequency and sedentary behaviour - Vitality Health Review

All participants completed a 'Vitality Health Review' (VHR Appendix B). This is a health, lifestyle and demographic questionnaire. This questionnaire evaluates frequency and intensity of self-reported physical activity participation, sedentary behaviour, and self-reported health status.

Participants who accumulated less than 150 minutes per week of moderate-vigorous intensity physical activity (categories 3 and 4) were considered inactive according to international recommendations (WHO). Sedentary behaviour was broken down into three categories of sedentary behaviour per day: computer time, meeting time and TV time. The recommended prescribed total sedentary time is <8 hours per day (73).

2.4. Sickness absenteeism data

Sickness absenteeism was measured by recording how often participants were absent from work due to sickness, within a 12-month period. The total number of sick days over a 12-month period (February 2016 - January 2017) was used in the analysis. The data excluded absence from work due to other factors such as religious days and family responsibility leave. This data was recorded by Discovery Health Human resource department.

2.5. Work performance data

Work performance was measured using two methods: Member Based Rating (MBR) and First Call Resolution (FCR). These measures are recorded monthly by Human Resources at Discovery Health, and are reviewed over a 12-month period.

The MBR score is a globally utilised rating system, often referred to using different naming conventions abroad, such as ‘client satisfaction survey’. It is used to measure an employee’s performance in the call centre, and surveys customer satisfaction, call centre staff helpfulness, and intent to satisfy (74). The customer is prompted to rate the quality of their interaction with call-centre staff on a scale from 1 (i.e. worst client satisfaction) to 10 (i.e. perfect client satisfaction). Each participant received many ratings throughout the 12-month period, and their average MBR score over that period was used in this study.

The FCR is an international metric measure used to guide and monitor call-centre staff performance and ensure customer satisfaction (75). The FCR is a survey sent via email to clients after the call centre employee has assisted the client. The client is asked to provide a ‘Yes’ or ‘No’ response as to whether or not their query was resolved on first contact after the initial interaction with the employee. A ‘Yes’ is provided if the employee resolved the query, and a ‘No’ if the query was not resolved. This is a once-off rating per client, and the proportion of positive client ratings (i.e. the number of ‘Yes’ responses divided by the total number of responses over the 12 month period) is calculated per employee.

2.6. Statistical Analysis

2.6.1 Data management

All statistical analyses were completed using Stata 14.2 for Windows. All continuous data were presented as mean (SD), or median (IQR) for non-parametric data. Statistical significance was set at $p<0.05$.

Continuous data was collected for the following variables: sickness absenteeism (days/year), MBR scores, FCR scores, physical activity times (min/week), sedentary times (min/day), weights (kg), heights (cm), waist circumferences (cm) and ages (years). A BMI for each individual was calculated as described above. In several analyses, total sedentary time was deconstructed into separate sedentary activities (i.e. TV time, computer time, and meeting time).

Categorical data were collected for the sex of each participant. Further categorical data were derived for: sickness absenteeism (i.e. participants were assigned into tertiles using the median sickness absenteeism days for the sample - Low: <2 days per year (n=26, 35%); Medium: 2-7 days per year (n=32, 43%); and High >7 days per year (n=16, 22%)); physical activity- those who follow WHO physical activity guidelines (n=310, 38%) vs those who do not (n=507, 62%); and sedentary time- those who follow WHO sedentary time guidelines (n=45, 33%) vs those who do not n=91, 67%).

2.6.2 Data analysis

Correlation coefficients (r) were calculated for each pair of continuous variables. This produced six correlation coefficients using the continuous predictor variables (and one using the response variables), each with a value from -1 (perfect negative linear relationship) to 1 (perfect positive linear relationship). A value of zero indicates that no relationship exists, and the closer the correlation coefficient is to ±1, the stronger the association.

Male and female participants were compared for each variable using Student’s unpaired t-tests for continuous data and Chi-squared tests for categorical data. To examine the effect of following vs not following WHO physical activity guidelines, on sickness absenteeism, the mean values for sickness absenteeism in these two groups were compared. A statistically significant difference was reported if the 95% confidence intervals for the mean values did not overlap. A similar analysis was performed for MBR and FCR scores, as well as for BMI. The entire group of analyses (i.e. for sickness absenteeism, MBR and FCR scores, and BMI) was then repeated to compare the effect of following vs not following WHO sedentary time guidelines.

Bivariate correlation analyses were performed on each pair of continuous variables to demonstrate independence of each variable and correlation of each exposure with the outcome. This allowed for these significantly correlated variables to be used in the regression analyses. Multiple linear regression analyses were used to identify significant relationships between predictor variables (also referred to as independent variables) and response variables (also referred to as dependent variables) while excluding collinear exposure variables, by fitting a linear equation to recorded data. For each analysis, the specific variables used are provided. Categorical, predictor variables were incorporated into the analysis using a numerical coding (i.e. 1 = male and 2 = female; 1 = does not follow WHO guideline and 2 = follows WHO guideline). A significant p-value (i.e. $p<0.05$) indicates that the null hypothesis (that the specific predictor variable has no effect, i.e. that its coefficient equals zero) can be rejected. In other words, all coefficients with p-value less than 0.05 demonstrate significant trends for all analyses.

For the regression analyses, participants were excluded if they had missing sickness absenteeism data, which reduced the sample size to n=439. Data from this group was suitable for regression analyses that did not use sedentary time as a predictor variable.

Complete data for all variables, including sedentary time, was available for 74 participants. Regression analyses, using sedentary time as a predictor variable, were performed with this cohort (n=74)

Logistic regression analysis was performed using sickness absenteeism as a categorical response variable with the three categories of sickness absenteeism. The result of the logistic regression analysis is a table containing relative risk reduction (RRR) values for each predictor variable. The low sickness absenteeism group was defined as the reference group. Each RRR denotes the risk of falling into either the medium or sickness absenteeism high groups, compared to the risk of falling into the low group. For example, a RRR > 1 indicates that the outcome is more likely to be in a comparison group (i.e. medium or high sickness absenteeism) than in the reference group (low sickness absenteeism). Similarly, a RRR < 1 indicates that the outcome is likely to fall into the reference group.

2.7. Ethics

Ethical approval was provided by the Human Research Ethics Committee of the University of the Witwatersrand (ethics number M170709- Appendix C). All participants gave written and informed consent for participation in the Vitality Wellness day and for their data to be used for research purposes (Appendix D). Full consent was provided by Discovery Health for use of this data for these research purposes. All staff participated on a voluntary basis, and the data that was collected remained strictly anonymous, aside from each participant receiving their results via email.

3.0. RESULTS

A total of 1237 call-centre staff were included, comprising of males and females with an age range of 19 to 62 years old. The sample was then reduced to a size of n=817, as participants were only included for bivariate correlation analysis if all required data was available (i.e. height, weight, BMI, waist circumference, exercise frequency, MBR score and FCR score). This final study cohort comprised of 28% males and 72% females, with a mean age of 29.3 years old.

3.1. Demographic and behavioural characteristics of participants

3.1.1. Predictor variables

Mean values were calculated for all predictor variables considered in this study. Results are presented in Table 1, which shows both the values for the full cohort as well as values stratified by sex. Significant differences between males and females were observed when comparing durations of physical activity per week (p<0.01). Males' average exercise participation was 199.4 (184.1) min/week, with 52.4 % (n=120) following the guidelines of 150 minutes per week and 47.6% (n=109) not following this recommended guideline. Females' average exercise participation was 120.1 (153.6) min/week with 32.3% (n=190) following the guideline and 67.7% (n=398) not following the recommended guideline.

Table 1: Data collected for the predictor variables stratified by sex.

	Total n=817	Male n=229	Female n=588	p-value
Physical activity (PA) (min/week)	142.72 (166.43)	199.4 (184.1)	120.1 (153.6)	<0.01
***Percentage following WHO PA guidelines (%)**	38 (310)	52.4 (120)	32.3 (190)	<0.01
Sedentary time (ST) (min/day)	488.10 (238.65)	439.98 (219.83)	511.83 (245.10)	0.10

***Percentage following WHO ST guidelines (%)**	33 (45)	15 (20)	18 (25)	0.05
Weight (kg)	77.85 (21.22)	85.03 (20.83)	75.05 (20.73)	<0.01
Height (cm)	1.65 (0.09)	1.75 (0.07)	1.61 (0.065)	<0.01
BMI (kg/m^2)	28.63 (7.25)	27.92 (6.30)	28.93 (7.57)	0.07
Waist circumference (cm)	86.72 (16.44)	90.58 (16.00)	85.22 (16.37)	<0.01
Age (years)	29.3 (4.96)	29.4 (4.93)	29.3 (4.98)	0.89
***Values for percentages of participants following WHO guidelines are presented as percentage (sample size). All other values are presented as mean (SD).**				

There was no significant difference in total sedentary time between males and females (p=0.10). However, as can be seen in Table 2, when breaking down total sedentary time into its component activities, there was a significant difference in computer time between males and females.

Table 2: Breakdown of sedentary time within the study population stratified by sex.

	Total n=817	**Male n=229**	**Female n=588**	**p-value**
TV time	79.69 (70.75)	79.67 (57.99)	79.70 (76.52)	1.00
Computer time	348.68 (174.66)	291.31 (173.97)	376.73 (168.92)	<0.01
Meeting time	60.96 (115.59)	69.00 (114.04)	56.98 (116.77)	0.57
All values are in minutes per day, and are presented as mean (SD).				

There were also no significant differences between males and females for BMI (p=0.07). Participants were further divided by body type into normal, overweight and obese categories, using standard BMI conventions. Results are shown in Table 3.

Table 3: BMIs of male and female participants, categorised as normal, overweight and obese.

		Male (n=229)	Female (n=588)
BMI	**Underweight (<18.5)**	2.18% (n=5)	2.55% (n=20)
	Normal (18.5 – 24.9)	36.24% (n=83)	34.35% (n=285)
	Overweight (25 – 30)	32.31% (n=74)	25.00% (n=221)
	Obese (>30 kg/m^2)	29.26% (n=67)	38.10% (n=291)

Waist circumference revealed a significant difference between the sexes ($p<0.01$). Participants were further classified as having normal or high waist circumferences. Results are shown in Table 4.

Table 4: Waist circumferences of male and female participants, categorised as normal and high.

		Male (n=229)	Female (n=588)
Waist circumference (cm)	**Normal**	69.4% (n=159)	46.8% (n=275)
	High	30.6% (n=70)	53.2% (n=313)

3.1.2. Response variables

Females took on average 1.55 sickness absent days per year more than their male counterparts ($p<0.01$). There was no significant difference in workplace performance between males and females, as demonstrated by both MBR and FCR scores. Sickness absenteeism and workplace performance data are shown in Table 5 and Table 6 respectively.

Table 5: Sample values of sickness absenteeism, MBR and FCR scores stratified by sex.

		Total n=817	**Male n=229**	**Female n=588**	**p-value**
Outcome 1	**Sickness absenteeism (days per year)**	5.91(4.84)	4.84(4.53)	6.39(4.90)	<0.01
Outcome 2	**MBR score**	8.83 (0.84)	8.84(0.81)	8.83 (0.85)	0.91
	FCR score	8.13 (1.46)	8.12 (1.32)	8.14 (1.52)	0.91
All values are presented as mean (SD)					

When comparing the effects of following vs not following WHO guidelines (for both sedentary time and physical activity) on sickness absenteeism and workplace performance, a significant difference was observed only in sickness absenteeism, between those who met sedentary time guidelines and those who did not. These results are shown in Table 6 and Figure 3 on the following page.

Table 6: Sickness absenteeism, BMI, and workplace performance data, stratified by those who follow WHO guidelines for physical activity and sedentary time.

	Sickness absenteeism (days per year)	**P-Value**	**BMI (kg/m^2)**	**P-Value**	**MBR score**	**P-Value**	**FCR score**	**P-Value**
Follow PA guidelines	5.20 (4.45, 5.95)	0.21	28.09 (27.36, 28.82)	0.10	8.85 (8.75, 8.94)	0.73	8.20 (8.00, 8.41)	0.23
Do not follow PA guidelines	6.31 (5.74, 6.87)		28.96 (28.29, 29.63)		8.83 (8.75, 8.91)		8.10 (7.95, 8.24)	
Follow ST guidelines	3.46 (2.09, 4.82)	**<0.01**	28.93 (26.23, 31.63)	0.91	8.67 (8.32, 9.01)	0.51	7.97 (7.56, 8.39)	0.39
Do not follow ST guidelines	6.56 (5.16, 7.96)		29.10 (27.57, 30.63)		8.80 (8.60, 9.03)		8.25 (8.02, 8.48)	
All values are presented as mean (95% CI)								

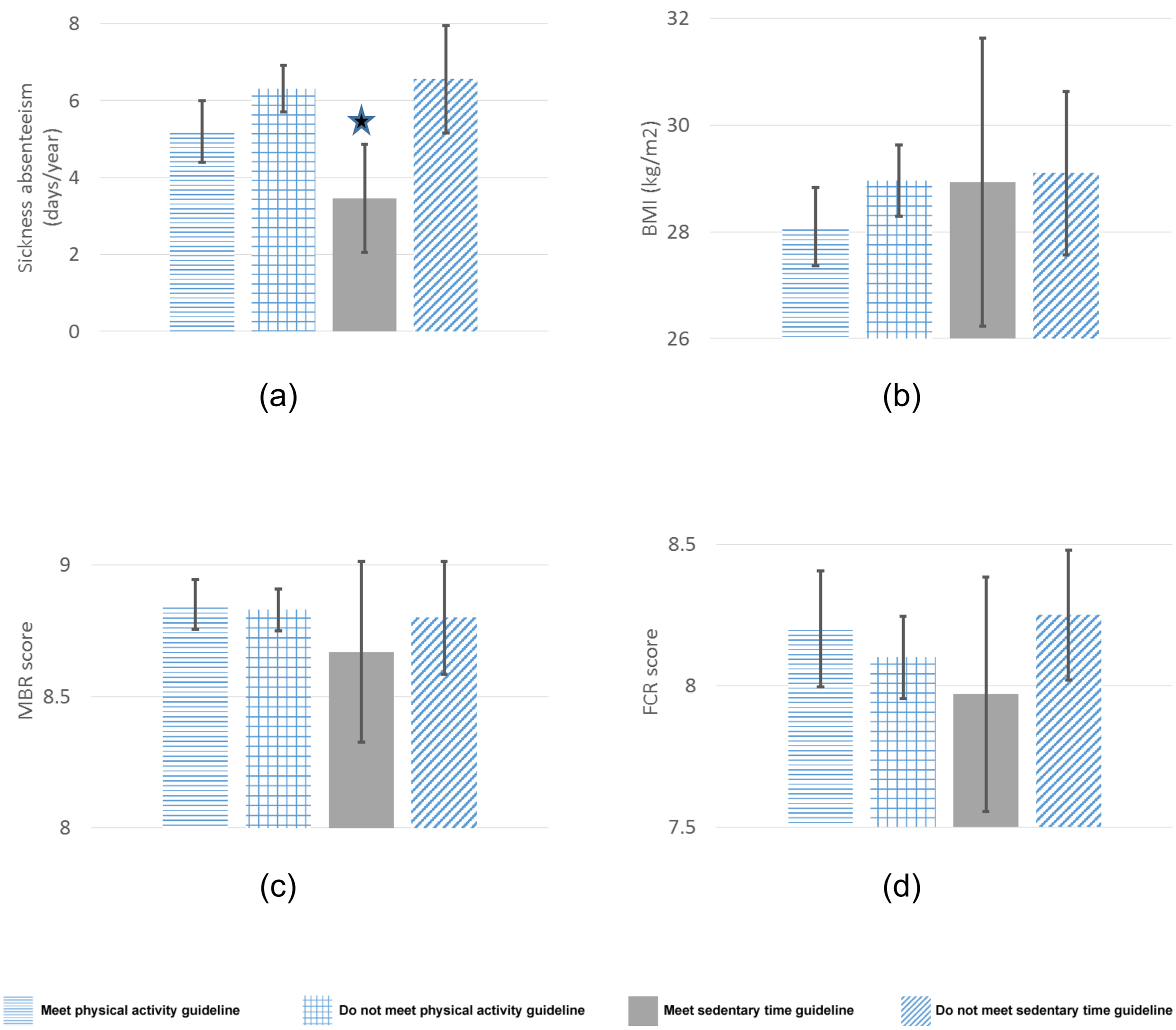


Figure 3: Graphical representation of data for (a) sickness absenteeism, (b) BMI, (c) MBR score, and (d) FCR score.

Participants were stratified by those who follow WHO guidelines for physical activity, those who do not follow WHO guidelines for physical activity, those who follow WHO guidelines for sedentary time, and those who do not follow WHO guidelines for sedentary time. Graphs show mean values, error bars show 95% confidence intervals.

★ Indicates $p < 0.05$

3.2. Bivariate correlation analysis

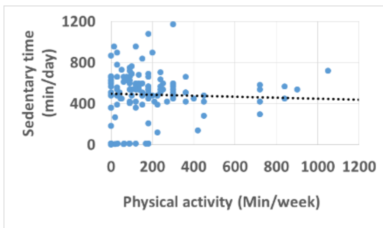
The results are summarised in Table 7 and Table 8. A graphical representation of the correlations is shown in Figure 4 and Figure 5. Cohen's conventions will be used to evaluate the strength of correlations. These conventions describe weak associations as having correlation coefficients less than 0.30 (76).

Table 7: Correlation coefficients (r) between continuous predictor variables.

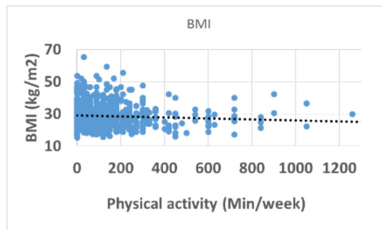
	Sedentary time (ST)	**BMI**	**Age**
PA (min/week)	-0.05	-0.07	0.02
ST (min/day)		-0.01	0.12
BMI (kg/m^2)			0.12

Table 8: Correlation coefficients (r) between response variables.

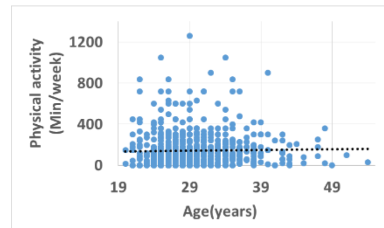
	MBR score	**FCR score**
Sickness Absenteeism (days per year)	0.10	0.03



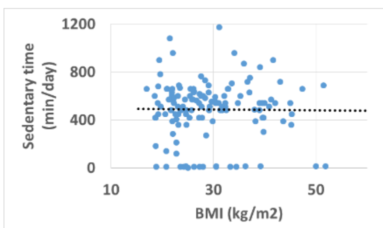
(a)



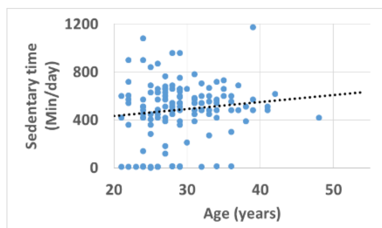
(b)



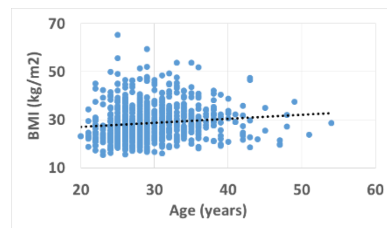
(c)



(d)

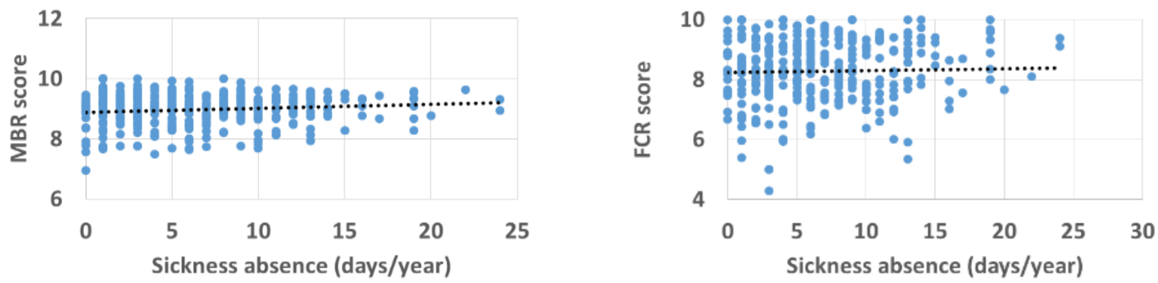


(e)



(f)

Figure 4: Scatter plots demonstrating weak correlations between (a) PA and ST; (b) PA and BMI; (c) PA and age; (d) BMI and ST; (e) age and ST; (f) age and BMI.



(a) (b)

Figure 5: Scatter plots demonstrating weak correlations between sickness absenteeism and: (a) MBR score; (b) FCR score. MBR and FCR scores are indicators of workplace performance.

As can be seen in Table 8 and Table 9, each of the correlation coefficients is less than 0.30 (the upper limit for weak association) and is actually very close to zero. The predictor variables can therefore be treated (in regression models) as if they possess no inherent relationship between themselves (i.e. no multicollinearity), as can the response variables. Figure 4 and Figure 5 provide a graphical illustration of the weak association between each pair of continuous predictor variables and between the response variables, respectively.

3.3. Regression analyses

3.3.1. Relationships between predictor variables and sickness absenteeism

Multiple linear regression analysis was performed using the predictor variables: physical activity, age, sex, and BMI. Data for these predictor variables and for sickness absenteeism was available for 439 participants. The results are shown in Table 9.

Table 9: Multiple linear regression analysis, showing relationships between PA, age, sex, BMI and sickness absenteeism.

	β coefficient	**p-value**
PA (min/week)	-0.003 (-0.006, <0.001)	0.05
Age (years)	-0.057 (-0.146, 0.032)	0.21
Sex (female)	1.312 (0.316, 2.307)	0.01
BMI (kg/m^2)	-0.023 (-0.085, 0.038)	0.45
R2 = 0.04. Values in brackets represent 95% confidence intervals. (Blocks containing significant results are coloured grey.)		

Next, sedentary time was used as an additional predictor variable in the analyses, to identify its effect on sickness absenteeism and examine its impact on the relationships of the other predictor variables with sickness absenteeism (n=74). The results from this multiple linear regression analysis are shown in Table 10.

Table 10: Multiple linear regression analysis, showing relationships between PA, ST, age, sex, BMI and sickness absenteeism.

	β coefficient	**p-value**
PA (min/week)	-0.002 (-0.006, 0.002)	0.40
ST (min/day)	0.006 (0.002, 0.010)	<0.01
Age (years)	0.020 (-0.182, 0.221)	0.85
Sex (female)	2.937 (0.794, 5.079)	<0.01
BMI (kg/m^2)	-0.032 (-0.149, 0.085)	0.59
R^2 = 0.24. Values in brackets represent 95% confidence intervals. Blocks containing significant results are coloured grey.		

The tables above demonstrate that, from these multiple independent variables, only female sex and sedentary time have positive, significant relationships with sickness absenteeism. Physical activity, age and BMI do not demonstrate significant effects on sickness absenteeism (when including sedentary time in the model).

Next, linear regression analyses were repeated, this time using physical activity and sedentary time as binary categorical variables (i.e. followed WHO guideline vs did not follow WHO guideline) (n=74). Results are shown in Table 11.

Table 11: Multiple linear regression analysis, showing relationships between categorical predictor variables and sickness absenteeism

	β coefficient	**p-value**
Followed PA guidelines (min/week)	-0.62 (-2.74, 1.50)	0.56
Followed ST guidelines (min/day)	-2.60 (-4.77, -0.43)	0.02
Age (years)	0.05 (-0.17, 0.26)	0.67
Sex (female)	3.03 (0.81, 5.26)	0.01
BMI (kg/m^2)	-0.02 (-0.14, 0.10)	0.69
R^2 = 0.20. Values in brackets represent 95% confidence intervals. PA: Physical Activity, ST: Sedentary Time. *Blocks containing significant results are coloured grey.*		

A generalisation can be made that those who followed guidelines for sedentary behaviour have significantly less sickness absenteeism. In contrast, WHO guidelines for physical activity do not show this effect.

When deconstructing total sedentary time into TV time, computer time and meeting time; neither TV time nor meeting time were significantly associated with sickness absenteeism. However, computer time was significantly and positively associated with sickness absenteeism. These results are from a multiple linear regression analysis, using the three sedentary activities, as well as age, sex and BMI, as predictor variables (n=74). Results are shown in Table 12.

Table 12: Multiple linear regression analysis, showing relationships between TV time, computer time, meeting time and sickness absenteeism.

Sedentary activity	**β coefficient**	**p-value**
TV time (min/day)	0.003 (-0.011, 0.017)	0.66
Computer time (min/day)	0.010 (0.003, 0.016)	<0.01
Meeting time (min/day)	0.000 (-0.008, 0.007)	0.90
Age (years)	0.057 (-0.146, 0.260)	0.58
Sex (female)	2.248 (0.011, 4.485)	0.05
BMI (kg/m^2)	-0.030 (-0.147, 0.086)	0.61
R^2 = 0.28. All values are in minutes per day, and are presented as mean (SD). ***Blocks containing significant results are coloured grey.***		

Next, logistic regression analysis was performed using sickness absenteeism (the response variable) as a categorical value (Low: <2 days per year; Medium: 2-7 days per year; and High >7 days per year). Predictor variables were physical activity, sedentary time, age, sex, and BMI. Once again, only participants whose sedentary time and workplace absenteeism data was available could be included in the analysis (i.e. n=74). Results are shown in Table 13.

Table 13: Logistic regression analysis, showing relationships between PA, ST, age, sex, BMI and categories of sickness absenteeism (low, medium and high).

Group	Predictor variables	RRR	p-value
Low	---- BASE OUTCOME -----		
Medium	**PA (min/week)**	0.998 (0.995, 1.002)	0.32
	ST (min/day)	1.004 (1.001, 1.007)	<0.01
	Age (years)	0.945 (0.837, 1.067)	0.36
	Sex (female)	1.793 (0.523, 6.148)	0.35
	BMI (kg/m^2)	1.014 (0.944, 1.090)	0.70
High	**PA (min/week)**	0.998 (0.994, 1.003)	0.50
	ST (min/day)	1.005 (1.002, 1.010)	<0.01
	Age (years)	1.018 (0.873, 1.187)	0.82
	Sex (female)	12.824 (1.326, 124.073)	0.03
	BMI (kg/m^2)	1.005 (0.916, 1.101)	0.92
Pseudo R^2 = 0.18. Values in brackets represent 95% confidence intervals. Blocks containing significant results are coloured grey.			

Sedentary time and female sex are once again shown to be significant predictor variables. An increase in sedentary time is likely to result in an individual's falling into the medium or high sickness absenteeism groups (favouring the latter). Female sex is a strong risk factor for falling into the high sickness absenteeism group.

3.3.2. Relationships between predictor variables and workplace performance

Multiple linear regression analyses were performed using the two workplace performance metrics (MRB score and FCR score) as response variables. Physical activity, sedentary time, age, sex, and BMI were used as predictor variables. Data from 439 participants were available for these analyses. Table 14 shows results with MBR score as the response variable – no significant relationships emerge. Table 15 shows results with FCR score as the response variable – in which it can be seen that BMI and

FCR score have a significant relationship, whereby an increase in BMI is likely to cause a decrease in FCR score.

Table 14: Multiple linear regression analysis, showing relationships between PA, ST, age, sex, BMI and MBR score.

	β coefficient	**p-value**
PA (min/week)	0.00 (<-0.01, <0.01)	0.23
ST (min/day)	0.00 (<-0.01, <0.01)	0.44
Age (years)	0.01 (-0.03, 0.05)	0.59
Sex (female)	0.22 (-0.19, 0.64)	0.28
BMI (kg/m²)	<-0.01 (-0.30, 0.02)	0.85

R^2 = 0.03. Values in brackets represent 95% confidence intervals.
PA: Physical Activity, ST: Sedentary Time

Table 15: Multiple linear regression analysis, showing relationships between PA, ST, age, sex, BMI and FCR score.

	β coefficient	**p-value**
PA (min/week)	0.00 (<-0.01, <0.01)	0.08
ST (min/day)	0.00 (<-0.01, <0.01)	0.60
Age (years)	0.03 (-0.01, 0.71)	0.09
Sex (female)	0.26 (-0.16, 0.69)	0.23
BMI (kg/m²)	-0.03 (-0.05, -0.01)	0.04

R^2 = 0.13. Values in brackets represent 95% confidence intervals.
PA: Physical Activity, ST: Sedentary Time
Blocks containing significant results are coloured grey.

Multiple linear regression analyses were performed, incorporating sedentary activities (TV time, computer time and meeting time) as well as other relevant predictor variables (age, sex, and BMI). Analyses results for the response variables, MBR score and FCR score, are shown in Table 16 and Table 17 respectively (n=439). No significant relationships were identified between these sedentary activities and MBR or FCR score. However, FCR score does demonstrate a positive and negative association with age and BMI respectively.

Table 16: Multiple linear regression analysis, showing relationships between TV time, computer time, meeting time, physical activity, age, sex, BMI and MBR score.

	β coefficient	**p-value**
TV time (min/day)	0.000 (-0.002, 0.003)	0.74
Computer time (min/day)	0.001 (-0.001, 0.002)	0.46
Meeting time (min/day)	0.000 (-0.002, 0.002)	0.92
PA (min/week)	<0.001 (0.000, 0.001)	0.23
Age (years)	0.010 (-0.027, 0.048)	0.58
Sex (female)	0.211 (-0.212, 0.634)	0.32
BMI (kg/m^2)	-0.003 (-0.029, 0.023)	0.81
R^2 = 0.03. Values in brackets represent 95% confidence intervals. PA: Physical Activity		

Table 17: Multiple linear regression analysis, showing relationships between TV time, computer time, meeting time, physical activity, age, sex, BMI and FCR score.

	β coefficient	**p-value**
TV time (min/day)	-0.001 (-0.004, 0.002)	0.48
Computer time(min/day)	0.001 (0.000, 0.003)	0.12
Meeting time (min/day)	0.000 (-0.002, 0.001)	0.68
PA (min/week)	-0.001 (-0.002, 0.000)	0.06
Age (years)	0.044 (0.004, 0.084)	0.03
Sex (female)	0.144 (-0.303, 0.591)	0.52
BMI (kg/m^2)	-0.028 (-0.054, -0.002)	0.04
R^2 = 0.17. Values in brackets represent 95% confidence intervals. **PA: Physical Activity** **Blocks containing significant results are coloured grey.**		

4.0. DISCUSSION

This study aimed to identify if physical activity, sedentary behaviour and body composition are associated with two separate outcomes: sickness absenteeism and workplace performance. In this section, the study results will be summarised and compared with findings from the literature.

4.1 Sickness absenteeism and its associations with physical activity and sedentary behaviour

This study identified statistically significant and independent associations between sedentary behaviour and sickness absenteeism. Participants who did not follow the recommended sedentary guidelines (i.e. their sedentary time exceeded 8 hours per day), had more sickness absenteeism than individuals who did follow sedentary guidelines i.e. 6.56 days per year vs 3.46 days per year.

The different types of sedentary behaviour in this study had different effects on sickness absenteeism. The three types of sedentary behaviours that where captured were: TV time, meeting time and computer time (all measured in minutes per day). Both TV time and meeting time had no independent effects on sickness absenteeism, yet computer time was associated with higher sickness absenteeism. Occupations in which excessive computer time is required are often associated with high levels of pressure, stress and anxiety. This serves as a possible hypothesis to explain why computer time has a more pronounced impact on sickness absenteeism than other categories of sedentary behaviour; however this hypothesis implies that workplace stress rather than the sedentary behaviour itself were responsible for sickness absenteeism.

A 2015 systematic review, containing papers from six databases (PubMed, PsycINFO, Embase, Web of Science, Sport Discus, and Scopus), provides some high level data on the direct impact of sedentary time (including total sedentary time and TV time) on health (50). The key findings of this review were that both sedentary time and TV time are associated with increased risk of illness (50). These findings can be compared with the results of this dissertation, if an assumption is made that increased risk of illness translates into an increased risk of sickness absenteeism.

The effect of total sedentary time on illness and sickness absenteeism is consistent between both this study and the systematic review. However, whilst the review states that TV time was associated with increased risk of illness (50), no relationship between TV time specifically and sickness absenteeism was observed in this study. One potential reason for this is that illness does not always translate into sickness absenteeism, i.e. employees may arrive at work whilst sick or illness may only manifest above the age of retirement. However, this inconsistency between these studies is more likely explained by noting that the point at which TV time started to produce negative health consequences in the review, was at three hours per day. In the present study, 94.9% of the cohort watched TV for less than three hours per day. It is therefore likely that, in this study, the number of participants who watch more than three hours of TV each day is too small for a significant effect to be observed.

The mechanisms by which sedentary behaviour affects sickness absenteeism are not well understood, and results are inconsistent (77). Most studies suggest that sedentary behaviour is not in itself responsible for worsening health, but rather the reduction in energy expenditure combined with the increased risk of obesity are causative factors (78). Studies have demonstrated that those who break up their sedentary time with physical activities (such as going for walks) have up to 30% decrease in insulin resistance compared to those who spend the entire day sedentary (79). Findings from intervention based research show that even small increases of sedentary time can produce insulin resistance and increased triglyceride levels (80-81)

While physical activity was significantly associated with sickness absenteeism in the first regression model, when including sedentary behaviour in the linear regression analysis, the relationship disappeared. When comparing individuals who met the WHO guidelines for physical activity with those who did not, differences in sickness absenteeism were not significant. Additionally, in all other analyses, no significant relationship was found between physical activity and sickness absenteeism.

Other research examining the association between physical activity (particularly sports participation) and sickness absenteeism, find that there is a negative relationship between these two variables. In a study by van Amelsvoort et al. (2006), participants who played sports two or more times per week had significantly lower sickness absenteeism (14.8 versus 19.5 days per year) due to decreased musculoskeletal disorders (66). Their study, however, was limited in that it did not capture sedentary time during the day. Physical activity and sedentary time are independent risk factors, and people who are physically active may demonstrate lower amounts of time spent sedentary as well. However, it is possible that in this published study's cohort, the sporting activities left little time for sedentary behaviours, and that low sedentary time was responsible for the observed benefits. Whilst physical inactivity and sedentary behaviour are both risk factors for poor health, the present study demonstrates that only sedentary behaviour increases sickness absenteeism.

Another study by Fitzgerald et al. (2016) found that central obesity, physical activity and quality of diet had a significant impact on sickness absenteeism (82). 540 employees from four different manufacturing workplaces were selected and data was collected, via questionnaire, for sickness absenteeism, BMI, waist circumference, blood pressure and physical activity. Moderate physical activity was found to be negatively associated with sickness absenteeism (82). There are multiple potential explanations for the discrepancy between these findings and those from this study. Firstly, Fitzgerald et al.(2016) estimate physical activity using the International Physical Activity Questionnaire (IPAQ), which describes physical activity levels by steps taken per day (low: <5000 steps/day; moderate: 5000–10 000 steps/day; and high: >10 000 steps/day). This is not comparable with the physical activity data obtained in this study. Secondly, sedentary behaviour is excluded from their analysis and may be a confounder in their results. Finally, Fitzgerald et al. (2016) analysed data from a cohort of workers at manufacturing plants, who likely spend much of their time standing and very little time seated at a desk. This is in direct contrast to the cohort used in this study, who are all full-time corporate employees, and likely to spend much of their time sedentary.

Research by van Amelsvoort et al. (2006) describes a negative correlation between physical activity and sickness absenteeism in workers (n=8902) (66). They determined that active workers have (on average) 14.8 days per year sickness absenteeism, compared to 19.5 days per year for inactive workers. They also determined that the effect of physical activity was strongest on sickness absenteeism caused by musculoskeletal disorders of the spinal column and nervous system disorders. van Amelsvoort et al (2006) did not examine physical activity and sedentary behaviour separately. Additionally, they did not report on the nature of their study groups' workplaces. It is possible that their participants held jobs that were physically laborious and thus taxing on the musculoskeletal system. Physical activity could very well alleviate some musculoskeletal symptoms from such a group. This would explain why results from this study, which includes sedentary time data and physical activity data from office-based corporate employees, differ from those of van Amelsvoort et al (2006).

4.2 Sickness absenteeism and its associations with *body composition*

When body composition (estimated using BMI) was analysed in this study, there was not a significant impact on sickness absenteeism.

The results of this study are contrary to other already published studies (83-84), which show negative relationships between obesity and sickness absenteeism. The possible reason that may explain why the findings from the present study differed from other published literature is due to the sample size was too small to detect differences in all variables, as illustrated in figure 2. As reported in other studies that have identified obesity as a risk factor for increased sickness absenteeism, it is not possible to draw a clear cause-effect relationship between obesity and sickness absenteeism in a cross-sectional analyses (59).

It is however possible that BMI has an indirect effect on sickness absenteeism, due to the vast number of pathologies for which higher BMI is a risk factor. Studies have stated that obesity will impact on one's sickness absenteeism as there are a host of ailments that accompany obesity, such as: musculoskeletal pain, orthopaedic pains, autoimmune arthritic pain and mental disorders, these all catalysts for increased sickness absenteeism taken by these obese employee (84). Further the effects of obesity that lead to sickness absenteeism may not affect ones health immediately, as there are long term effects of obesity such as, increased levels of sex hormones like estrogen, insulin resistance, chronic inflammation, and abnormal release of adipokines (85). With the increased risk of non-communicable diseases amongst the obese employee population, more sickness absence will be taken due to medical attention needed to treat these related medical conditions (83).

A study with a larger sample size of overweight and obese participants would be more likely to observe this indirect effect. Further research would be useful to gain a deeper understanding of this interaction between obesity and sickness absenteeism where the study cohort numbers are sufficiently high.

4.3 Workplace performance and its associations with sedentary behaviour and physical activity

When comparing individuals who followed WHO guidelines for sedentary behaviour with those who did not, differences in workplace performance were not significant. Similarly, in all regression analyses, using either total sedentary behaviour or individual sedentary activities, no significant relationship between sedentary behaviour and workplace performance was found (MBR or FCR scores). There is very little evidence to describe the relationship between sedentary behaviour throughout the day and workplace performance. This is a relatively unique contribution of this study. Available studies focus on the impact of active (i.e. movement-based) workstations on workplace performance while the individual is using the active workstation (86-87). Despite these studies not measuring sedentary time in accordance with health guidelines such as the data from this study, the logic can be drawn that if an employee is using an active workstation, their total daily sedentary time will be decreased. With this notion, the findings of this study are comparable to other already published literature as there is no definitive evidence that increased daily movement improves workplace performance (87).

Active workstations are designed to decrease sedentary time while at work. Studies demonstrate that movement while working does not improve (and in some instances, it actually worsens) workplace performance (86). Outcomes such as increased mistakes and decreased memory related work tasks are seen (86). A systematic review of three studies found no effect on workplace performance after 3 months of active workstation use (86). Torbeyns et al (2014) demonstrate that active workstations reduce the harmful effects of sedentary behaviour on health. However, they too demonstrate that active workstations do not have any impact on work performance, irrespective of worker age (87).

The literature cited above describes the effect of a sedentary behaviour intervention (i.e. active workstations) on future workplace performance. This differs from the analysis performed in this study, which used self-reported sedentary times and historic workplace performance metrics. Despite these differences, the results from this study agree with those found in the literature.

When comparing individuals who followed WHO physical activity guidelines with those who did not, differences in workplace performance were not significant. Similarly, in all regression analyses, no significant relationship was identified between physical activity and either MBR score or FCR score. Some researchers have suggested that increased levels of physical activity do produce positive effects on cognitive ability, alertness and stress reduction (67). However, there are conflicting views as to whether physical activity alone can contribute to work performance. Other studies explain that there are multiple factors that may affect the relationship between cognitive function and exercise (69).

A study by Drannan et al (2016) used a questionnaire to establish physical activity levels, self-evaluated workplace performance, and mood (n=413) (88). Drannan et al (2016) found that physical activity was positively correlated with mood improvement, and that this translated into better workplace performance (88). A study by Adams et al. (2005) found that those who are physically active have higher cardiovascular fitness levels, lower rates of obesity and improved workplace performance, compared to those who are physically inactive (89).

It is worth noting that improvements in cognitive ability and alertness, as measured by other studies, may not be measurable using the MBR or FCR scoring systems that were used in this study. Both the studies above measure workplace performance subjectively, using questionnaires completed by the employees. This method may be more sensitive than MBR and FCR scores, to performance improvements that arise from changes to emotional states (e.g. happier mood, decreased stress, etc.). However, self-reported performance measures are likely to suffer from biases.

In this study, FCR score was negatively associated with obesity. Those who participate in physical activity have lower risks of obesity, and hence physical activity may have an indirect effect on workplace performance. This is a subject for future research.

Objective measures were used in this study to quantify workplace performance, thereby strengthening the findings of this study. However, these objective scoring systems are also susceptible to biases. For example, a customer rating an employee using the MBR score may be hesitant to score the employee badly. Indeed, most of the recorded MBR scores lie towards the upper limit. The MBR and FCR scoring systems may lack the resolution to accurately detect even moderate changes in workplace performance. Other scoring systems should be investigated for future research.

It must be highlighted that there are multiple factors that contribute to performance in the workplace, including “workplace culture, organisational communication, managerial style, trust, respect, leadership, and company reputation” (90-91). Additional factors that can directly impact sickness absenteeism and workplace performance include “stress and resilience, depression, social connections, sense of self and financial status” (92-93).

4.4 Workplace performance and its associations with body composition

In this study, high BMI had a negative impact on FCR score (p=0.04). The FCR scores were significantly worse in those who had a higher BMI, even when adjusting for physical activity, sedentary behaviour, age and sex. No significant relationship was identified between BMI and MBR score. Therefore, this study produces conflicting results regarding the effect of BMI on workplace performance. Similar conflicting results are found in the literature. Some studies have shown inverse associations between BMI and cognitive function (44) (55) (70).

Studies have examined cardiovascular fitness and its associations with cognitive function. Fedor et al (2013) investigated whether BMI is associated with cognitive function in those who have high levels of cardiovascular fitness (71). They demonstrate that an individual who has an elevated BMI is likely to have diminished cognitive function, despite high levels of cardiovascular fitness (71). Key findings from a study by

Shrestha et al.(2016) showed that those with high BMI’s were at higher risk of decreased work quality, however, overall work performance was not affected (83).

The FCR score captures the ability of an employee to resolve customer queries on the first contact. It is therefore reasonable to assume that a resourceful employee (i.e. an employee without diminished cognitive function) is more likely to receive a higher FCR score than a less resourceful employee. If BMI does indeed cause a reduction in cognitive function, this may be captured using the FCR score. In contrast, helpfulness and intent to satisfy are highly weighted in the MBR score. These quantities may be unaffected by a diminished cognitive function, thus explaining why BMI does not correlate with MBR score. The suitability of the scoring systems used in this study, and the areas in which they are most sensitive and specific, are subjects for future research.

4.5. Relationship between sickness absenteeism and workplace performance

Relationships between the two independent outcomes, sickness absenteeism and workplace performance, were examined. In this cohort, sickness absenteeism had no impact on workplace performance and vice versa. These results are surprising because they contradict the available literature. Other studies show that poor lifestyle factors and high workplace absenteeism result in bad overall work performance (94). This inconsistency is possibly explained by the choice of workplace performance measures. MBR score and FCR scores were used in this study, but not in any of the other identified literature (79). Several researchers make use of self-reported workplace performance data. Other metrics and rating systems are also used, such as the defects per million opportunities score (DPMO) or the WHO Health and Work Performance Questionnaire (HPQ) (95). MBR and FCR scores were used in this study because they are commonplace in call centres, and the data was readily available.

As described previously, the objective measurement of workplace performance is complex, and certain scoring systems are best suited to specific environments. A scoring system that is capable of detecting performance fluctuations (caused by oscillations of mood, stress, cognitive ability, etc.) in all workplace environments has not yet been identified. Future research will place a greater emphasis on the evaluation of different scoring systems for workplace performance.

4.6. Summary of findings

A major finding of this study was that sedentary lifestyle has a statistically significant association with sickness absenteeism in call centre employees. These are novel findings in the South African context, where there is limited research available regarding sedentary behaviour.

These findings raise an important point for consideration: large corporations expect their employees to follow ambitious work targets, which often result in excessive sedentary time. This becomes a double-edged sword for employers. Corporations need to encourage staff to increase their movement behaviours during the day without affecting their outputs or performance.

The second key message to take from these findings is that physical activity did not attenuate the negative effects of sedentary behaviour. Many corporations have workplace gyms. However, this is not necessarily enough to counteract a sedentary work day. Additionally, studies have found that physical activity during working hours may in fact increase sickness absenteeism (67).

It must be highlighted that despite not seeing an inverse relationship between physical activity and sickness absenteeism, there are many other proven health benefits of physical activity. This dissertation is in no way suggesting that physical activity has no health benefits. Daily physical activity, and following the WHO guidelines, are highly encouraged in order to prevent NCD’s and improve overall health and wellbeing.

The third point for consideration is that these findings may be important for national public health, including but not limited to schools and healthcare facilities. If the impact of sedentary behaviour on sickness absenteeism is seen in a corporate setting, one could reasonably assume that sedentary behaviour might have similar effects in different settings. This encourages further research on sedentary behaviour and its associations with sickness absenteeism in other setting such as schools and other working environments.

BMI had no impact on sickness absenteeism. However, BMI had a negative association with the FCR score. Those who had an elevated BMI (specifically those who were obese) had poorer FCR scores. This gives an indication that body mass may have an impact on working abilities and efficiency. There are, however, limitations to this finding as there are multiple factors that contribute to obesity such as nutrition intake, physical activity levels, and financial status. In contrast to these findings, other studies did show a strong relationship between obesity and sickness absenteeism.

4.7. Limitations

This study has several limitations that may have affected the results. Firstly, the available sample size to investigate sickness absenteeism was smaller than initially anticipated, due to missing data for many of the original cohort. Second, physical activity frequency, intensity and sedentary behaviour were all self-reported, which allows room for inaccuracy and subjective bias. The third limitation is that sickness absenteeism data was only available as total amount of days absent per year, rather than the specific dates and duration of periods absent. The analysis was therefore limited by comparison to other studies, which had the data to demonstrate that those who are physically active are sick as frequently as those who are physically inactive, but for shorter periods of time. The fourth limitation is the methodology used to measure workplace performance variables. While the FCR and MBR tools are internationally recognised workplace performance metrics, there are alternatives that future studies could include such as the defects per million opportunities score (DPMO) or the WHO Health and Work Performance Questionnaire (HPQ) (94). The fifth limitation is that there is data that was not included in this study that could have a direct impact on the outcomes measures such as diet, mental health, smoking status, alcohol, workplace culture, organisational support, team member dynamics and sleep. The sixth limitation to the study is that due to the data being cross sectional only the associations between the variables were found and the study was unable to determine cause and effects.

5.0. RECOMMENDATIONS

These findings have major implications for workplace performance, economic impact, and various health risks associated with sedentary behaviour. Corporations should aim to reduce the amount of time that their employees spend sedentary in the workplace, in an attempt to reduce sickness absenteeism. This would have a positive financial impact on the employer. The financial impact that is felt by an employee missing a day's work due to absenteeism is that employee's salary for that given day, i.e. if we use this studies average call centre salary (approximately R25 000 per month), one days sickness absence will cost the company R1 250 for each day missed per employee. With a department size of 1237, each person within that department reduced their sickness absenteeism by just 2 days per year, would save this department within Discovery R3 092 500 per year.
With this calculation logic, a corporate company with 5000+ employees would save millions of rands per annum by reducing sickness absenteeism amongst their staff. International studies have found that having just one chronic condition or negative lifestyle habit such as physical inactivity can cost the relevant company and economy millions of dollars per annum (58).

Possible methods by which large corporations can reduce sedentary behaviour include the provision of standing desks, to give staff the ability to stand while working, and incentivising staff to increase daily movement such as increasing the amounts of steps completed during their respective working hours, thus breaking up their sedentary time. There is a tendency for incentivised behaviour-change programs to be successful.

Furthermore, reducing body mass of obese employees should be considered a point of intervention for large corporations, especially given the high proportion of overweight and obese call centre employees in this study sample. Initiatives, such as weight loss challenges between departments, would encourage this healthy behaviour and may improve workplace efficiency metrics by improving cognitive performance. Both increasing physical activity and reducing sedentary behaviour can help reduce body mass.

6.0. *FUTURE RESEARCH* AND INTERVENTIONS

6.1. Future research

Future study 1 - A useful future study to establish the associations between physical activity, sedentary behaviour and health indicators would be to incorporate health outcome measures such as blood pressure, cholesterol and blood glucose. With these measures, it would be possible to establish if those who met the WHO physical activity and sedentary behaviour guidelines had improved health outcomes compared to those who did not.

Future study 2 - To establish the association between mental health and workplace absenteeism and workplace performance. Studies show that high levels of depression seen in the workplace have a direct impact on workplace absenteeism and workplace performance (93). Depression and stress levels were not included in this study - this does prompt the need for future research, incorporating depression and stress levels into the model to identify and quantify additional relationships that may exist.

Future study 3 – To examine the duration of sickness absenteeism. The literature demonstrates that those who have lower amounts of sedentary behaviour were absent from work as frequently as those who are highly sedentary, however, for shortened periods of time. This results in less total absenteeism per annum. It would be useful to perform a study assessing specific dates and durations of absenteeism periods per employee, to establish if these findings are replicable in a South African cohort.

Future study 4 - Objectively measuring sedentary behaviour and physical activity would be highly beneficial. In order to fully understand the impact that sedentary behaviour and physical activity have on sickness absenteeism and other health outcomes, it would be best to objectively measure both of these behaviours. Wrist worn accelerometers successfully and accurately measure sedentary behaviour and physical activity, and could therefore provide the necessary data for such a study.

Future study 5 -Investigating why the relationship between sedentary behaviour and sickness absenteeism is stronger in females than in males. Females are at greater risk of sickness absenteeism than males. Future research into this topic would be needed to understand the mechanisms that differ between the sexes, which could explain this phenomenon.

6.2. Interventions

Once these relationships have been properly understood, it would be beneficial to design and conduct an intervention aimed at targeting a department within a large corporation that has high levels of sedentary behaviour, in order to implement an increased movement intervention. A possible intervention could create a ‘move more’ group, who would be encouraged to complete at least 10 000 steps during the day. A control group from the same department would continue with their normal daily behaviours. By recording sickness absenteeism and workplace performance over a twelve month period, one could observe how these variables are modified by changes in sedentary behaviours.

7.0 CONCLUSION

This study has shown that sedentary behaviour had a significant association with sickness absenteeism amongst call centre employees, regardless of physical activity participation outside of the working environment. This has significant economic and financial implications. Corporates should aim to reduce the amount of sedentary time that their employees spend in the workplace. This may reduce sickness absenteeism and hence have a positive financial impact on the employer. This study is the first of its kind to examine the effects of sedentary behaviour on sickness absenteeism in South African adults in the workplace. This has added relevant and useful information to the scientific literature, and may guide future research in the field of sedentary behaviour and workplace performance

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APPENDIX A: DATA COLLECTION

Data Collection

Height (cm)

Weight (kg)

Waist circumference (cm)

Exercise frequency (min/week)

Sedentary behaviour (min/day)

APPENDIX B: VITALITY HEALTH REVIEW (VHR)

<u>About yourself</u>

Sex

Age

Race

<u>Physical activity levels</u>

On average how many times a week do you exercise?	
On the days you exercise, on average	
How many minutes do you exercise?	
How intense are your exercise sessions?	☐ Low ☐ Moderate ☐ Vigorous
Low intensity: you can sing several phrases of a song without breathing hard. Moderate intensity: you can have a conversation and breathe comfortably. High intensity: you have to take a breath between every word you say.	
How often do you do strength exercises like pull-ups, push-ups, sit-ups, lifting free weights or using weight machines?	☐ Rarely or never ☐ Once or twice a week ☐ Three to five times a week ☐ Six to seven times a week
How often do you do flexibility exercises like stretching, yoga or Tai Chi?	☐ Rarely or never ☐ Once or twice a week ☐ Three to five times a week ☐ Six to seven times a week

Sedentary behaviour

On the average day how long do you do the following?

Sitting in followings	Hours□ Minutes□
Sitting in front of your computer	Hours□ Minutes□
Watching TV	Hours□ Minutes□

APPENDIX C: ETHICS CLEARANCE

R14/49 Mr Adam Stein

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M170709

NAME: (Principal Investigator)	Mr Adam Stein
DEPARTMENT:	Paediatrics Discovery Health Offices, Sandton
PROJECT TITLE:	Physical Activity, Sedentary Behaviour and Body Composition: Associations with Workplace Perfomance among Call Centre Employees
DATE CONSIDERED:	28/07/2017
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Dr Alessandra Prioreschi
APPROVED BY:	Professor CB. Penny Co-Chairperson, HREC (Medical)
DATE OF APPROVAL:	14/09/2017

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary in Room 10004,10th floor, Senate House/3rd floor, Phillip Tobias Building, Parktown, University of the Witwatersrand. I/We fully understand the conditions under which I am/we are authorised to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit to the Committee. **I agree to submit a yearly progress report**. The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. in this case, the study was initially review July and will therefore be due in the month of July each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Principal Investigator Signature Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

APPENDIX D: PARTICIPANT CONSENT

Participant consent

The healthcare providers have confirmed to Discovery that they will treat my health records as confidential and in line with the relevant legislation.

I confirm that I give consent for Discovery Health to use my data for research purposes and other third parties for analysis purposes

My consent is provided of my own free will without any undue influence from any person.

Signed_______________ Date_________________

APPENDIX E: TURNITIN REPORT

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