School of Psychology and Speech Pathology
Curtin University

The Effect of Increased Physical Activity on Sexual Functioning in Overweight and Obese Males

Saeideh Botlani Esfahani

This thesis is presented for the Degree of
Doctor of Philosophy
Of
Curtin University

March 2023

DECLARATION

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgement has been made.

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

Human Ethics (For project involving human participants/tissue, etc): The research presented and reported in this thesis was conducted in accordance with the National Health and Medical Research Council National Statement on Ethical Conduct in Human Research (2007) – updated March 2014. The proposed research study received human research ethics approval from the Curtin University Human Research Ethics Committee (EC00262), Approval Number: HRE2016-0367.

Signature:

Date:

13 March 2023

ABSTRACT

Background

Obesity and being overweight currently affect two billion adults over the world and it causes at least 2.8 million deaths per year. It leads to many complications, such as type 2 diabetes, metabolic syndrome, cardiovascular disease, stroke and some cancers. The World Health Organisation recommends physical activity as a health benefit strategy to address this issue. Evidence suggests that physical activity can assist people with sexual activities or sexual satisfaction.

The current project was designed to assess the effect of an intervention involving the use of an activity checker, a target of 10,000 steps/day, and related feedback, on sexual functioning in overweight and obese males. The number of steps and other psychological and physiological mediators were measured as the indicators relating to the impact of the intervention.

Aim

The overall aim of this project was to evaluate whether an intervention involving an activity checker (specifically a 'Fitbit') with the target goal of 10,000 steps/day with displayed steps would lead to better improvements in sexual functioning, psychological and physiological outcome measures in sedentary overweight and obese men than for a control group wearing the same device without displayed steps, over 12-week intervention period. It also aimed to determine the correlation between increased physical activity and sexual functioning, and a range of psychological and physiological mediators, in addition to the correlation between sexual functioning and all the aforementioned mediators in two groups (intervention and control) in three time points (week 0,6 and 12).

Methods

This project was a randomized controlled trial. Participants were recruited from the Perth community, and were randomly allocated to two groups: the intervention group and the control group. Both groups used an activity checker such as the Fitbit to increase their steps. The intervention group were encouraged to reach a step goal of 10,000 steps/day. They were

distinguished from the control group in the way that all displays were enabled for them. They could see the number of their steps/day throughout the day, sync their device daily to record the number of their steps, earn badges for activity achievements, add their friends to compare weekly step goals, and compete in challenges to win trophies. By contrast, the displays for the clock and floors climbed were enabled for the control group.

All participants attended three clinical appointments at Curtin University in the fasting state at baseline, week 6 and week 12, to collect physiological, psychological and sexual functioning data. The physical activity measure was the number of steps recorded on the activity checker. The physiological measures were blood pressure, blood lipids, glucose and insulin. The psychological measures were self-esteem (by way of the Rosenberg Self-esteem test), self-esteem and relationship (the Self Esteem and Relationship Scale), body esteem (by way of the Mendelson test), depression, anxiety and stress (the DASS-21), and health survey-36 V2 and its subscales (physical functioning, role limitation due to physical health problem, role limitation due to emotional problem, vitality, mental health, social functioning, bodily pain, general health, health transition). The sexual functioning measures were the International Index of Erectile Function (IIEF) and its subscales (erectile function, orgasmic function, sexual desire, intercourse satisfaction, and overall sexual satisfaction) and the Male Sexual Function Index (MSFI) and its subscales (sexual drive, erectile function, ejaculatory function, sexual problem assessment, and sexual satisfaction).

All statistical analysis was implemented through GLMM in SPSS 24, and $p<0.05$ was used to ascertain statistical significance.

Results

Physical activity: After controlling for between-group differences at baseline, the intervention group engaged in significantly more steps at 6 weeks ($F[1,50] = 23.56$, $p < .001$) and 12 weeks ($F[1,44] = 19.15$, $p < .001$), compared to the control group.

Sexual functioning: By week 6, the intervention group had significantly higher scores on the IIEF ($F[1,46] = 7.096$, $p = .011$) and the MSFI ($F[1,46] = 9.328$, $p = .004$) compared to the control group, but there were no significant between-group differences at 12 weeks for either the IIEF ($F[1,44] = 3.691$, $p = .061$) or the MSFI ($F[1,44] = 3.854$, $p = .056$). In terms of subscales,

at week 6, the intervention group had significantly IIEF higher scores for erectile function (F[1,46] = 7.338, p =.009) and overall satisfaction (F[1,46] = 8.373, p = .006), and significantly higher MSFI scores for erectile function (F[1,46] = 6.875, p = .012), sexual satisfaction (F[1,46] = 6.259, p = .016), and ejaculatory function (F[1,46] = 4.686, p = .036). No other between-group difference was significant.

Physiological outcomes: Compared to the control group, the intervention group showed a significant reduction in diastolic blood pressure (p=.038) at week 12. No other between-group differences were significant.

Psychological outcomes: At week 6, the intervention group scored significantly higher than the control group on 11 of the 15 outcomes: Self-esteem (F[1,46] = 10.19, p = .003), self-esteem and relationship (F[1,46] = 13.17, p = .001), depression (F[1,46] = 8.673, p = .005), physical functioning (F[1,46] = 4.464, p =.040), role limitation due to physical health problem (F[1,46] = 9.833, p = .003), role limitation due to emotional health problem (F[1,46] = 7.675, p = .008), vitality (F[1,46] = 5.958, p = .019), mental health (F[1,46] = 9.914, p = .003), social functioning (F[1,46] = 9.109, p = .004), bodily pain (F[1,46] = 11.792, p = .001) and general health (F[1,46] = 14.183, p < .001). At week 12, between-group differences were significant for 6 of the 15 outcomes: Self-esteem and relationship (F[1,44] = 11.20, p = .002), depression (F[1,44] = 7.179, p = .01), physical functioning (F[1,44] = 6.981, p = .011), mental health (F[1,44] = 7.614, p = .008), social functioning (F[1,44] = 6.068, p = .018) and health transition (F[1,44] = 5.878, p = .020). No other effect was significant at either 6 or 12 weeks.

Mediation effect: The physiological variables could not mediate intervention effects because they were not affected by the intervention at 6 weeks. However, two psychological variables showed intervention effects at 6 weeks: self-esteem and relationship and bodily pain, which were potential mediators of the intervention effect on sexual functioning.

Conclusion

This study shows that using an activity checker such as the Fitbit, together with target setting, feedback, incentives and competition, can lead to more physical activity in sedentary obese and overweight men, to improve their psychological and physiological well-being and, then have a better sexual life. These results have important implications for public health to investigate

physical activity as an alternative treatment to improve sexual functioning, and psychological and physiological health.

DEDICATION

This thesis is dedicated to the memory of my beloved father, who passed away before I finished my Doctoral study.

A sincere “thank you” to my mom, who is my constant source of inspiration.

A special gratitude to my loving husband, who encouraged me to fulfil my dreams and complete my Doctor of Philosophy degree. Thank you for your encouragement and believing in me, and I appreciate all the sacrifices made and the love has given to me to get me here.

Also, my great appreciation to my children, Zahra and Mohammadreza, who deserve awards for their patience and endurance. They have made my life joyful and have always motivated me to live a better life.

And finally, a heartfelt “thank you” to my sisters for providing love and support.

ACKNOWLEDGEMENTS

I would like to acknowledge my principal supervisors, Associate Professor Sebely Pal (until December 2019) and Associate Professor Sam Winter (from January 2020), and my co-supervisors at various points in my research, including Dr Emily Calton, Dr Suleen Ho, Professor Martin Hagger, Associate Professor Rosanna Rooney, and Dr Robert Kane for giving their knowledge and advice to finish this project with ease.

A special thanks to Dr Suleen Ho for her guidance and support and Dr Robert Kane specifically for his assistance on statistical analyses.

A debt of gratitude is also owed to my friend, Dr Monica Jane. Your words cannot express how much your guidance and help meant to me during this process and throughout the program. You are indeed a great friend.

Also, a special thanks to those who participated in this study voluntarily. Without their cooperation, this thesis would not have been possible. Your time and generous contribution are greatly appreciated.

LIST OF PUBLICATIONS

Published (see Appendix A)

Botlani Efahani, S. and Pal, S. (2019). Does metabolic syndrome impair sexual functioning in adults with overweight and obesity? *International Journal of Sexual Health*, 31:2, 170-185, doi: 10.1080/19317611.2019.1611688

Botlani Efahani, S. and Pal, S. (2018). Obesity, mental health, and sexual dysfunction: A critical review. *Health Psychology Open*, 1-13, doi: 10.1177/2055102918786867

TABLE OF CONTENTS

List of tables

List of figures

ABBREVIATIONS AND ACRONYMS

AHT: Antihypertensive

ANOVA: Analysis of Variance

ANCOVA: Analysis of Covariance

BMI: Body Mass Index

BP: Blood Pressure

BSFI: Brief Sexual Function Inventory

BES: Body Esteem Scale

CI: Confidence Interval

CVD: Cardiovascular Disease

DASS21: Depression Stress Anxiety Scale, 21 question version

DBP: Diastolic Blood Pressure

DSM-5: Diagnostic and Statistical Manual of Mental Disorders- Fifth Edition

ED: Erectile Dysfunction

FSFI: Female Sexual Function Index

GLMM: Generalized Linear Mixed Models

GLU: Glucose

HDL: High Density Lipoprotein

HREC: Human Research Ethic Committee

HRQOL: Health Related Quality of Life

IIEF: International Index of Erectile Function

INS: Insulin

IPAQ: The International Physical Activity Questionnaires

LDL: Low Density Lipoprotein

MET: Metabolic Equivalent Task

MS: Metabolic Syndrome

MSFI: Male Sexual Function Index

NHMRC: National Health and Medical Research Council

OR: Odds Ratio

PA: Physical Activity

PAR-Q: Physical Activity Readiness Questionnaire

RSES: Rosenberg Self-Esteem Scale

SBD: Systolic Blood Pressure

SEAR: Self-Esteem and Relationship

SF-36 V2: Short Form Health Survey, 36 question version

TC: Total Cholesterol

TG: Triglycerides

T2D: Type 2 Diabetes

WHO: World Health Organisation

CHAPTER ONE

INTRODUCTION AND OVERVIEW

This thesis reports the results of an experimental clinical trial to determine the effectiveness of increased physical activity to improve sexual functioning by improving depression, anxiety, stress, body image, self-esteem and overall health (psychological mediators) and lipids, insulin, glucose, and blood pressure (physiological mediators), in sedentary overweight and obese males.

1.1 Sexual functioning

The WHO (World Health Organization) defines sexual health as "a state of physical, mental and social well-being in relation to sexuality (World Health Organization, 2012). It requires a positive and respectful approach to sexuality and sexual relationships as well as the possibility of having a pleasurable and safe sexual experience, free of coercion, discrimination and violence" (Seen Heng et al., 2013). In addition, sexual functioning is defined as the perceived quality of a person's sexual life and relationships (DeLamater & Karraker, 2009).

The sexual response is divided into four phases: excitement, plateau, orgasm and resolution (Seen Heng et al., 2013). These four phases occur consecutively, and the sexual response cycle is not complete without all four phases occurring (Seen Heng et al., 2013). When there is a problem during at least one of these four phases, sexual dysfunction occurs. Sexual dysfunction can be defined as an impairment in the normal flow and physiology of sexual function (Howard, 2010), preventing individuals from experiencing satisfaction from sexual activity (Seen Heng et al., 2013). The prevalence of sexual dysfunction varies from 11-43% in women (Grewal et al., 2014) and 20-90% in men (Yildiz & Bölüktas, 2015).

Erectile Dysfunction (ED) is a public health problem affecting 1-10% of men younger than 40 years, 2-9% of men aged between 40-49 years, and increasing substantially to 20-40% in men aged between 60-69 years and 50-100% of men older than 70 years worldwide (Shamloul & Ghanem, 2013). Australian surveys identify this issue as a notable problem within the population, as 57.8% of men (McCabe & Connaughton, 2014) and 41% of women report experiencing sexual dysfunction (Dunn, 2000). Accordingly, the most common sexual

dysfunction in men is a self-reported lack of sexual desire, early ejaculation, and anxiety about sexual performance, while women more commonly report a lack of sexual desire and orgasmic dysfunction (Richters et al., 2003).

1.2 Body weight and sexual functioning

Obesity and overweight are chronic health problem which increases mortality rates and the proportion of people with one or more comorbid conditions (Sarwer et al., 2012). Obesity is defined as abnormal or excessive fat accumulation that may impair health (World Health Organization, 2018). Being overweight is defined as having a BMI between 25 and 29.9 kg/m^2 ,and obesity is defined as having a BMI of 30 kg/m^2 or more (World Health Organization, 2015a). Obesity is also a risk factor for chronic diseases such as heart disease, hypertension, stroke, type 2 diabetes, and metabolic syndrome, which negatively impacts mental health and leads to poorer quality of life (Sarwer et al., 2012).

In recent years, numerous studies have been conducted on the health consequences and the increasing prevalence of overweight and obesity. According to the World Health Organisation (WHO), obesity is one of the fastest-growing and most challenging public health problems and in 2014, was estimated to affect 1.9 billion adults globally (World Health Organization, 2015a). Nearly 70% of Australian adults are either overweight or obese, while in the United States and the United Kingdom, it is 72% and 68%, respectively. The figures are scarcely lower in most mainland European nations (World Health Organisation, 2017).

Furthermore, a growing body of research indicates that excess body weight is a risk factor for sexual dysfunction both in males and females (Andersen et al., 2008; Chung et al., 1999), and associations between obesity and sexual health and erectile dysfunction in males have been widely reported (Ahmed et al., 2011; Andersen et al., 2008; Bacon et al., 2003; Cheng & Ng, 2007; Derby et al., 2000; Esposito, Giugliano, Ciotola, De Sio, et al., 2008).

The physical health consequences of overweight and obesity include an increased risk of chronic diseases, such as heart disease, hypertension, stroke, type 2 diabetes (T2D), and metabolic syndrome (MS), itself a risk factor for the aforementioned conditions (Australian Institute of Health and Welfare, 2006; Lechleitner, 2008; Royal Australian College of General Practitioners National Standing Committee., 2006; Tsai et al., 2014). Excessive weight gain is

associated with an increased risk of metabolic syndrome (MS) and type 2 diabetes (T2D) by a reduction in insulin sensitivity which reduces glucose uptake and raises blood-sugar levels (Esposito, Giugliano, Ciotola, De Sio, et al., 2008). Furthermore, research has established the link between obesity and hypercholesterolemia (elevated amounts of cholesterol in the blood) and demonstrated that hypercholesterolemia is a risk factor for atherosclerosis, or narrowed and inflexible arteries, and can lead to heart attack, stroke, and other cardiovascular diseases (Ravnskov, 2002). Conversely, weight loss is associated with improvements in chronic disease risk factors (such as HDL, LDL, insulin, glucose, and blood pressure) (Agnieszka & Ehud, 2006; Kolotkin et al., 2008; Yildiz & Bölüktas, 2015).

The causes and consequences of overweight and obesity are not limited to physical health but can involve a wide range of psychosocial issues such as depression, anxiety, stress, and self-esteem (Atlantis & Baker, 2008; McCrea et al., 2012; Wit et al., 2010). The Royal Australian College of General Practitioners Standing Committee (2006) highlights psychological disorders as a considerable health impact associated with overweight and obesity. Both McCrea et al. (2012) and Kubzansky et al. (2012) demonstrate a positive correlation between high body weight and common mental illnesses such as depression, anxiety, and stress. Furthermore, the likelihood of experiencing anxiety or depression has been reported to increase with BMI classification (Kubzansky et al., 2012). Research has also shown that weight reduction can considerably improve the quality of life and reduce the mental health disorders associated with obesity (Carmichael et al., 2001; Järvholm et al., 2012). Other research findings indicate that improvements in BMI are positively associated with improvements in mental health disorders such as anxiety and depression in individuals with obesity (Thonney et al., 2010).

Overweight and obesity are reported as major factors that negatively impact the sexual functioning of both men and women (Adolfsson et al., 2004; Esposito, Giugliano, Ciotola, De Sio, et al., 2008). There is strong evidence to indicate that obesity may cause sexual dysfunction; in particular, a direct correlation exists between erectile dysfunction (ED) and obesity (Larsen et al., 2007). A growing body of evidence reports a strong significant relationship between obesity and ED in sexually active men; almost half reported mild to moderate degree of ED, while a quarter reported complete ED (Rosen et al., 2009). Further research has established an association between sexual quality of life and obesity and has revealed a significant negative correlation between the sexual quality of life and BMI (Kolotkin et al., 2008).

On the other hand, studies have reported that individuals with overweight and obesity experience improved sexual functioning following weight loss (Moore et al., 2013; Mora et al., 2013). Specifically, evidence has shown that men with obesity and erectile dysfunction had improved sexual functioning following lifestyle modifications for weight loss (Esposito et al., 2004). In addition, a 2-year study of male patients who underwent surgical (gastric bypass) weight loss reported improvement in erectile functioning following 24 kg weight loss compared to their counterparts in the wait-list control group, as measured by the IIEF (Reis et al., 2010).

1.3 Physical activity and sexual health

According to the WHO, physical activity is defined as any bodily movement produced by skeletal muscles that require energy expenditure (World Health Organization, 2015b). Physical activity occurs while working, playing, carrying out household chores, travelling, and engaging in recreational activities (World Health Organization, 2015b). Physical inactivity has been identified as the fourth leading risk factor for global mortality, causing an estimated 3.2 million deaths worldwide (World Health Organization, 2015b). It is estimated that 56% of Australian adults are either inactive or have low levels of physical activity (Australian Institute of Health and Welfare, 2012). A sedentary adult takes less than 5000 steps/day (Tudor-Locke & Bassett, 2004). Walking 10,000 steps/day is effective in increasing physical activity and improving health outcomes (White et al., 2012). Australia's physical activity guidelines state that 30 minutes of moderate physical activity at least 5 days a week is required to achieve health benefits and reduce the risk of chronic disease. Moving more and sitting less reduces the risk of mental health conditions such as depression, cardiovascular disease, type 2 diabetes, and some cancers, and prevents unhealthy weight gain (Australian Institute of Health and Welfare, 2012; Egger et al., 2001).

Physical activity has been identified as an important and modifiable lifestyle behaviour that can influence body weight and composition (Jakicic et al., 2018). According to a recent epidemiologic study, both obesity and physical inactivity are associated with sexual dysfunction (Derby et al., 2000) and increased physical activity is also associated with a lower risk of erectile dysfunction (Laumann et al., 1999). Furthermore, a cross-sectional study's findings indicate there is a positive correlation between physical activity and sexual

functioning, and lower levels of physical activity are related to poorer sexual functioning (Dahn et al., 2005).

Being sedentary has an adverse impact on sexual functioning. A recent epidemiologic study suggests that physical inactivity is associated with sexual dysfunction (Derby et al., 2000). In contrast, little research investigates the associations between physical activity and sexual functioning. One study investigating this relationship, found that increased physical activity is associated with a lower risk of erectile dysfunction (Laumann et al., 1999). This is a major gap in the current literature and needs to be addressed before efficacious interventions for improving sexual functioning can be developed.

Therefore, randomized controlled trials need to be conducted to investigate whether there is an effect between increased physical activity and improved sexual functioning and to evaluate the specific psychological and physiological mediators responsible for this effect.

1.4 Physical activity and metabolic syndrome

Metabolic syndrome is defined by the presence of three or more of these four risk factors: hypertension, hyperglycaemia, dyslipidaemia and abdominal obesity (Grundy et al., 2005). Randomized controlled trials and cross-sectional studies have demonstrated that physical activity has a mild or moderate effect on metabolic and cardiovascular risk factors related to metabolic syndrome (Lakka & Laaksonen, 2007).

A cross-sectional study of 963 individuals aged ≥50 years old found that participants with low levels of physical activity had higher chances of having diabetes (OR=1.79, 95% CI=1.17-2.72), hypercholesterolemia (OR=1.85, 95% CI=1.24-2.76), hypertension (OR=1.20, 95% CI=0.74-1.97) (Turi et al., 2016). Another cross-sectional design study, assessed the association between the prevalence of metabolic syndrome and physical activity. A total number of 24,178 participants, between 19 and 60 years old, completed this study. The results showed that physical activity reduces the prevalence of metabolic syndrome. The lowest prevalence of metabolic syndrome was observed in those who walked six times in a week (OR=0.67, 95% CI= 0.53-0.85) (Lee et al., 2016)

Physical activity is commonly recommended as an important lifestyle behaviour for the prevention and management of hypertension, hyperglycaemia, central or abdominal obesity and dyslipidaemia (Diaz & Shimbo, 2013). Physical inactivity is a significant and independent factor contributing to obesity (Fogelholm, 2010; Fogelholm et al., 2006). Both low exercise and long-lasting sedentary activities decrease energy expenditure and impair weight control and prevention of obesity (Fogelholm, 2008). The data from an epidemiological follow-up study showed that those individuals who remained at a low level of physical activity throughout a 10-year follow-up time gained more weight than those who became more active or remained at a higher level of physical activity (Jakicic et al., 2018; Williamson et al., 1993).

Recent data from different studies have shown that exercise is conversely associated with the development of hypertension and the effect of physical activity on blood pressure is significant (Figueira et al., 2014; Hegde & Solomon, 2015; Rossi et al., 2012). In an interventional study, exercise was recommended for a group of hypertensive patients. The active group had a decrease in systolic blood pressure by 4.3 mmHg and diastolic blood pressure by 1.7 mmHg compared to the non-active group (Cornelissen et al., 2013).

A similarly designed study was conducted to investigate the effect of physical activity on patients with type 2 diabetes. A group of patients with T2D participated in a 16-week physical activity program. The finding revealed that after the intervention, the exercise group showed a significant reduction in fasting blood glucose (-7.1%, $p<0.05$) (Ibañez et al., 2005). Collectively, research shows that increasing physical activity to 10,000 steps per day can have significant improvements in self-esteem, depression, anxiety, stress, overall health, blood pressure, lipids, insulin and glucose (Carraca et al., 2012; Helle´nius et al., 1993; Li et al., 2014; Pal et al., 2009).

1.5 Physical activity and mental health

A growing body of research has indicated the effects of physical activity on mental health, revealing a wide variety of psychological outcomes, including effects on mood, self-esteem, cognitive functioning, depression, and quality of life (Biddle, 2016). Moderate levels of physical activity often lead to the reporting of pleasure and positive mood (Ekkekakis, 2003). Moreover, the association between physical activity and self-esteem has been demonstrated in recent studies. Physical activity, such as sports, leads to beneficial changes in global self-

esteem and physical self, including improvements in skills and competence, body image, and physical fitness (Biddle, 2016). The results of Dishman's study revealed 20-33% lower odds of depression for active individuals (Dishman et al.,2004, Biddle, 2016). The findings of Paluska and Schwenk's study (2000) revealed that physical activity plays a pivotal role in the management of mild-to-moderate mental health diseases, particularly depression and anxiety. They found that increased aerobic exercise or strength training reduced depressive symptoms, anxiety symptoms and panic disorder significantly (Paluska & Schwenk, 2000). The association between physical activity and cognitive functioning have been assessed, and the findings of research have indicated that more physical activity in older adults ameliorates or prevents cognitive decline (Biddle, 2016). Therefore, physical activity is a major health behaviour that impacts mental health and is strongly recommended for the prevention and treatment of several diseases (Biddle, 2016).

Given that overweight and obese individuals are at risk of psychological and physiological problems related to weight gain and sedentary lifestyles, increasing physical activity may have a beneficial impact on these psychological and physiological factors and hence their sexual functioning.

1.6 Aims and objectives

1.6.1 Aim

This research aimed to evaluate the association between physical activity and sexual functioning in sedentary overweight/obese men by conducting a randomized controlled trial. In this 12-week study, with a 12-week follow-up, overweight/obese sedentary males were randomized into two groups: an "intervention" group and a "control" group. Sexual functioning, psychological and physiological information were collected at baseline, 6 and 12 weeks. This study explored the effect of increased physical activity on sexual functioning and whether this relationship was mediated by changes in psychological factors such as self-esteem, depression, anxiety, stress, body image and overall health and physiological factors such as blood pressure, blood lipids, glucose and insulin.

1.6.2 Specific objectives

- Determine the correlation between increased physical activity and 1) sexual functioning, 2) psychological mediators such as depression, anxiety, stress, self-esteem, body image and overall health, and physiological mediators such as blood pressure, blood lipids, glucose and insulin.

- Determine the correlation between sexual functioning (IIEF), depression, anxiety, stress, self-esteem, overall health, blood pressure, blood lipids, glucose and insulin.

1.7 Study overview

This study was a 12-week, randomised, controlled trial design investigation conducted with males with overweight and obesity from the Perth community (Australia). Participants were randomly assigned into: an "intervention" group and a "control" group. Both groups were given the National Australian Physical Activity Guidelines, and the information within these guidelines, such as intensity, duration, and prompts for exercise (i.e, stairs or elevators), were discussed with the participants. Participants from both groups were asked to wear a sealed Fitbit Charge HR to record the number of steps and were encouraged to initially set small achievable goals like 10 minutes of walking a day. They were to do this for the first two weeks and then gradually increase the walking goal each week to reach the goal of at least 30 min/day or more. No further advice was given to the control group; however, a goal of reaching 10,000 per day was given to the intervention group after this initial consultation. Participants attended clinical appointments at Curtin University in the fasted state at baseline and weeks 6 and 12. Data, including anthropometric measures, blood samples, blood pressure, step counts, and self-reported psychological and sexual functioning measures, were collected.

The purpose of this study was to determine whether higher levels of physical activity during daily life were associated with higher levels of sexual functioning through changes in both psychological factors (depression, anxiety, body image and self-esteem) and physiological factors (lipids, insulin, glucose, and blood pressure) in sedentary males with overweight and obesity.

1.8 Chapter overview

1.8.1 Chapter Two

Chapter Two, the literature review[1], provides an overview of sexual functioning, the effect of obesity and metabolic syndrome (e.g. hypertension, dyslipidaemia, and insulin resistance) on sexual functioning, and the effect of psychological health conditions (depression, anxiety, body image and self-esteem) on sexual dysfunction. The remainder of the chapter focuses on how weight loss can improve psychological and physiological health and discusses efficacious interventions for improving sexual functioning in individuals with overweight or obesity. Furthermore, an overview of physical activity and its beneficial impact on psychological and physiological factors and sexual functioning are provided. Finally, conclusions are drawn based on this evidence and shed new light on the effect of those psychological and physiological mediators that regulate sexual functioning in individuals with overweight and obesity, which is a gap in the literature.

1.8.2 Chapter Three

Chapter Three: This chapter outlines the methodology of the study. Briefly, this study was a randomized, controlled design clinical physical activity trial conducted over a 12-week intervention period. There was one intervention group (an "intervention" group) and one control group, with three data collection points during the intervention: baseline, 6 and 12 weeks. Clinical assessments included measuring physiological biomarkers (lipids, insulin, glucose, and blood pressure) and level of physical activity (using a Fitbit) along with self-reported sexual functioning. Self-reported psychometric measures were also collected in this trial (depression, anxiety, stress, body image, self-esteem).

1.8.3 Chapter Four

Chapter Four: This chapter illustrates the results of the analysis of the between-group differences in all of the physiological outcomes data collected, specifically metabolic syndrome risk factors such as blood pressure, lipids, glucose and insulin. It also presents the psychological mediators (self-esteem, depression, anxiety, stress, body image and general health) that may have influenced sexual functioning Self-reported sexual functioning and physical activity

recorded data are also explored, together with the step counts of the two groups (intervention group and control group). Moreover, the analysis of the direct effect of physical activity on overall sexual functioning as well as on the separate questionnaire domains between the intervention and control groups were presented. The sexual functioning of male participants was evaluated using the International Index of Erectile Function questionnaire (IIEF) and Male Sexual Function Index (MSFI). IIEF includes 15 questions in five specific areas or domains that measure erectile function, orgasmic function, sexual desire, intercourse satisfaction and overall satisfaction during the past four weeks. MSFI consists of 11 questions comprising five sexual function domains: sexual drive, erectile function, ejaculatory function, sexual problem assessment, and sexual satisfaction. The results presented in this chapter discuss some successful measures of the intervention and the success of using Fitbit to increase the number of steps and better sexual functioning.

1.8.4 Chapter Five

Chapter Five: This chapter briefly summarizes the results of the analysis discussed in the previous chapter and places them in the context of the wider literature. The strengths and limitations of the study are also discussed. Finally, this chapter provides the conclusions from the study and discusses the implications for future research and clinical practice.

1-(Two reviews papers were submitted: 1- Journal of *Health Psychology Open* on 12 July 2018 with the title of "obesity, mental health, and sexual dysfunction: A critical review".2- *International Journal of Sexual Health* on 25 May 2019 with the title of "Does metabolic syndrome impair sexual functioning in adults with overweight and obesity?") begins by laying out the theoretical dimensions of the research and provides a more detailed examination of previous research regarding sexual functioning and obesity, both from a psychological and a physiological perspective.

CHAPTER TWO

REVIEW OF THE LITERATURE

Overview

Obesity is a growing public health concern worldwide, affecting populations in both developed and developing countries. In 2014, the worldwide estimate of overweight and obesity in adults was approximately 1.9 billion, and poses a considerable threat to population health; as such, this issue has received considerable attention from researchers. Obesity is a risk factor for early mortality, greater morbidity, and chronic diseases such as heart disease, hypertension, stroke, type 2 diabetes, the metabolic syndrome, which negatively impact mental health, and lead to poorer quality of life. The severity of these conditions is positively correlated to the degree of obesity.

Previous research suggests that excess body weight may be a risk factor for sexual dysfunction, both in males and females. Therefore, given that individuals with overweight and obesity are at risk of psychological and physiological health problems related to weight gain and sedentary lifestyles, losing weight (through diet modification or increasing physical activity) may have a beneficial effect on these psychological and physiological factors, and therefore sexual functioning.

According to the WHO, physical activity is defined as any bodily movement produced by skeletal muscles that require energy expenditure. Physical inactivity is a significant and independent factor contributing to obesity. Both low exercise and long hours of sedentary activities decrease energy expenditure and contribute to obesity risk. While the use of physical activity in sedentary individuals with overweight/obesity is an emerging field of investigation, preliminary research suggests that there is a relationship between physical activity and improved sexual functioning. Increasing physical activity has been shown to improve sexual functioning and reduce the risk of serious mental and physical health conditions by improvements in self-esteem, depression, anxiety, stress, overall health, blood pressure, lipids, insulin, and glucose. However, randomized controlled trials need to be conducted to investigate the causation between increased physical activity and improved sexual functioning and to evaluate which psychological and physiological mediators may be responsible for this effect.

2.1 Background

2.1.1 Overweight and obesity

The World Health Organization (WHO) definition of overweight and obesity is "abnormal or excessive fat accumulation that presents a risk to health" (World Health Organization, 2015a). Body mass index (BMI) can be used to classify individuals' weight status according to weight and height (World Health Organization, 2015a) and is calculated by dividing the weight in kilograms by the squared height of the individual, in meters (kg/m2). Overweight is defined as having a BMI between 25 and 29.9, and obesity is defined as having a BMI of 30 or more (World Health Organization, 2015a). The distribution of body fat is a particularly important indicator of the associated health risk, as central or abdominal obesity is associated with a greater risk to health than a gynoid fat distribution (World Health Organization, 2015a).

Obesity is one of the fastest-growing and most challenging public health problems, and in 2014 was estimated to affect 1.9 billion adults globally (World Health Organization, 2015a). The detrimental effects of obesity are well documented within the academic literature. Obesity is a risk factor for early mortality, greater morbidity, and chronic diseases such as heart disease, hypertension, stroke, type 2 diabetes, metabolic syndrome, and a negative impact on mental health (Cook et al., 2003; Lechleitner, 2008; McLaren et al., 2008; Weiss et al., 2004; Wit et al., 2010), and can lead to poorer quality of life (Residori et al., 2003; Sturm & Wells, 2001).

The causes and consequences of overweight and obesity involve a wide range of psychosocial and physiological problems (Atlantis & Baker, 2008; McCrea et al., 2012; Wit et al., 2010). The Royal Australian College of General Practitioners Standing Committee (2006) highlighted psychological disorders as a considerable health impact associated with overweight and obesity. Both McCrea et al. (2012) and Kubzansky et al. (2012) demonstrated a positive correlation between body weight and common mental illnesses such as depression, anxiety, and stress. On the other hand, the physical health consequences of overweight and obesity include an increased risk of chronic diseases, such as heart disease, hypertension, type 2 diabetes (T2D), and metabolic syndrome (MS), itself a risk factor for the previously mentioned conditions (Australian Institute of Health and Welfare, 2006; Cook et al., 2003; Jean-Pierre & Isabelle, 2006; Lechleitner, 2008; Royal Australian College of General Practitioners National Standing Committee., 2006; Tsai et al., 2014; Weiss et al., 2004). In addition, excessive weight

gain is associated with an increased risk of metabolic syndrome (MS) and type 2 diabetes (T2D) by a reduction in insulin sensitivity which reduces glucose uptake and raises blood-sugar levels (Esposito, Giugliano, Ciotola, De Sio, et al., 2008). Furthermore, research has indicated the link between obesity and dyslipidaemia (excessive cholesterol) and demonstrated that dyslipidaemia is a risk factor for atherosclerosis, or narrowed and inflexible arteries, and can lead to heart attack, stroke, and other cardiovascular diseases (Ravnskov, 2002).

Given the role overweight and obesity plays in chronic disease, one could theorize a correlation between sexual functioning and obesity (World Health Organization., Geneva, 2006). Although both weight gain and a sedentary lifestyle have been associated with sexual dysfunction, little research investigates the associations between obesity and sexual functioning or physical activity and sexual functioning. A recent epidemiologic study suggests that both obesity and physical inactivity are associated with sexual dysfunction (Derby et al., 2000), while increased physical activity is associated with a lower risk of erectile dysfunction (Laumann et al., 1999). Furthermore, there is a positive association between sexual functioning and mental well-being (Korfage et al., 2009); and sexual dysfunction and several cardiometabolic risks (MS, hypertension, dyslipidaemia, T2D, and obesity). Therefore, in this section, we focused on sexual functioning, provided information regarding the relationship between sexual functioning with psychological and physiological conditions and investigated the impact of physical activity on these factors.

2.1.2 Sexual functioning

The WHO (World Health Organization., Geneva, 2006) has defined sexual health as: “a state of physical, mental and social well-being in relation to sexuality; it is not merely the absence of disease, dysfunction or infirmity. Sexual health requires a positive and respectful approach to sexuality and sexual relationships, as well as the possibility of having pleasurable and safe sexual experiences, free of coercion, discrimination, and violence. For sexual health to be attained and maintained, the sexual rights of all persons must be respected, protected and fulfilled.” Therefore, sexual functioning is broader than the frequency of sexual activity alone and includes the occurrence of desire, arousal, lubrication, orgasm, pain, satisfaction, and sex hormones (DeLamater & Karraker, 2009; Rosen, 2000; Rosen et al., 2002).

According to the DSM-5 (Diagnostic and Statistical Manual of Mental Disorders, 5th Edition), sexual dysfunction is defined by disorders of desire, arousal, orgasm, and pain (Cooper, 2014); however, there is no universally recognized definition of sexual dysfunction (Boyle et al., 2003; Lewis et al., 2004). As epidemiological research is based on common definitions, prevalence rates have been difficult to determine (Lewis et al., 2004). Epidemiological data shows the prevalence of sexual dysfunction to be approximately 40-45% in females and 20-30% in males worldwide (Aschkenazi & Goldberg, 2009; Lewis et al., 2004). Similarly, Australian surveys identified this issue as a notable problem within the population, as 57.8 percent of men (McCabe & Connaughton, 2014) and 41 percent of women reported experiencing sexual dysfunction (Dunn, 2000). According to the Australian Study of Health and Relationships, the most common sexual dysfunctions in men were lack of sexual desire, early ejaculation, and anxiety about sexual performance, while women more commonly reported a lack of sexual desire and orgasmic dysfunction (Richters et al., 2003). To further determine the prevalence of sexual dysfunction in Australia, Boyle et al. (2003) conducted a study with 1793 participants (876 males and 908 females between 18 and 59 years) selected from the Commonwealth electoral roll. In this sample, sexual dysfunction was reported by 55 percent of men and 60 percent of women (Boyle et al., 2003). Of these, 42 percent of men and 41 percent of women had one or two symptoms of sexual dysfunction, and 13 percent of men and 20 percent of women had three or more symptoms (Boyle et al., 2003). Only 6 percent of participants with sexual dysfunction reported seeking help, and help-seeking behaviours were more common in older respondents (Boyle et al., 2003). Clearly, sexual dysfunction is a significant public health issue.

2.2 Sexual functioning and obesity

Some researches has examined the relationship between body weight and sexual functioning (Lewis et al., 2004). Larsen et al. (2007) reviewed the available medical literature concerning sexual functioning and obesity from 1966 onwards and found no evidence to suggest that sexual dysfunction causes obesity; however, there is strong evidence to indicate that obesity can cause sexual dysfunction in men, in particular, a direct correlation exists between erectile dysfunction and obesity (Larsen et al., 2007). Although there are few studies investigating the association between female sexual functioning and obesity, there is support from cross-sectional and prospective studies linking erectile dysfunction and obesity. The above review also noted a positive impact of body weight reduction on sexual functioning in women and men

with obesity (Larsen et al., 2007). However, the reviewer could not conclude whether the improvements in sexual functioning were attributable to body weight reductions or the intervention methods.

Further research has supported these findings. To investigate the association between sexual quality of life and obesity, Kolotkin et al. (2006) conducted a cross-sectional prevalence study with 1,158 obese weight loss treatment candidates, who were either patients awaiting gastric bypass surgery (n = 372; mean body mass index (BMI) = 41.3kg/m^2), an intensive weight loss program and lifestyle modification (n = 500; mean BMI = 47.1kg/m^2), or a control group (n = 286; mean BMI = 43.6kg/m^2). Results revealed a statistically significant negative correlation between the sexual quality of life and BMI ($p<0.001$). Females with obesity reported greater sexual impairment than obese males. Of the three groups, surgery patients reported the greatest sexual impairment. In contrast, individuals who opted for the weight loss program reported sexual quality of life greater than or equal to the control group. This research supports a relationship between obesity and poor sexual quality of life in obese individuals; even so, reduced sexual quality of life is a frequently reported yet rarely studied the consequence of obesity.

Furthermore, a growing body of research indicated the association of obesity with sexual health and erectile dysfunction in males (Ahmed et al., 2011; Andersen et al., 2008; Bacon et al., 2003; Cheng & Ng, 2007; Derby et al., 2000; Esposito, Giugliano, Ciotola, Sio, et al., 2008). Individuals with overweight and obesity have an increased prevalence of erectile dysfunction (30-90%) compared to normal- weight subjects (Esposito, Giugliano, Ciotola, Sio, et al., 2008). Other studies have reported that overweight and obesity are associated with sexual dissatisfaction (Adolfsson et al., 2004) and impaired sexual quality of life (Kolotkin et al., 2006). Men with a 25<BMI<30 kg/m^2 reported poor sexual quality of life (Han et al., 2011) and are likely to carry a 30% higher risk for ED than those with a normal BMI (25 or lower) (Esposito, Giugliano, Ciotola, De Sio, et al., 2008). Moreover, the prevalence of impotence in obese men is higher than normal-weight subjects (Chung et al., 1999; Pinnock et al., 1999). According to Massachusetts Male Aging Study (Feldman et al., 2000) and Rancho Bernardo Study (Fung et al., 2004), body weight was determined as an independent risk factor for ED, with a risk exceeding 90% of controls. On the other hand, Feldman et al. (2000) showed that obese men had severe levels of ED (41%), whereas overweight men had moderate levels of ED (28%). Rowland et al. (2017) compared sexual dysfunction in 30 obese men and 30 normal-

weight men. The findings of this study indicated obese men had greater sexual dysfunction like lower sexual desire, lower erotic fantasy, lower energy or motivation for sexual propositions, as well as less sexual pleasure compared to normal-weight men. Regarding female sexual dysfunction, some research has indicated that higher BMI was associated with several types of sexual dysfunction like lower sexual arousal, lower lubrication, higher orgasmic disorder, and lower sexual dissatisfaction in women (Esposito et al., 2007).

2.3 Psychological issues in obesity and sexual functioning

Obesity has been associated with a wide range of psychosocial issues such as depression, anxiety, stress, self-esteem, and poor body image (Larsen et al., 2007). Studies have investigated the relationship between anxiety, self-esteem, depression symptoms, and sexual dysfunction in men and women and found that people with sexual dysfunction experience high levels of these psychological factors (Kim & Jeon, 2013; McCabe et al., 2010). These psychosocial issues are important for understanding the relationship between obesity and impaired sexual functioning (de Boer et al., 2004; Kilic et al., 2007; Yildiz & Bölüktas, 2015).

2.3.1. Sexual functioning and mental health disorders

Sexual desire and sexual arousal were negatively associated with depression in both men and women (Laurent & Simons, 2009). Laurent and Simons (2009) identified a negative association between depression and sexual pleasure or satisfaction, as well as a correlation between orgasm, pain, and depression. Other studies have demonstrated that depression is significantly associated with orgasm difficulty and pain in women, and delayed and premature ejaculation in men (Frohlich & Meston, 2002; Kennedy et al., 1999). More specifically, the likelihood of premature ejaculation was more than double in men with emotional problems or stress, and sexual pain was twice as likely in women with emotional problems or stress (Laumann et al., 1999). Furthermore, a study with 203 middle-aged Korean men reported a significant positive association between erectile dysfunction and depressive symptoms, which remained strong after adjusting for age, marital status, education, smoking, alcohol, hypertension, physical activity level, cholesterol, and BMI (Jeong et al., 2011). Mezones-Holguin et al. (2011) measured sexual functioning, menopause, and depression in a sample of 335 healthy, middle-aged, sexually active Peruvian women. They found depression associated with reduced sexual functioning and hormonal status in this cohort (Mezones-Holguin et al., 2011). Moel et al.

(2010) reported an association between poor sexual functioning and increased depression in postpartum women with depression compared to those who had never suffered depression. Despite an improvement in sexual functioning following psychotherapy, sexual functioning remained lower than in those who had never suffered postpartum depression (Moel et al., 2010). In addition, research assessing sexual functioning in women with hypoactive sexual desire disorder reported that lower FSFI scores were associated with greater sexual distress (Connor et al., 2011). These results provide further evidence of the relationship between sexual dysfunction and depression in women.

Anxiety, another common mental health disorder, is also associated with sexual dysfunction. While this relationship is evident in both women and men (Kaya et al., 2006), the research is not extensive. According to the theoretical framework developed by Masters and Johnson (1970) and Kaplan (1974), anxiety is thought to negatively affect sexual arousal. Masters and Johnson (1970) articulate the role of anxiety on sexual performance in their book, *Human Sexual Inadequacy,* and they believed anxiety plays a vital role in the development and maintenance of sexual dysfunction, especially in arousal disorders and in some point, it affects on a variety of field. Kaya et al. (2006) reported a positive correlation between sexual dysfunction and anxiety in women with chronic pelvic pain. In addition, increased anxiety is associated with a greater risk of erectile difficulties and reduced sexual enjoyment in men (Laurent & Simons, 2009). Moreover, according to classic theoretical perspectives, anxiety plays a pivotal role in the development and maintenance of sexual dysfunctions for both men and women (Kaplan, 1974; Masters, 1970). Anxiety inhibits automatic nervous system functioning that impairs physiological arousal (Barlow, 1986; Kaplan, 1974; Masters, 1970).

In general, sexual functioning and mental health disorders appear to have a bidirectional associative relationship; that is, mental health disorders have been shown to influence sexual activity and vice versa (Ein-Dor & Hirschberger, 2012; Kashdan et al., 2011; Laurent & Simons, 2009). Kashdan et al. (2011) examined the effects of anxiety and depression on the sexual activity of 150 college students over 3 weeks. They found both social anxiety and depression to be associated with less pleasure and connectedness during sexual activity. Furthermore, the frequency of sexual contact was negatively associated with depressive symptoms (Kashdan et al., 2011), indicating that sexual contact may have a protective effect against depressive symptoms.

2.3.2. Sexual functioning and self-esteem

Self-esteem is an individual's subjective evaluation of his or her worth as a person (Bleidorn et al., 2016) and encompasses beliefs individuals have about themselves, as well as their emotional responses to those beliefs (McClure et al., 2010). Therefore, self-esteem can act as a predictor of life satisfaction (Biro et al., 2006).

The relationships between self-esteem, sexual functioning, and obesity are unclear (Goodson et al., 2006; Shackelford, 2001). However, a correlation between self-esteem and the components of sexuality has been found (e.g. relationship satisfaction and sexual behaviours). Observing a sample of 214 heterosexual married individuals, Shackelford (2001) reported that self-esteem was positively correlated with marital satisfaction. Choi et al. (2011) reported a similar relationship in an elderly married cohort (n = 156) after conducting a cross-sectional investigation into self-esteem and sexual behaviours They found that individuals with a more active sexual life had significantly higher self-esteem than those who were less sexually active ($p < 0.05$) (Choi et al., 2011). Furthermore, satisfaction with their sexual life was positively correlated with levels of self-esteem (Choi et al., 2011).

Erectile dysfunction is known to cause anxiety and lower self-esteem (Anonymous, 1993; Ar et al., 1997; Krane et al., 1989). Martinez- Jabaloyas et al. (2010) demonstrated this relationship in a 14-week case-control study (treatment vs placebo) conducted in 119 men with erectile dysfunction. They found that erectile function improved significantly as a result of sildenafil oral treatment ($p < 0.0001$). In addition, the treatment group reported significant improvements in self-esteem compared to the placebo group ($p < 0.0001$) (Martinez-Jabaloyas et al., 2010). Furthermore, the authors noted a positive correlation between self-esteem and erectile functioning (Martinez-Jabaloyas et al., 2010).

Evidence of a relationship between sexual functioning and self-esteem also exists for older age cohorts. A discussion paper examining the impact of menopause on self-esteem by Lachowsky (2002) noted that women identified menstruation as a critical component of their youth and femininity. Therefore, menopause had the potential to represent the end of youth and femininity and may negatively impact sexuality and potentially reduce self-esteem (Reid et al., 2014; Tremayne & Norton, 2017).

2.3.3. Sexual functioning and body image

Body image, the perception of one's own body, is a major component of self-esteem (Akhondi et al., 2011). A positive correlation between body image and sexual functioning has been reported in many population cohorts (Lachowsky, 2002; Seal et al., 2009). Akhondi et al. (2011) investigated the correlation between body image and sexual functioning in a study of 120 fertile and 120 infertile men and noted that fertile men reported a better body image compared to their infertile counterparts.

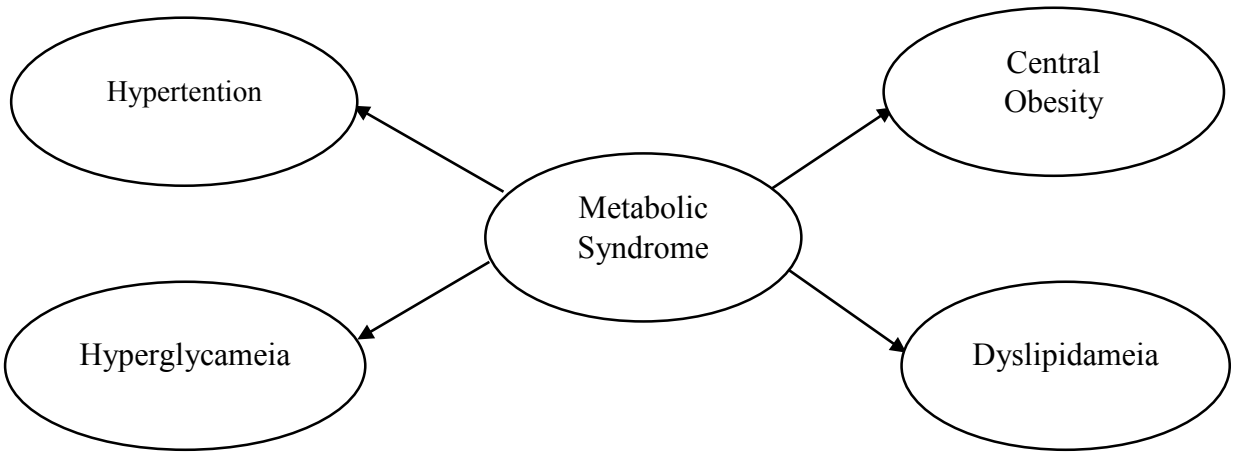
Seal et al. (2009) examined body esteem (self-evaluation of physical appearance) and sexual desire in 85 female college students by measuring arousal, sexual functioning, and body esteem at baseline and after reading an erotic story. Body esteem was positively correlated with greater sexual desire and functioning, although there was no significant relationship between body-esteem and mental and physical sexual arousal or lubrication (Seal et al., 2009).

Strong evidence exists of an association between sexual functioning, body weight, and self-esteem in women. Woertman and Van den Brink (2012) conducted a review of body image and desire, arousal and lubrication, orgasm, satisfaction, pain, and sexual functioning in general. They found that a better body image was associated with greater sexual functioning across all domains. In addition, a positive association between improvements in body image and sexual functioning was associated with weight loss in this group (Woertman & Van Den Brink, 2012). The reviewers could not comment extensively on the relationship between sexual pain and body image; however, the pain was noted as negatively correlated with satisfaction; a domain positively associated with body image (Woertman & Van Den Brink, 2012)

There may be a link between body image and BMI, a hypothesis investigated by Watkins et al. (2008). These investigators analysed body image scores, together with BMI, collected from 188 male college students, and found BMI to be negatively correlated with body image, noting that satisfaction with body image diminished as BMI increased (Watkins et al., 2008).

2.4 Metabolic syndrome as a mechanistic link for the association between obesity and sexual functioning

The metabolic syndrome (MS) is a combination of risk factors including hypertension, central obesity, dyslipidaemia, and hyperglycaemia (Harris, 2013; Repousi et al., 2018). A patient is diagnosed as having metabolic syndrome when there is at least three health risk factors present. These can include central (abdominal) obesity (which is excess fat in and around the stomach, as identified by a waist circumference >102 cm in men and >88 cm in women), raised blood pressure (hypertension, >135/85 mmHg), high blood triglycerides and low levels of high-density lipoproteins, < 40 mg/dl in men and < 50 mg/dl in women) and impaired fasting glucose (>110 mg/dl) (Esposito & Giugliano, 2005; Ginsberg & MacCallum, 2009; Repousi et al., 2018; Rosenthal, 2013). The MS predicts type 2 diabetes and CVD (Shin et al., 2013).



Obesity is an important risk factor for developing T2D and a central component of MS (American Diabetes Association, National Institute of Diabetes, Digestive and Kidney Diseases, 2003; Franz et al., 2002; Ginsberg & MacCallum, 2009; U.S. Department of Health and Human Services, 2005 & 2001). As with the prevalence of obesity, the prevalence of MS is increasing globally (Cheung & Thomas, 2007; Eberly et al., 2006).

The association between MS and sexual dysfunction in women has also been explored. Esposito et al (2005) conducted a case-control study (n=120 women with MS and n=80 women in the control group) to determine whether the MS was associated with females' sexual dysfunction- as assessed by Female Sexual Function Index (FSFI).They found that women with MS reported lower FSFI scores as compared to other women in the control group (23.2±5.4 and 30.1±4.7 respectively, $p<0.001$). In particular, women with MS reported lower arousal, lubrication, orgasm, and satisfaction scores when compared to general female in the control

group. In addition, sexual dysfunction was found to be positively associated with the severity of MS (Esposito et al., 2005).

Over the recent decades, there is a concomitant with the rise of MS and increased prevalence of children with overweight and obesity. It is estimated the prevalence of diabetes increases by 9% for every 1-kg increase in weight (Mokdad et al., 2000). Sullivan et al (2005) conducted a survey for 68,500 adults and found the likelihood of having diabetes and diabetes-related cardiovascular comorbidities increased with BMI. Therefore, obesity seems to be strongly and independently associated with diabetes and diabetes-related comorbidities (Sullivan et al., 2005).

Obesity is a significant risk factor for such metabolic conditions (Esposito, Giugliano, Ciotola, De Sio, et al., 2008; Grievink et al., 2004), This section will examine the possibility of an association between these metabolic conditions and sexual functioning.

2.4.1 Sexual functioning and insulin resistance

Insulin is necessary for the regulation of carbohydrate and fat metabolism, allowing liver, muscle, and adipose tissues to utilize glucose from the blood. A reduction in insulin sensitivity reduces glucose uptake by skeletal muscle and adipose tissue and raises blood-sugar levels, which can eventually lead to metabolic complications such as metabolic syndrome (MS) and type 2 diabetes (T2D) (Esposito, Giugliano, Ciotola, De Sio, et al., 2008).

There is limited research into the relationship between insulin resistance and sexual functioning, even though obese individuals are at greater risk of both of these conditions (Esposito, Giugliano, Ciotola, De Sio, et al., 2008; Kolotkin et al., 2006). In a review of the literature, Esposito et al (2008) highlighted an association between sexual dysfunction and MS in both males and females. In males, MS was identified as a risk factor for erectile dysfunction. An earlier uncontrolled prospective study supported this finding such that 29% of males with sexual dysfunction also had MS, and of these 96% had erectile dysfunction, 40% had the hypoactive sexual disorder, 23% experienced premature ejaculation, and 5% experienced delayed ejaculation (Corona et al., 2006). Furthermore, a separate case-control study by Esposito et al (2008) reported that individuals with MS had a higher rate of erectile dysfunction when compared to age- and weight-matched controls. Hypogonadism, (indicating lower levels

of circulating testosterone and is associated with erectile dysfunction), was also shown to be a risk factor for MS (Esposito, Giugliano, Ciotola, De Sio, et al., 2008; Kupelian et al., 2006). This evidence suggests that impaired male sexual functioning was associated with insulin resistance, and demonstrates a relationship between male sexual dysfunction and MS.

As insulin resistance is a characteristic of T2D, the relationship between sexual functioning and insulin resistance can also be examined by investigating the association between sexual functioning and T2D (Esposito, Giugliano, Ciotola, De Sio, et al., 2008). Research by Sayuk et al (2011) in patients with T2D demonstrated a positive association between sexual dysfunction and T2D, as well as hyperglycaemia, further demonstrating the influence of insulin resistance on sexual functioning (Kolotkin et al., 2006).

Research has demonstrated that males with diabetes are at an increased risk for erectile dysfunction (Awad et al., 2009). Specifically, erectile dysfunction is negatively correlated with glycaemic control (Awad et al., 2009). Impairment of erectile function may be a consequence of the vasculopathy associated with poor blood glucose control in men with T2D, resulting in damage to the nerves and blood vessels controlling blood flow to the penis (Yildiz & Bölüktas, 2015) (Figure 2.1). Over the long term, poor control of blood sugar may result in damage to the nerves and circulation that control blood flow to the penis (Yildiz & Bölüktas, 2015). T2D frequently evolves atherosclerosis (a condition in which blood vessel walls thicken as a result of a build-up of fatty materials such as cholesterol). In men, atherosclerosis is thought to precede endothelial dysfunction and because a penile erection is dependent on intact endothelial function, erectile dysfunction can result (Böhm et al., 2007).

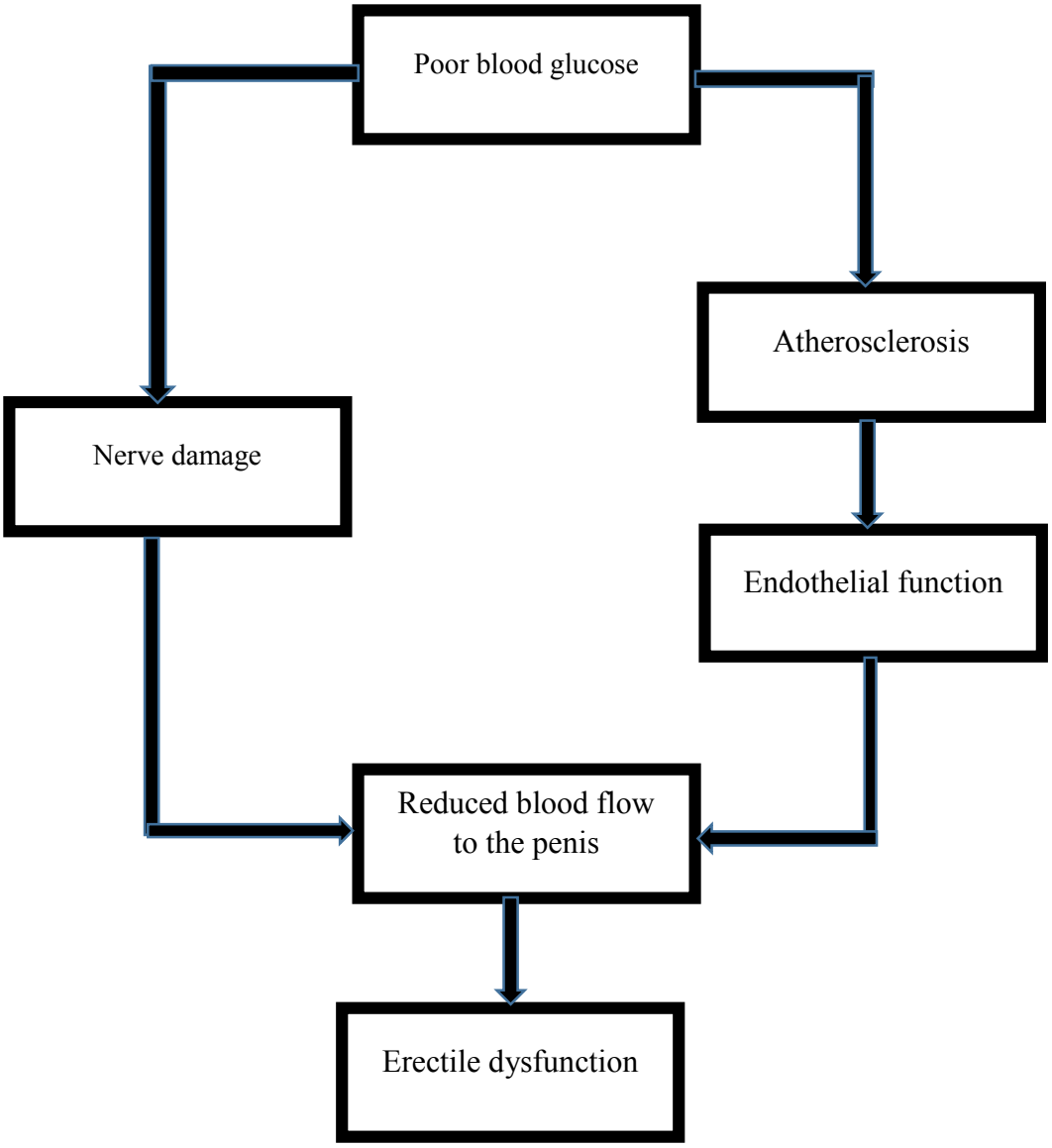


Figure 2.1: The link between diabetes and erectile dysfunction

2.4.2 Sexual functioning and Hypercholesterolemia

Hypercholesterolemia or high cholesterol is defined as the presence of excessively high levels of cholesterol in the blood (Stapleton et al., 2010), and is an important risk factor for cardiovascular disease (Stapleton et al., 2010).

Hypercholesterolemia is a risk factor for atherosclerosis, or narrowed and inflexible arteries, and can lead to heart attack, stroke, and other cardiovascular diseases (Ravnskov, 2002). While the link between obesity and hypercholesterolaemia is well-established, there is limited research into the effect of hypercholesterolemia on sexual functioning (Gonen et al., 1983).

To determine the relationship between testosterone deficiency and cardiovascular risk factors, Garcia-cruz et al (2012) conducted a study with 384 prostate biopsy patients and found low testosterone to be associated with hypertension, hypercholesterolemia, T2D, and overweight, although the nature of the relationship was not explained. Research examining the relationship between sexual functioning and obesity demonstrates an association between erectile dysfunction and hypercholesterolemia (Larsen et al., 2007; Vrentzos et al., 2007). Hyperlipidemia may impair erectile function by affecting endothelial and smooth muscle cells of the penis (Vrentzos et al., 2007). Hypercholesterolemia also negatively impacted on nitric oxide levels in the penile and vascular tissue. In addition, these investigators reported that high total cholesterol and reduced high-density lipoprotein impaired endothelial function, which was associated with an increased risk of erectile dysfunction, and that oxidized low-density lipoprotein impaired the relaxation response of the corpus cavernosum (Vrentzos et al., 2007).

Interestingly, a review by Larsen et al (2007) identified hyperlipidemia as a common condition in males with erectile dysfunction, finding that lipid-lowering drugs had the potential to cause erectile dysfunction, although this effect was only recorded in smaller studies in the review. However four possible mechanisms of the relationship between erectile dysfunction and lipid-lowering medication have been postulated (Vrentzos et al., 2007): 1) they may contribute to erectile dysfunction as they act to reduce blood pressure; 2) erectile dysfunction may be a side effect; 3) reduced cholesterol synthesis may inhibit testosterone synthesis, resulting in erectile dysfunction; and 4) confounding factors influence the relationship, including other cardiovascular disease risk factors. While questions remain regarding the impact of lipid-lowering medications on erectile function, it is critical that alternative methods of improving lipid profiles, such as dietary measures, are investigated to determine the impact on sexual functioning in males with hypercholesterolemia.

2.4.3 Sexual functioning and hypertension

Hypertension refers to high pressure of blood on the inner walls of the arteries (Cheriyan, 2009). Hypertension is defined as a systolic blood pressure (SBP) of 140 mm Hg or higher or a diastolic blood pressure (DBP) of 90 mm Hg or higher in adults ages 19 to 79 (Scordo & Pickett, 2015). In adults age 80 or older, a SBP greater than 150 mm Hg is considered elevated (Scordo & Pickett, 2015).

Obesity and hypertension contribute significantly to the risk of cardiovascular disease (Sowers & Sowers, 1999). Hypertension also contributes to impaired sexual functioning in males and females, although far less is known of the impact in female compared to male populations (Doumas et al., 2005; Duncan et al., 1997; Yousef Abdulah Al, 2009).

Unlike associations between other conditions of MS and erectile functioning, a considerable amount of research has been reported regarding the relationship between hypertension and erectile dysfunction (Doumas et al., 2005; Esposito et al., 2010; Larsen et al., 2007; Ledda, 2000; Yousef Abdulah Al, 2009). Since hypertension and other metabolic complications coexist, this research typically includes observations of metabolic conditions, such as T2D. For example, Feldman et al (1994) found that hypertension and T2D were both independent risk factors for erectile dysfunction. Sub-analysis showed that erectile dysfunction in those aged between 40 and 70 years was 52%, whereas in younger age in males with T2D the prevalence of impotence was 75%, most likely due to the relaxation of the penile smooth muscle (Feldman et al., 1994; Hakim & Goldstein, 1996; Ledda, 2000).

Doumas (2005) investigated the impact of hypertension duration and severity on erectile function in a study with participants aged 31 to 65 years (n=358), which showed the duration of hypertension significantly affected erectile function ($p<0.0001$), and reported the following: erectile dysfunction was 14% for participants with hypertension for up to three years, 28% for those with hypertension for three to six years, and 60% for those with hypertension for more than six years. The severity of hypertension was also associated with erectile dysfunction, such that 24% of participants with Stage 1 hypertension were affected, while for participants with Stage 2 it was 44.6%, with the strength of the relationship increasing with age (Doumas et al., 2005).

In light of this, it is important to determine if other vascular risk factors may contribute to erectile dysfunction. Using data from the free voluntary annual health screening service in Vienna, Ponholzer et al (2006) investigated vascular risk factors in males aged 30 to 59 years (n= 1,519), and found no association between erectile dysfunction and blood pressure, BMI, and waist/hip ratio, however age ($p<0.01$), total cholesterol ($p<0.04$), and low-density lipoprotein ($p<0.01$) were significantly associated with erectile functioning. These results may have been due to the relatively low mean age of the sample (42.9 ± 7.9 years).

While antihypertensive medication (AHT) may successfully treat hypertension, documented side-effects include negative effects on sexual wellbeing (Chiesa et al., 2003; Duncan et al., 1997). To examine this, Chiesa et al (2003) evaluated the side-effects of a newer AHT valsartan, on sexual activity in hypertensive males, mean age of 54 years (n=2,202), compared to controls who received either β-blockers, angiotensin-converting enzyme inhibitors, calcium-channel blockers, or diuretics. Blood pressure decreased significantly for all groups; the conventional AHTs used in the control group resulted in reduced sexual activity, while patients treated with the newer AHT medication reported increased sexual activity (Chiesa et al., 2003). It may be that conventional AHTs reduce blood pressure to the extent that there is insufficient pressure to fill small calibre pelvic blood vessels, resulting in impaired erectile functioning (Okeahialam & Obeka, 2006).

To determine if the negative impact on erectile functioning of conventional AHTs could be countered, Aranda et al. studied the effect of sildenafil citrate (Viagra) administration and reported improved erectile functioning in hypertensive patients (Aranda et al., 2004). According to the Sexual Health Inventory for Men, sildenafil citrate improved erectile functioning in 83.2% of 975 hypertensive participants with erectile dysfunction as it appears to inhibit phosphodiesterase-5 in the corpus cavernosum, increasing penile response to sexual stimulation (Ali, 2010). Another study with this medication reported that sildenafil significantly improved erectile functioning, orgasmic functioning, intercourse satisfaction, and overall satisfaction compared to controls ($P<0.0001$) (Ali, 2010). This latter result may be explained by the fact that sildenafil citrate users need to take this medication when they anticipate sexual activity. Therefore, alternative treatments for hypertension such as weight loss need to be explored to determine the safety and efficacy as an alternative to AHTs and/or sildenafil citrate.

2.4.4 Sexual dysfunction and sex hormones

There is limited research into the relationship between obesity and the sex hormones, testosterone and estrogen, however, it is known that fat accumulation generally impacts females and males, in different ways (Power & Schulkin, 2008). Strong evidence has shown that sexual dysfunction is associated with low testosterone in males, and low estrogen in females (Basson, 2006; Jones, 2007), however, there is limited research investigating the effects of excess body weight on testosterone/estrogen production (Basson, 2006; Dhindsa et

al., 2010; Diaz-Arjonilla et al., 2008; Yaylali et al., 2010). Observational research has shown testosterone to be lower in obese males, although clear evidence of the etiology is yet to be determined (Diaz-Arjonilla et al., 2008). Given that testosterone is positively associated with erectile functioning, it has been suggested that low testosterone acts as a contributing factor for erectile dysfunction in obese males (Jones, 2007; Larsen et al., 2007; Mikhail, 2006). Some studies have reported erectile functioning and testosterone to be negatively correlated with BMI (Diaz-Arjonilla et al., 2008; Kratzik et al., 2005), although no interventional studies are investigating the effect of weight loss on these variables in an obese sample, and whether weight loss would be an appropriate strategy to resolve these issues.

Evidence of the effect of obesity on estrogen and/or obese female sexual functioning and estrogen levels is very limited (Basson, 2006). Research in non-obese females has shown low estrogen levels to be associated with vaginal atrophy and reduced vaginal blood circulation (indicating reduced arousal), which negatively impacts sexual functioning (Basson, 2006; Stenberg et al., 1996). Research has also shown that sexual functioning in obese females is typically worse than their normal weight counterparts (Kolotkin et al., 2009; Metwally et al., 2007). Yayali et al (2010) reported estradiol levels (a type of circulating estrogen), in a case-control study investigating sexual dysfunction in an overweight female population. They found reduced sexual functioning to be associated with increased BMI, although there was no significant correlation between estradiol and BMI. Further research should focus on the effect obesity has on estrogen status and the effect this has on sexual functioning, as well as whether weight loss can improve estrogen status and/or improve sexual functioning.

2.5 Weight loss and sexual functioning

Given an association between obesity and sexual dysfunction exists, the next step would be to investigate whether reductions in body weight improve sexual functioning in individuals with obesity. Several studies have evaluated the relationship between weight loss (through surgery, medication and diet) and sexual functioning in overweight and obesity (Khoo, 2010; Khoo et al., 2011; Slavin, 2005; Thonney et al., 2010). Often, individuals with overweight and obesity report better sexual functioning after weight loss (Moore et al., 2013; Mora et al., 2013). Studies also show improvements in physiological risk factors (such as HDL, LDL, insulin, glucose, and blood pressure) and mental health when weight loss occurs (Agnieszka & Ehud, 2006; Kolotkin et al., 2008; Yildiz & Bölüktas, 2015). Therefore, it could be hypothesised that an

improvement in these factors through weight loss may lead to an improvement of sexual dysfunction.

While the results of a review of the benefits of weight management on sexual function were inconclusive (Larsen et al., 2007), some studies found that individuals with overweight and obesity report better sexual functioning following weight loss (Moore et al., 2013; Mora et al., 2013). To investigate the benefits of weight management on sexual function, Kolotkin et al (2008) conducted a study with 187 patients undergoing weight loss treatment over two years, whose treatment consisted of regular meetings with a dietitian, personalized individual diets, an exercise regime, and medication and measured sexual quality of life as well as BMI. Results revealed that reductions in BMI were significantly associated with improvements in sexual quality of life ($p<0.0001$) with an average weight loss of 13.1% of baseline body weight over the trial period, even though the greatest reduction in weight occurred at three months (Kolotkin et al., 2008). Nevertheless, this research clearly demonstrates the benefits of weight loss on sexual functioning by dietary and exercise intervention (Kolotkin et al., 2008).

These results have also been supported in studies specifically investigating the effect of weight loss on the sexual functioning of individuals with obesity. For example, studies using the IIEF to measure male sexual functioning reported improvements in sexual functioning post-intervention with 1-1.5 kg per week (Hsiao et al., 2012; Khoo, 2010). Evidence has also been found to demonstrate that obese males with erectile dysfunction, diagnosed by an IIEF score of 21 or less, had improved sexual functioning following lifestyle modifications for weight loss (Esposito et al., 2004). An 8-month study in men with overweight and obesity who recorded 17 kg weight loss following bariatric surgery reported increased levels in testosterone, sex-hormone-binding globulin, and high-density lipoprotein-cholesterol as well as decreased levels of insulin and leptin (Kaukua et al., 2003). A 2-year study of male bariatric patients reported improvement in erectile functioning following 24 kg weight loss compared to men in the wait-list control group, as measured by the IIEF (Reis et al., 2010).

Prospective studies investigating the relationship between weight loss and female sexual functioning are less abundant, although there is some evidence of an association between treatment for obesity and/or MS and lower sexual dysfunction in women (Miner et al., 2012). Kim et al (2006) investigated this issue in 46 overweight and obese females participants receiving daily doses of 10 mg sibutramine (weight loss drug) as well as regular behavioural

therapy over eight weeks and measured sexual functioning using the FSFI. Results showed reductions in body weight to be significantly associated with improvements in sexual functioning, specifically in arousal and orgasm scores ($p<0.05$) ($M=0.27$ and $M=0.18$, respectively) (Kim et al., 2006). The female participants in a 2-year weight reduction trial, combining medication with dietary counselling, reported improvements in all of the sexual quality of life items ($P<0.0001$) after 3-month assessment, when weight loss was 11.7% of initial body weight. Improvements were substantial across all dimensions assessed (sexual attractiveness, desire, performance and enjoyment of being seen undressed and avoidance of sexual encounters) (Kolotkin et al., 2008). In addition, 32.2% of women who achieved a normal weight ($BMI<30kg/m^2$) following weight loss surgery reported a significant improvement in sexual desire, arousal, lubrication, satisfaction and total sexual function as well as a decrease in pain during intercourse ($M=0.84$), as assessed by the FSFI (Assimakopoulos et al., 2011).

In contrast to surgery and pharmaceutical treatments, dietary weight loss programs for individuals with overweight and obesity and sexual dysfunction have been trialled in a relatively small number of studies, and mainly with male participants. Khoo et al (2011) investigated the impact of a low-energy weight loss diet on the sexual functioning in males with T2D compared to males without T2D, and standard diet control (n= 26, 25 and 26 respectively), by measuring changes to weight, waist circumference, insulin sensitivity, plasma testosterone, erectile functioning, sexual desire, and lower urinary tract symptoms (Khoo, 2010). Weight loss (10% of initial body weight) was associated with increased insulin sensitivity, erectile functioning, sexual desire, and plasma testosterone in both diabetic and non-diabetic participants (Khoo, 2010).

Khoo et al (2011; 2013) followed up this research with further studies investigating the effects of dietary interventions on sexual function in males with obesity. They compared a high-protein, carbohydrate-reduced, low-fat diet to a low-energy diet and examined changes to sexual and endothelial function, inflammation and urinary tract symptoms over a one-year study in 31 men with obesity and T2D (Khoo et al., 2011). The results show that diet-induced weight loss can improve sexual, endothelial and urinary function. Also, following a high-protein, carbohydrate-reduced, low-fat diet can sustain these benefits for one year, as well as decrease systemic inflammation ($P<0.05$) (Khoo et al., 2011). Another study compared the effects of a partial meal replacement plan (for weight loss) with a conventional reduced-fat diet on weight, testosterone, sexual and endothelial function, and quality of life in obese Asian men

(Khoo et al., 2013) . The initial 12-week intervention resulted in significant reductions in weight (4.2±0.8 kg), and waist circumference (4.6±0.7 cm), among other outcomes, in the meal replacement group, compared with the conventional diet group (2.5±0.4 kg, 2.6±0.5 cm). Erectile function, sexual desire, testosterone, endothelial function and quality of life all showed greater improvements (3.4±0.7 points) in the meal replacement group compared to the conventional diet group (Khoo et al., 2013). Besides, improvements in weight, waist circumference and erectile function were maintained after all participants were switched to (or remained on) the conventional diet for a further 28 weeks (Khoo et al., 2013).

2.5.1 Weight loss, sexual functioning, and mental health

Due to the interrelated nature of body weight, mental health, and sexual functioning, possible associations between all of these factors warrant further discussion. Strain et al (2014) examined changes in BMI along with self-reported health- and impact of weight-related quality of life as well as depression in 105 bariatric surgery patients, approximately 2 years after surgery. Participants experienced a reduction in BMI ($p = 0.0001$), as well as improved general health, depression, and sexual life scores ($p = 0.05$, 0.0001, and 0.04, respectively), among many other variables (Strain et al., 2014). More specifically, Efthymiou et al. (2015) explored changes to BMI, sexual functioning (IIEF and FSFI), and health-related quality of life at four time points in the first year after bariatric surgery in 80 adults with morbidly obese adults. BMI improved significantly ($p < 0.001$), along with all components of sexual functioning, with the exception of male orgasm, as well as all health-related quality of life sub-scales (Efthymiou et al., 2015).

Existing evidence clarifying the sex differences in the relationships between weight loss, mental health, and sexual function is scarce. A review by Glina et al (2013) investigating modifiable risk factors to treat and prevent erectile dysfunction concluded that weight loss may improve erection functioning, either by increasing testosterone, reducing inflammation, or by improving self-esteem and mood, in men without comorbidities; however, co-existing conditions such as depression, diabetes, and hypertension may require additional treatments. As well as enhancing mental wellbeing, reductions in body weight appear to improve sexual functioning in individuals with obesity (Assimakopoulos et al., 2011; Dymek et al., 2002; Kolotkin et al., 2009; Mamplekou et al., 2005). Assimakopoulos et al (2011) investigated the impact of bariatric surgery on depressive symptoms and sexual functioning in female patients

with obesity (n = 59). Significant reductions in BMI (M= 20.16) in all patients were reported ($p < 0.001$) and was associated with a reduction in depression (M=2.89), as well as improved sexual functioning (M=4.33) (Assimakopoulos et al., 2011). Detailed analysis revealed significant improvements in desire, arousal, lubrication, and satisfaction (M=0.71) ($p < 0.02$), as well as a significant reduction in the experience of sexual pain (M=0.84) ($p < 0.02$) (Assimakopoulos et al., 2011); however, a causal relationship between these outcome measures was not established. Strong associations between weight loss, mental health, and sexual function cannot be confirmed based on the current evidence; therefore, further research is needed to develop a range of treatment options for overweight and individuals with obesity experiencing sexual dysfunction.

2.6. Physical activity and sexual functioning

According to the WHO, physical activity is defined as any bodily movement produced by skeletal muscles that require energy expenditure. Physical activity occurs while working, playing, carrying out household chores, travelling, and engaging in recreational activities (World Health Organization, 2015b). Physical inactivity has been identified as the fourth leading risk factor for global mortality causing an estimated 3.2 million deaths worldwide (World Health Organization, 2015b). It is estimated that 56% of Australian adults are either inactive or have low levels of physical activity (Australian Institute of Health and Welfare, 2012). A sedentary adult takes less than 5000 steps/day (Tudor-Locke & Bassett, 2004). Walking 10,000 steps/day is found to be effective in increasing physical activity and improving health outcomes (White et al., 2012). Australia's physical activity guidelines state that 30 minutes of moderate physical activity on at least 5 days of the week is required to achieve health benefits and reduce the risk of chronic disease. Moving more and sitting less reduces the risk of mental health disease such as depression, cardiovascular disease, type 2 diabetes, some cancers, and prevents unhealthy weight gain (Australian Institute of Health and Welfare, 2012; Egger et al., 2001).

Physical inactivity is a significant and independent factor contributing to obesity (Fogelholm, 2010; Fogelholm et al., 2006). Both low exercise and long sedentary activities decrease energy expenditure and impair weight control and prevention of obesity (Fogelholm, 2008). A recent epidemiologic study suggests that both obesity and physical inactivity are associated with sexual dysfunction (Derby et al., 2000) while increased physical activity is associated with a

lower risk of erectile dysfunction (Laumann et al., 1999). In a cohort study, 593 men, age range 40-70 years with no prostate cancer nor a history of heart disease or diabetes were observed at 8.8 years follow-up (Derby et al., 2000). Physical activity was assessed by a recall of activities, frequency, and duration of the past 7 days. A patient's total weekly energy expenditure was estimated by rating moderate, vigorous, and heavy physical activity. The results showed that independent of BMI, physically active men (greater than 16 [MET= Metabolic Equivalent Task] hours per week of exercise) were at a 30% lower risk for developing erectile dysfunction than sedentary men. In another study, high amount of physical activity was independently associated with a lower risk of incident erectile dysfunction (Derby et al., 2000). According to the findings of Derby's study (2000), men who were sedentary at follow-up had a higher incidence of ED, regardless of their baseline activity level, while men who were obese at baseline had a higher incidence of ED, regardless of follow-up status. The results from the adjusted logistic regression models indicated that obesity and sedentary behaviour status were associated with ED risk. Therefore, for obesity, the lowest risk of developing erectile dysfunction was among men who were not obese at baseline, while for sedentary behaviour status, the highest risk of ED was among men who remained sedentary and the lowest was among those who remained active or initiated physical activity and continued to exercise between the baseline and follow up evaluation (Derby et al., 2000). A meta-analysis of 11 cohort and cross-sectional studies noted an apparent protective effect of physical activity on maintaining good erectile function. This analysis revealed that the presence of erectile dysfunction was negatively correlated with physical activity. These investigators observed a dose-response relationship between erectile dysfunction and physical activity, with higher physical activity conferring a lower risk for developing erectile dysfunction (odds ratio [OR] = 1 for low activity, OR = 0.63 for moderate activity, and OR = 0.42 for high activity) (Cheng et al., 2006).

In a cross-sectional study, physical activity and sexual functioning of men who underwent radiotherapy for prostate cancer were evaluated. The results of regression analysis showed that physical activity was independently related to sexual functioning, adding significant incremental variance (R^2= 0.04, F[1, 104] = 5.78, P<0.05). The findings of this study have indicated that the level of physical activity contributes independently to the explanation of variance in sexual functioning scores and physical activity was positively correlated with sexual functioning for men who underwent external beam radiotherapy. Therefore, the greater levels of physical activity were related to poorer sexual functioning (Dahn et al., 2005). A

survey to assess physical activity and sexuality in pre-menopausal Polish women showed that the general level of physical activity was significantly positively correlated with women's sexual functioning. Impaired sexual functioning was less frequent among women with moderate and high physical activity. Indeed, a low level of physical activity related to the job, transportation, housework, and leisure and was associated with reduced quality of sexual functioning in women aged 45–49 years old ($p < 0.003$) (Dabrowska et al., 2010).

The only randomized controlled trial which evaluated the effect of weight loss and increased physical activity on erectile dysfunction of a group of obese men showed that weight loss and physical activity improved sexual function in one-third of the men after 2 years (Esposito, Giugliano, Ciotola, De Sio, et al., 2008). However, it is difficult to determine from this study whether improved sexual functioning was due to weight loss or an increase in physical activity.

Collectively, research shows that an increase to 10,000 steps per day can have significant improvements in self-esteem, depression, anxiety, stress, overall health, blood pressure, lipids, insulin and glucose in both the general population and overweight and obesity (Carraca et al., 2012; Helle´nius et al., 1993; Li et al., 2014; Pal et al., 2009). Also, the findings of the studies described above suggest that there is a relationship between physical activity and improved sexual functioning. However, randomized controlled trials need to be conducted to investigate whether there is an effect between increased physical activity and improved sexual functioning and also need to evaluate which psychological and physiological mediators may be responsible for this effect.

One study reported that obese individuals are less likely to be physically active than non-obese individuals (Larsen et al., 2007), another found that both obesity and physical inactivity are associated with sexual dysfunction (Derby et al., 2000), while a third showed increased physical activity to be associated with lower risk of erectile dysfunction (Laumann et al., 1999). Esposito et al (2008) evaluated the effect of weight loss and increased physical activity on erectile dysfunction in men with obesity and found sexual function improved in one-third of the men after 2 years; however the study failed to determine whether improved sexual functioning was due to weight loss or an increase in physical activity. Fewer studies examine the effect of physical activity and sexual function in women. Dabrowska et al (2010) assessed self-reported physical activity and sexuality in pre-menopausal Polish women and reported that impaired sexual functioning was less frequent among women with moderate and high physical

activity. This evidence provides some indication of the positive impact of physical activity and/or weight loss, via various intervention methods, on sexual functioning in both males and females. However, further research should examine the effects of alternative weight management methods on these variables.

2.7 Physical activity and metabolic syndrome

Randomized controlled trials have demonstrated that physical activity has a mild or moderate effect on lots of metabolic and cardiovascular risk factors that build or are related to metabolic syndrome (Lakka & Laaksonen, 2007). A cross-sectional study in 963 individuals, aged ≥50 years old, found that participants with low levels of physical activity had higher chances of having diabetes (OR=1.79, 95% CI=1.17-2.72), hypercholesterolemia (OR=1.85, 95% CI=1.24-2.76), hypertension (OR=1.20, 95% CI=0.74-1.97) and metabolic syndrome (Turi et al., 2016). In another study, the association between the prevalence of metabolic syndrome and physical activity was assessed. A total number of 24,178 participants, between 19 and 60 years old, completed this study. The results showed that physical activity reduces the prevalence of metabolic syndrome. The lowest prevalence of metabolic syndrome was observed in those who walked six times in a week (OR=0.67, 95% CI= 0.53-0.85) (Lee et al., 2016).

Physical activity is commonly recommended as an important lifestyle behaviour for preventing hypertension, hyperglycaemia, central obesity and dyslipidaemia (Diaz & Shimbo, 2013). The data from an epidemiological follow-up study showed that those individuals who remained at a low level of physical activity throughout a 10-year follow-up time gained more weight than those who became more active or remained at a higher level of physical activity (Jakicic et al., 2018; Williamson et al., 1993). Recent data from different studies have shown that exercise is conversely associated with the development of hypertension and the effect of physical activity on blood pressure was significant (Figueira et al., 2014; Hegde & Solomon, 2015; Rossi et al., 2012). In an interventional study, exercise was recommended to a group of hypertensive patients. The active group had a decrease in systolic blood pressure by 4.3 mmHg and diastolic blood pressure by 1.7mmHg compared to the non-active group (Cornelissen et al., 2013). A similarly designed study was conducted to investigate the effect of physical activity on patients with T2 diabetes. A group of patients with T2D participated in 16-week physical activity program. The finding revealed that after the intervention, the exercise group showed a significant reduction in fasting blood glucose (-7.1%, $p<0.05$) (Ibañez et al., 2005).

2.8 Physical activity and mental health

A considerable amount of literature has been published on the effects of physical activity on mental health and addressed it as it can impact a wide variety of psychological outcomes, including effects on mood, self-esteem, cognitive functioning, depression, and quality of life (Biddle, 2016). Physical activity makes good feeling and mood enhancement, and a moderate level of physical activity often leads to the reporting of pleasure and positive mood in people (Ekkekakis, 2003). In addition, the relationship between physical activity and self-esteem has been shown in previous studies. Physical activity, such as sport, makes changes in the global self-esteem and physical self, including improvements in skills and competence, body image, and physical fitness (Biddle, 2016). Indeed, some research suggests the beneficial effects of physical activity on depression. The results of Dishman's study revealed 20-33% lower odds of depression for active individuals (Dishman et al., 2004, Biddle, 2016). In their study, Paluska and Schwenk's (2000) found that physical activity plays a pivotal role in the management of mild-to-moderate mental health disease, particularly depression and anxiety. They found increased aerobic exercise or strength training reduced depressive symptoms, anxiety symptoms and panic disorder significantly (Paluska & Schwenk, 2000). The association between physical activity and cognitive functioning has been assessed and the findings of research have indicated that more physical activity in schools, as well as in older adults to ameliorate or prevent cognitive decline (Biddle, 2016). Therefore, physical activity is a major health behaviour that impacts mental health and strongly recommended for the prevention and treatment of several diseases (Biddle, 2016).

2.9 Conclusions

Currently, obesity is at epidemic proportions throughout the world. Many interventions have been implemented to address this critical issue. Obesity is associated with a variety of chronic diseases, as well as sexual dysfunction. The relationship between sexual functioning and obesity is highly complex, and research exploring the mechanisms of this association is limited. For example, sexual functioning and the psychological (specifically, depression, anxiety, stress, self-esteem, and body image) and physiological (specially, blood pressure, lipids, insulin and glucose) impacts of obesity are limited. Even less research exists for the impact of weight loss on these relationships, which is important for demonstrating causation. Therefore, research investigating the impact of obesity on sexual functioning, and identifying efficacious

interventions to inform clinical practice and public health recommendations, is much needed. Furthermore, while physical activity can improve mental health, it is unclear whether increasing physical activity and therefore mental health and physiological conditions will improve sexual functioning in individuals with overweight and obesity suffering from sexual dysfunction.

2.10 Aims, hypotheses and objectives

The current study has six expected findings:

1) The intervention group will engage in a higher level of physical activity (1 outcome: number of steps) at 6 weeks and 12 weeks compared to the control group.

2) The intervention group will experience greater improvements in sexual functioning (12 outcomes: IIEF and MSFI total scores and their subscale scores) at 6 weeks and 12 weeks compared to the control group.

3) The intervention group will experience greater improvements in physiological outcomes (8 outcomes: DBP, SBP, TC, TG, LDL, HDL, Glu, and Insulin) at 6 weeks and 12 weeks compared to the control group.

4) The intervention group will experience greater improvements in psychological outcomes (15 outcomes: Self-esteem, self-esteem and relationship, body esteem, depression, anxiety, stress, physical functioning, role limitation due to physical health problem, role limitation due to emotional problem, vitality, mental health, social functioning, bodily pain, general health, health transition) at 6 weeks and 12 weeks compared to the control group.

5) The impact of the intervention on sexual functioning will be mediated by improvements in physiological outcomes.

6) The impact of the intervention on sexual functioning will be mediated by improvements in psychological outcomes.

The aims of this research is to:

1. explore the association between increased physical activity and sexual functioning in sedentary overweight/obese men

2. Whether this relationship is mediated by changes in psychological factors such as self-esteem, depression, anxiety, stress, body image and overall health and/or physiological factors such as blood pressure, blood lipids, glucose and insulin.

In this 12-week RCT, overweight/obese sedentary males, will be randomized into two groups: an "intervention" group and "control". Sexual functioning, psychological and physiological information will be collected at baseline, 6 and 12 weeks.

Post-intervention follow-up for 12 weeks will also be conducted in study. This study explored the effect of increased physical activity on sexual functioning and whether this relationship was mediated by changes in psychological factors such as self-esteem, depression, anxiety, stress, body image and overall health and/or physiological factors such as blood pressure, blood lipids, glucose and insulin.

CHAPTER THREE

METHODOLOGY

Overview of the Chapter

The chapter describes the process involved and how all of the participants were recruited by the researcher and also how the research was conducted. The chapter consists of the following sections: Summary of research design, study design, aim of the study, hypotheses, methods (participants and procedures and intervention in brief), assessment (anthropometric measures, physiological measures, psychological measures, physical activity measures and screening measures), ethical considerations, methods for statistical analysis, and summary of the chapter.

3.1 Summary of the Research Design

This study was a randomized controlled clinical trial over a 12-week period where overweight or obese participants from Perth, Western Australia, were randomly allocated into either an intervention group or a control group. Activity checker (Fitbit) with a step goal of 10,000 steps/day, were used to increase physical activity levels in overweight/obese sedentary males. Both groups were subjected to a set of psychological, physiological and physical activity measures at baseline, 6 and 12 weeks.

3.2 Study Design

This study was a randomized controlled intervention trial, conducted over a 12-week trial period. Participants were sedentary males with overweight and obesity. Participants in this study were only men because, as discussed in the literature review, men are less likely to seek help not only for obesity (Kolotkin et al., 2012) but also for sexual difficulties (Kolotkin et al., 2012). There also appears to be a higher prevalence of sexual difficulties in overweight/obese men (Esposito, Giugliano, Ciotola, De Sio, et al., 2008). Furthermore, men and women require separate questionnaires for their sexual functioning (FSFI for women and IIEF for men). Moreover, having both genders would require the recruitment of an increased number of

participants, which could not be conducted given the time frame of this randomized controlled study.

Previous studies have demonstrated that the use of activity checkers with a step goal can significantly increase physical activity levels in overweight and obese sedentary individuals (Bravata et al., 2007; Pal et al., 2009; Pal et al., 2011). As activity checkers can motivate individuals to be more active, we used a Fitbit with a step goal to increase participants' physical activity levels.

The participants were required to attend Curtin University in Bentley, Western Australia on five occasions: 1) the orientation session, obtaining the consent form and collecting the Fitbit one week before the study commenced; 2) the first clinic appointment to collect baseline measurements at week 0; 3) the second clinic appointment to collect measurements at week 6; 4) the third clinic appointment to collect measurements at week 12, and 5) 3-month follow-up post-intervention

In this study, the research coordinator screened and recruited all the participants against the exclusion/inclusion criteria using an online screening questionnaire (Qualtrics ^{TM}) (*see* Appendix B). Those eligible were allocated a three-digit code number by the research coordinator to preserve anonymity, and were assigned to one of two groups (ie intervention group and control group), using research randomisation software which is a resource for the researchers in need of a quick way to generate random numbers for the groups of intervention and non-intervention. The allocated number was used as the participants' identification number, for all records and (Schulz et al., 2010; "Urbaniak GC, Plous S. Research Randomizer (Version 4.0) questionnaires. Eligible participants attended an orientation session informing them of the study details which was presented via PowerPoint slides (*see* Appendix C).

Baseline data collection involved assessment on a range of anthropometric measures, psychological and sexual functioning questionnaires. After baseline data collection, participants were also instructed how to use the Fitbit and record their steps accurately through a video and an instruction sheet and then were given National Australian Physical Activity Guidelines (*see* Appendix D) informing them the intensity, duration, prompts for exercise (ie, stairs or elevators). In addition, they were discussed the details of fasting blood sample testing

and how to complete the questionnaires accurately. The research coordinator then measured body weight, height, and collected blood samples by venipuncture, at baseline, 6 and 12 weeks. Blood pressure was measured in a supine position after a rest period of 5-10 minutes. To get an accurate blood pressure measurement, an experienced and trained doctor was used. These measurements were taken on the same arm three times at 1-min intervals and these readings were then averaged. Questionnaires were completed by the participants during each clinic visit at each time point. Given that in-depth assessments required at baseline, 6 weeks and 12 weeks, the clinic assessments for each participant took 90 minutes to complete. All of the above-mentioned measurements were repeated at 3-time points (baseline, 6 and 12 weeks). The intervention group involved 26 participants whereas 27 were in the control group. In week 6, two participants in each group withdrew from the study and consequently, in week 12, four in the intervention group and two in the control group did not attend anymore. (See Figure 3.1 and 3.2 Flow of participants).

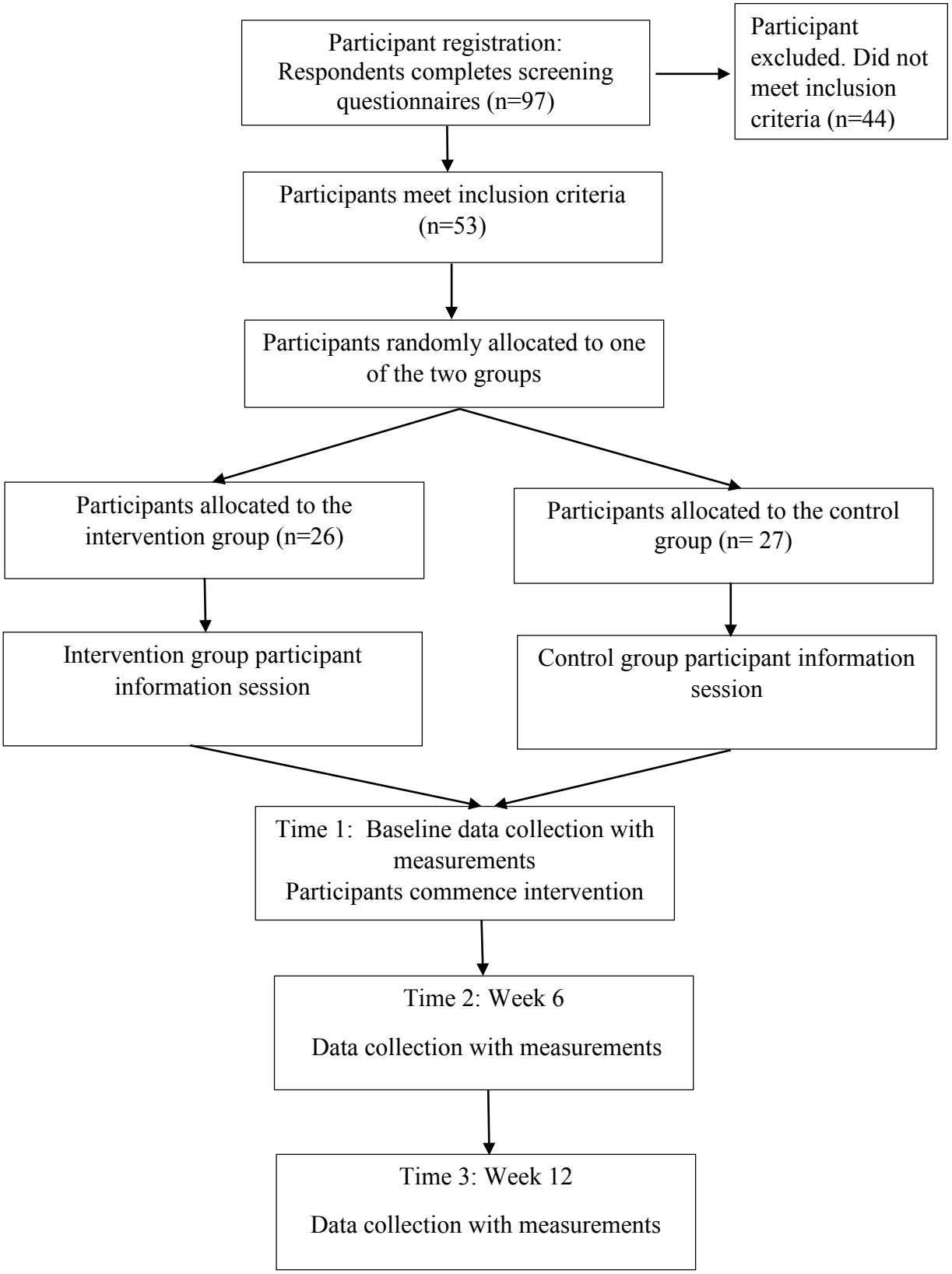


Figure 3.1 Flow of participants

3.3 Aim of the study

This study was designed to determine whether using Fitbit with an explicit goal of 10,000 steps/day (plus visual feedback) would assist sedentary overweight and obese men to achieve greater improvements in sexual functioning and other outcome measures than wearing the same device without observing the steps, over a 12-week intervention period.

The aim of this project was to determine the correlation between increased physical activity and 1) sexual functioning 2) psychological mediators (specifically, depression, anxiety, stress, self-esteem, body image, self-esteem and relationship, and overall health), and 3) physiological mediators (specifically, blood pressure, blood lipids, glucose and insulin).

This project also aimed to determine the correlation between sexual functioning, depression, anxiety, stress, self-esteem, body image and overall health, blood pressure, blood lipids, glucose and insulin at three time points (week 0, 6 and 12).

3.4 Hypotheses

In the present study, it was hypothesized that:

1 - Compared to the control group, the intervention group engaged in a higher level of physical activity (one outcome: number of steps) at 6 weeks and 12 weeks.

2- Compared to the control group, the intervention group experienced greater improvements in sexual functioning (12 outcomes: IIEF and MSFI total scores and their subscale scores) at 6 weeks and 12 weeks.

3- Compared to the control group, the intervention group experienced greater improvements in physiological outcomes (8 outcomes: DBP, SBP, TC, TG, LDL, HDL, Glu, and Insulin) at 6 weeks and 12 weeks.

4- The intervention group experienced greater improvements in psychological outcomes (15 outcomes: Self-esteem, self-esteem and relationship, body esteem, depression, anxiety, stress,

physical functioning, role limitation due to physical health problem, role limitation due to emotional problem, vitality, mental health, social functioning, bodily pain, general health, health transition) at 6 weeks and 12 weeks compared to the control group.

5. The impact of the intervention on sexual functioning was mediated by improvements in physiological outcomes.

6. The impact of the intervention on sexual functioning was mediated by improvements in psychological outcomes.

3.5 Methods

3.5.1 Participants and procedures

Participants were sedentary (<5000 steps/day) overweight (25>BMI<29.9) and obese (BMI>30) males, between 18 and 65 years of age, with a BMI between 25 and 47 kg/m^2 inclusive, living in Perth, Western Australia. Stratified sampling was used to ensure participants were representative of the sedentary overweight/obese population. Participants were recruited using poster advertising, local newspaper, and local community radio station (*see* Appendix E). Information such as age, marital status, education level, physical activity levels, demographic and socioeconomic status were collected during the online screening questionnaire (Qualtrics^{TM}) (*see* Appendix F). Ninety-seven respondents were screened and fifty-three males were found to be eligible (See Figure 3.2). Interested participants screened against the exclusion criteria and those who met the selection criteria attended an orientation session where details of the study explained. Eligible participants were required to have access to a computer, laptop, tablet or smartphone. Exclusion criteria included smoking, use of lipid and blood pressure lowering medication, use of steroids, use of warfarin, Viagra, medication controlled diabetes mellitus, hypo- and hyperthyroidism, psychological unsuitability, high physical activity levels (≥30 min/day), cardiovascular events within the last six months, major systemic diseases, gastrointestinal problems, proteinuria, liver, renal failure, weight fluctuations over the past six months, homosexual relationships, those who were not sexually active and participated in any other clinical trials within the last six months (*see* Appendix G).

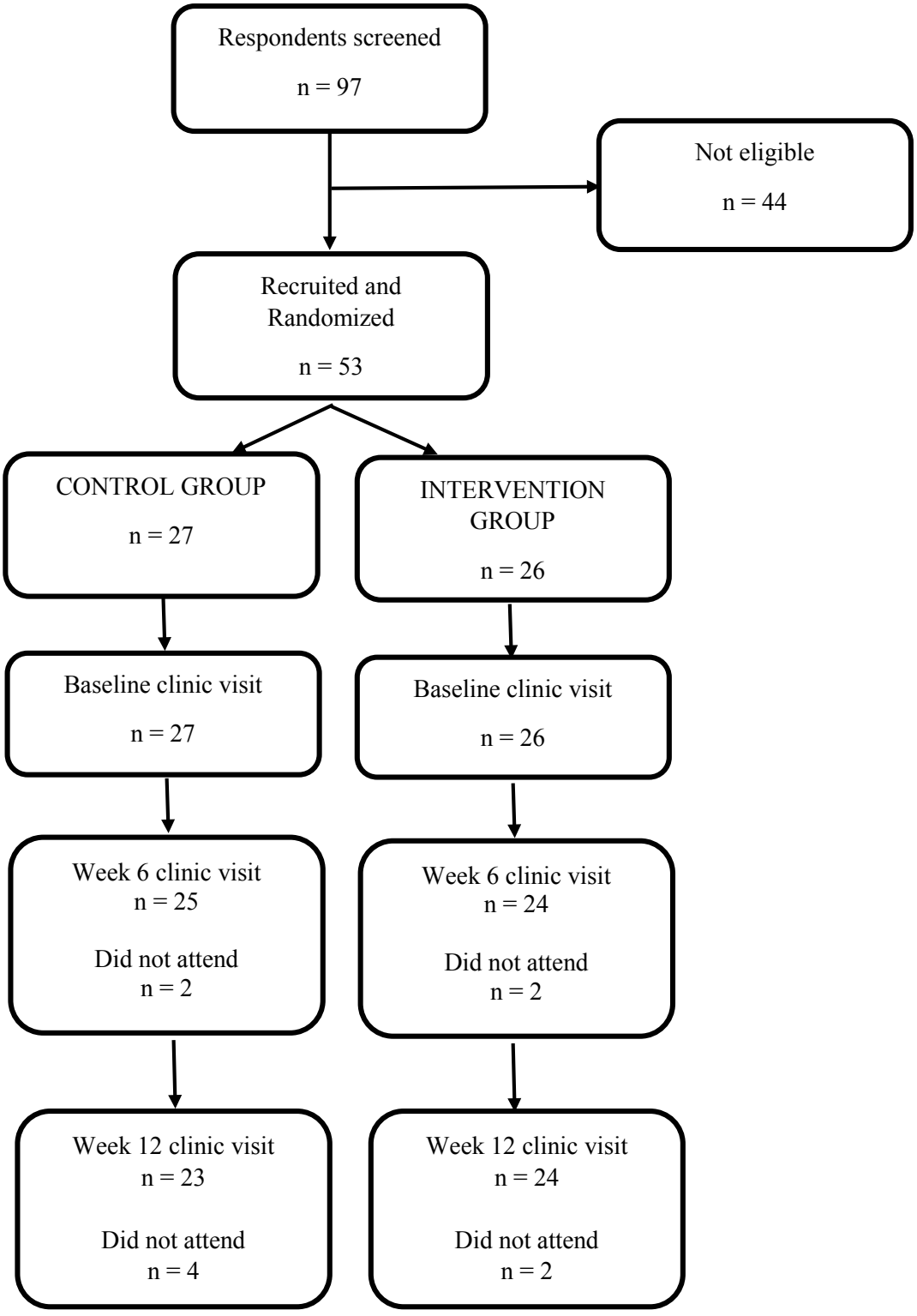


Figure 3.2. Flow of clinical trial participants

Reasons for non-attendance (n=6): change in personal issues

Overweight and obese males (N=53; *M* age= 40.25 years, *SD*=10.72; Body Mass Index (BMI) = 30.42, *SD*=4.43) were assigned to two different groups and did not significantly differ on any

of the demographic data. The intervention group consisted of 26 males (15 overweight and 11 obese), aged between 21-66, with body mass index (kg/m2) ranging from 25.70 to 35.60. The control group were 27 males (10 overweight and 17 obese), aged between 23-64, with body mass index (kg/m2) ranging from 25-44.40. Table 3.1 provides a summary of the participants' BMI information. The majority of the participants were not born in Australia (69.8%) and were of other nationality (43.4%). The majority of participants living arrangements included living with adults without children (52.8%). The majority of the participants were in full-time employment (49.1%) and the type of work was predominately sitting (35.9%). The highest level of schooling for the most of participants included university or tertiary level (75.5%). Sample characteristics and demographic data are presented in Table 3.2.

Table 3.1. Summary of BMI information

Group	Age Range	BMI (mean)		Overweight (mean)	Obese (mean)
Intervention	21-66	25.70	35.60	15	11
Control	23-64	25	44.40	10	17

Table 3.2. Sociodemographic Details of Participants

Demographic	N	Percentage
Place of birth		
• Australian	16	30.2%
• Other	37	69.8%
Nationality		
• White/Caucasian	19	35.8%
• Asian	11	20.8%
• Other	23	43.4%
Current living arrangements		
• Living alone	3	5.7%
• Living with adults without children	28	52.8%
• Living with adults with children	22	41.5%
Employment status		
• Don't work	8	15.1%
• Full time employment	26	49.1%
• Part time employment	13	24.5%
• Other	6	11.3%
Highest level of schooling		
• Some high school	1	1.9%
• Completed High school	4	7.5%
• Technical/trade certificate	8	15.1%
• University or tertiary level	48	75.5%
Type of work		
• Predominately physical	8	15.1%
• Standing and some walking	14	26.4%
• Predominately sitting	19	35.9%
• Other	6	11.3%
• None	6	11.3%

3.5.2 Intervention in brief

Fifty-three sedentary males with overweight and obesity were enrolled in the 12-week intervention, and randomly allocated into two groups: an intervention group and a control group. Both groups were given the National Australian Physical Activity Guidelines and were discussed the information from these guidelines. The intervention group wore a Fitbit with all displays enabled and encouraged to reach a daily step goal of 10,000 steps/day; in other words, they were able to observe their number of steps performed throughout the day. Participants in the intervention group were requested to sync their devices on a daily basis to record steps/day.

The control group wore the same Fitbit with only the clock and floors climbed displays enabled for 12 weeks and, therefore, had no knowledge of their record of steps/day. No steps goal were set for the control group. The intervention group therefore differed from the control group in the ways that the intervention group had access to the number of steps taken and the goal of achieving 10,000 steps. All displays were enabled for the intervention group, and they could see the number of their steps/day throughout the day, sync their device daily to record the number of their steps, earn badges for activity achievements, add their friends to compare weekly step goals, and compete in challenges to win trophies. By contrast, the displays for clock and floors climbed were enabled for the control group.

The changes to biomedical outcome measures were analysed for between group differences to determine the efficacy of the intervention, whereas the psychological outcome measures were analysed to identify possible mechanisms for these changes.

3.6 Assessments

All participants were required to attend 3 times clinical appointments at Curtin University for approximately 90 minutes, as follows: at baseline, at week 6 and week 12. Bodyweight, height measurements were undertaken at baseline, 6 and 12 weeks. Weight was recorded in light clothing without shoes (UM-018 Digital Scales; Tanita Corporation, Tokyo, Japan). Height was measured without shoes using a wall-mounted stadiometer (26SM 200 cm SECA, Hamburg, Germany), measured once to calculate participants' BMI. Body mass index was then calculated using weight in kilograms divided by height in metres squared (kg/m^2).

Prior to each appointment, participants were required to complete a selection of questionnaires (previously tested for reliability and validity) at week 0, 6 and 12. Table 3.3 provides more information on the measures used in the study.

Note: In this study, the researcher did follow up after 24 weeks to see the effect of the intervention, but refrained from sharing results, on grounds that there was poor participation.

Table 3.3. Schedule for measures during the study

Measurement by Group	Week 0		Week 6		Week 12	
	Intervention	Control	Intervention	Control	Intervention	Control
ANTHROPOMETRIC MEASURES						
Height	•	•				
Weight	•	•	•	•	•	•
BMI	•	•	•	•	•	•
PHYSIOLOGICAL MEASURES						
Diastolic Blood Pressure	•	•	•	•	•	•
Systolic Blood Pressure	•	•	•	•	•	•
Total Cholesterol	•	•	•	•	•	•
Triglyceride	•	•	•	•	•	•
Low Density Lipoprotein (LDL)	•	•	•	•	•	•
High Density Lipoprotein (HDL)	•	•	•	•	•	•
Blood Insulin	•	•	•	•	•	•
Blood Glucose	•	•	•	•	•	•
PSYCHOLOGICAL MEASURES						
Rosenberg Self-esteem	•	•	•	•	•	•
Depression, Anxiety and Stress Scale (DASS)	•	•	•	•	•	•
DASS: Depression	•	•	•	•	•	•
DASS: Anxiety	•	•	•	•	•	•
DASS: Stress	•	•	•	•	•	•
Overall DASS	•	•	•	•	•	•
Mendelson Body-esteem	•	•	•	•	•	•
Self-Esteem And Relationship	•	•	•	•	•	•
RAND Health Survey-36 V2 (SF-36 V2)	•	•	•	•	•	•
SF: Physical functioning	•	•	•	•	•	•
SF: Social functioning	•	•	•	•	•	•
SF: Bodily pain	•	•	•	•	•	•
SF: Role limitations due to emotional problems	•	•	•	•	•	•
SF: Role limitations due to physical problems	•	•	•	•	•	•
SF: Vitality	•	•	•	•	•	•
SF: General health perceptions	•	•	•	•	•	•
SF: Perceived mental health	•	•	•	•	•	•
SF: Health transition	•	•	•	•	•	•
SEXUAL FUNCTION MEASURES						

International Index of Erectile Function (IIEF)	•	•	•	•	•	•
IIEF: Erectile function	•	•	•	•	•	•
IIEF: Orgasmic function	•	•	•	•	•	•
IIEF: Sexual desire	•	•	•	•	•	•
IIEF: Intercourse satisfaction	•	•	•	•	•	•
IIEF :Overall sexual satisfaction	•	•	•	•	•	•
Male Sexual Function Index (MSFI)	•	•	•	•	•	•
MSFI: Sexual drive	•	•	•	•	•	•
MSFI: Erectile function	•	•	•	•	•	•
MSFI: Ejaculatory function	•	•	•	•	•	•
MSFI: Sexual problem assessment	•	•	•	•	•	•
MSFI: Sexual satisfaction	•	•	•	•	•	•
PHYSICAL ACTIVITY MEASURES						
Step Measures	•	•	•	•	•	•

Note: Screening questionnaires are not included in this table.

3.6.1 Anthropometric measures

Anthropometric measurements were collected during the clinic appointments at baseline, weeks 6 and 12. Weight was measured in light clothing without shoes (UM-018 Digital Scales; Tanita Corporation, Tokyo, Japan). Height was measured once (baseline only) without shoes using a wall-mounted stadiometer (26SM 200 cm SECA, Hamburg, Germany) to calculate participants' Body Mass Index (BMI). BMI was then calculated using weight in kilograms divided by height in metres squared (kg/m^2).

3.6.2 Physiological measures

3.6.2.1 Serum (blood) measurements

Fasting blood samples were drawn by venipuncture at baseline, 6 and 12 weeks. Participants attended Curtin University, after a 10-12 hour fast, for baseline measurements. After a mandatory rest period of approximately 10 minutes, fasting blood samples (10 mL) were drawn by venipuncture. The collection of fasting blood samples was repeated at 6 and 12 weeks. Blood samples were centrifuged at 2,500 rpm at 4ºC for 10 minutes using a Hettich Rottina 48R centrifuge. Serum was collected to measure circulating levels of triglycerides (TG), total

cholesterol (TC), high-density lipoprotein (HDL), low-density lipoprotein (LDL), insulin and blood glucose. Serum samples were stored at -80ºC and analyzed after the completion of the study.

Serum triglyceride and total cholesterol were measured by enzymatic colorimetric kits (TRACE Scientific LTD, Melbourne, Australia). Serum HDL cholesterol was determined after precipitation of apo B-containing lipoproteins with phosphotungstic acid and $MgCl_2$, the supernatant containing the HDL cholesterol were determined by enzymatic colorimetry (TRACE Scientific LTD, Melbourne, Australia). Serum LDL cholesterol was determined by using the Friedewald equation.

Serum glucose levels were measured using the Randox glucose GOD-PAP kit (Antrim, United Kingdom), according to the manufacturer's instructions. Serum insulin was measured by an ELISA kit (Dako Diagnostic, Japan).

HOMA2-IR (homeostasis model assessment of insulin resistance) was used to assess insulin resistance from fasting glucose and insulin concentrations using a computer model.

3.6.2.2 Blood Pressure

Blood pressure was measured with a manual sphygmomanometer (ALP K2-TANAKA SANGY Co, JAPAN) with participants in a supine position after resting for at least 10 minutes. The measurements were taken on the same arm three times at 1-min intervals. These readings were then averaged.

3.6.3 Psychological measures

3.6.3.1 Rosenberg Self-Esteem Scale (RSES)

The Rosenberg Self-Esteem Scale (Rosenberg, 1965) is a 10-item measure assessing global self-worth by measuring both positive and negative feelings about the self. The scale is uni-dimensional and all items are answered using a 4-point Likert scale, ranging from strongly agree to strongly disagree. The original sample for which the scale was developed in the 1960s

consisted of 5,024 high school juniors and seniors from 10 randomly selected schools in New York State and was scored as a Guttman scale. This measure has shown test-retest reliability (.82 to .88) and internal consistency (.77 to .88 Cronbach alpha value) (Blascovich & Tomaka, 1993; Rosenberg, 1965). The reliability of this research data was .89.An example item from the questionnaire is: "I wish I could have more respect for myself." (*see* Appendix H)

3.6.3.2 Depression, Anxiety and Stress Scale (DASS)

The Depression Anxiety Stress Scales is a 21-item measure and a short form of Lovibond and Lovibond's (1995) 42-item self-report measure of depression, anxiety, and stress (DASS). The DASS-21 instrument measuring current (over the past week) symptoms of depression, anxiety and stress which are responded to using a 0-3 scale, where 0= did not apply to me at all, and 3= applied to me very much or most of the time. Each of the three scales consists of 7-item self-report scales taken from the full version of DASS. An example item from the Depression subscale is: "I felt I wasn't worth much as a person.", Anxiety subscale is: "I felt I was close to panic." and Stress subscale is: "I found it difficult to relax". In the past research, this measure has shown test-retest reliability (.73 to .86), internal consistency (.97,.92 and .95), and discriminant validity (.73 to .85) in both clinical and non-clinical samples (Antony et al., 1998; Brown et al., 1997; Crawford & Henry, 2003; Lovibond & Lovibond, 1995). The reliability of this research data was .94. DASS-21 scores for the symptoms of depression, anxiety and stress are categorized by symptom severity level as illustrated in Table 3.4 (Lovibond & Lovibond, 1996) (*see* Appendix I).

Table 3.4 Depression Anxiety Stress Scale symptom severity levels

Severity	Depression	Anxiety	Stress
Normal	0-9	0-7	0-14
Mild	10-13	8-9	15-18
Moderate	14-20	10-14	19-25
Severe	21-27	15-19	26-33
Extremely severe	28-42	20-42	34-42

Note: Participant DASS21 scores were multiplied by two to provide the total score.

3.6.3.3 Body Esteem Scale (BES)

Body Esteem Scale (BES) (Mendelson et al, 2001) is a 23-item measure assessing the participants' attitudes and feelings about their bodies and appearance. In the scale, all items are answered using a 5-point Likert scale, ranging from strongly agree to strongly disagree (0= never, 4= always). The body esteem scale consists of three subscales: appearance (10 items that assess general feelings about one's appearance); weight (8 items assessing weight satisfaction); and attribution (5 items that assess evaluations about one's body and appearance that are attributed to others). Psychometric studies indicated test-retest reliability and internal consistency (Appearance = .89, Weight = .92 and Attribution = .83) and (Cronbach's α = .91) (Mendelson et al, 2001). An example item from the questionnaire is: "I am proud of my body." (*see* Appendix J). The reliability of this research data was .93.

3.6.3.4 Self-Esteem And Relationship (SEAR) Scale

The Self-Esteem And Relationship (SEAR) scale is a 14-item questionnaire in a brief, self-administered, disease-specific scale for assessing the relevant psychosocial manifestations of ED, specifically, patient-reported outcomes of self-esteem, confidence, and relationships (Cappelleri et al., 2004). It has two domains: Sexual relationship (eight items) and confidence (six items), the latter comprising self-esteem (four items) and overall relationship (two items) subscale. Higher scores report a more favorable response. All items are rated using a 5-point Likert scale where: 1= almost always/always, 2= most times (much more than half the time), 3= sometimes (about half the time), 4= a few times (much less than half the time), 5=almost never/never. An example item from the questionnaire is: "I was satisfied with my sexual performance."

A measure of internal consistency reliability (Cronbach's α), for the overall score, Sexual Relationship domain, the Confidence domain were 0.93, 0.91 and 0.86, respectively. Cronbach's α values for the Overall Relationship subscales of the Confidence domain and Self-Esteem were 0.76 and 0.82, respectively. The reliability of this research data was.92.The intraclass correlation coefficients, a measure of test–retest reliability, for the Confidence domain and Sexual Relationship domain, and the overall score were 0.71, 0.78, and 0.79, respectively. Intraclass correlations for the Self-Esteem and the Overall Relationship subscales were 0.72 and 0.57, respectively (Cappelleri et al., 2004). (*see* Appendix K)

3.6.3.5 Short Form Health Survey (SF-36 V2)

The Short-Form Health Survey (SF-36) is a general quality of life instrument that measures eight health-related concepts: physical functioning (PF-10 items), social functioning (SF-2 items), bodily pain (BP-2 items), role limitations due to emotional problems (RE-3 items), role limitations due to physical problems (RP-4 items), vitality (VT-4 items), general health perceptions (GH-5 items), and perceived mental health (MH-5 items). The SF-36 also includes a single item measure of health transition or change over one year. In this scale, items are answered using the (1 to 6) Likert scale (depending on the subscale) and scores are summed to produce raw scale scores for each health concept which are transformed to a 0-100 scale. Psychometric studies indicated test-retest reliability (.74-.92) and internal consistency (.74-.91) (Bullinger, 1995; Leplege A, Ecosse E, Verdier A, Perneger TV, 1998). The reliability of this study data was .94. An example item from the questionnaire is: "Does your health now limit you on climbing one flight of stairs?" (*see* Appendix L)

3.6.4 Sexual functioning measures

3.6.4.1 International Index of Erectile Function (IIEF)

The sexual functioning of (male) participants was evaluated using the International Index of Erectile Function questionnaire (IIEF). IIEF developed by Rosen et al (2002) and includes 15 questions in 5 specific areas that measure the components of male sexual functioning by collecting scores for five domains: erectile function, orgasmic function, sexual desire, intercourse satisfaction and overall sexual satisfaction during the past 4 weeks. Each domain has a score from 0-5 with higher scores indicating better functioning. The zero score implies no sexual activity which is out of the inclusion criteria in the study. IIEF was measured at baseline, 6 and 12 weeks.

This self-administered questionnaire relates to experiences of the previous four weeks, with several items defining each domain. For example, *erectile function* is determined by such questions as: *When you had erections with sexual stimulation, how often were your erections hard enough for penetration?* and rated on a scale where: 0=no sexual activity, 1=almost never or never, 2=a few times (less than half the time), 3=sometimes (about half the time), 4=most

times (more than half the time), and 5=almost always or always. The o*rgasmic function* is determined by such questions as: *When you had sexual stimulation or intercourse, how often did you have the feeling of orgasm or climax (with or without ejaculation)?* and rated on a scale where: 1=almost never or never, 2=a few times (less than half the time), 3=sometimes (about half the time), 4=most times (more than half the time), and 5=almost always or always. *Sexual desire* is determined by such questions as*: How would you rate your level of sexual desire?* and rated on a scale where: 1=very low or none at all, 2=low, 3=moderate, 4=high, and 5=very high. *Intercourse satisfaction* is determined by such questions as: *When you attempted sexual intercourse, how often was it satisfactory for you?* and rated on a scale where: 0=did not attempt intercourse, 1=almost never or never, 2=a few times (less than half the time), 3=sometimes (about half the time), 4=most times (more than half the time), and 5=almost always or always. Finally, *overall sexual satisfaction* is determined by such questions as: *How satisfied have you been with your overall sex life?* and rated on a scale where: 1=very dissatisfied, 2=moderately dissatisfied, 3=equally satisfied and dissatisfied, 4=moderately satisfied, and 5=very satisfied. Domain scores are calculated to provide an overall sexual functioning score. Sexual dysfunction is classified by an overall score of 21 or less (Esposito et al., 2004; Rosen et al., 2002).

A high degree of internal consistency, test-retest reliability, and discriminant validity was observed for all five domains and a high degree of internal consistency (Cronbach's alpha, range=0.73-0.99) and test-retest reliability (*r*, range=0.64-0.84) across domains was demonstrated (Rosen et al., 2002). The reliability of this research data was .94. Furthermore, a high level of sensitivity and specificity was demonstrated by using the IIEF to assess sildenafil treatment (otherwise known as Viagra) response in patients with erectile dysfunction (Rosen et al., 2002). (*see* Appendix M)

3.6.4.2 Male Sexual Function Index (MSFI)

MSFI is also called Brief Sexual Function Inventory (BSFI). The questionnaire consists of 11 questions comprising five sexual function domains: sexual drive (two items), erectile function (three items), ejaculatory function (two items), sexual problem assessment (three items), and sexual satisfaction (one item). All questions were scored on a scale from 0 to 4 with domain scores equalling the sum of the individual questions comprising the domain. The range of the domain scores were 0–8 for sexual drive, 0–12 for erectile function, 0–8 for ejaculatory

function, 0–12 for sexual problem assessment, and 0–4 for overall satisfaction with sex life, respectively. Lower domain scores indicate impaired sexual function). An example item from the questionnaire is: "During the past 30 days, how would you rate your level of sexual drive?" O'Leary et al. tested the psychometric properties of the MSFI in men in a general medical clinic and men who complained of sexual dysfunction. Internal consistency coefficients for the domains were 0.62–0.95 measured by Cronbach's α. Test-retest reliability for a 1-week interval showed intra-class correlation coefficients of 0.79–0.90 for the domains (Mykletun et al., 2006) .The reliability of the data in this research was .92. (*see* in Appendix N)

3.6.5 Physical Activity Measures

3.6.5.1 Step Counts

Participants' step counts were measured by an activity checker (Fitbit Charge HR, San Francisco, CA). A Fitbit account was created for all participants prior to the commencement of the intervention. The intervention group wore a Fitbit with all displays enabled and encouraged to reach a daily step goal of 10,000 steps/day. The intervention group had access to their accounts and were able to view their step counts, heart rate, calories burned, distance, floors climbed, sleep and time at any point in the day. The associated Fitbit Connect software and Fitbit app also allowed participants in the intervention group to earn badges for activity achievements, add friends to compare weekly step totals, as well as compete in challenges to win trophies. Participants in the intervention group were requested to sync their devices daily to record steps/day. Control group participants had no access to their Fitbit accounts and were unable to view the step counts; they were only to view the time and the number of floors climbed. Therefore, the research student could preview and collect the recorded data on the computer once the intervention group had synced their device on their mobile or laptop but the control group had to attend the clinic to be able to collect the data.

3.6.6 Screening Questionnaires

Two instruments were used at screening. They are described below.

3.6.6.1 Physical Activity Readiness Questionnaire (PAR-Q):

This questionnaire includes 7 questions and completed by anyone who was looking to start an exercise program to increase their current activity level or partake in a fitness testing assessment. This questionnaire was only used at screening (*see* Appendix O).

3.6.6.2 The International Physical Activity Questionnaires (IPAQ)

Physical activity was assessed using short-form International Physical Activity Questionnaires (IPAQ) and was used for screening. The IPAQ provides information on the time spent walking, in moderate physical activity, in vigorous physical activity and total physical activity in (MET. min/wk) (MET=Metabolic Equivalent Task) in a usual week. This version of the IPAQ has been found to be valid and reliable. Previous research showed criterion validity Spearman correlations with a median of 0.30 and test-retest reliability Spearman correlations clustered around 0.8 (Craig et al., 2003).

All the questionnaires were scored by the research coordinator and entered all of the raw data into excel spreadsheets (MS Office, Microsoft Corporation, Redmond, WA), to be prepared for statistical analysis (*see* Appendix P).

3.7 Ethical Issues

This study was conducted according to the ethical guidelines that are specified in the Curtin University Human Research Ethics Committee (HREC) and the National Health and Medical Research Council (NHMRC guidelines. This trial was approved by Curtin University HREC (approval number: HRE2016-0367) (*see* Appendix Q). The current project adhered to the following Curtin University Human Research Ethics Committee guidelines:

- Consent: Since sensitive information such as sexual function was asked in this study, participants were requested to read the invitation letter. They were informed that by signing the consent form, they are interested to participate in the study (*see* Appendix R).

- Anonymity and confidentiality: All the participants were informed that the collected information was anonymous and the confidentiality of the responses was protected.

The data were collectively analysed and the results of the research presented in group and not individual information.

- Voluntary participation: Participants were informed that their participation was completely respected and they could withdraw at any time if they felt uncomfortable.

- Enquiries: The contact details of the research coordinator were provided in the information sheet for participants to ask any questions about the study.

1.8 Statistical Analysis

A series of Generalised Linear Models (GLMM) were used to test the hypotheses to determine whether the intervention group report changes on the physiological and psychological outcome measures relative to the control group. The GLMM for H1 and H2 includes one categorical random effect (participants), one categorical fixed effect (group: intervention and control) and one ordinal fixed effect (time: baseline, week 6 and week 12). The mediation effects predicted in H3, H4, H5 and H6 were tested with the SPSS PROCESS module (Hayes, 2018) using the Model 4 option.

SPSS (V 24) was used to perform all statistical analyses. Frequencies and percentages were calculated for categories of BMI, place of birth, nationality, living arrangement, employment status, educational background and employment status of the participants.

3.8.1 The statistical model

Three sets of Generalised Linear Mixed Models (GLMMs) were conducted in order to test for intervention effects at 6-weeks and 12 weeks on the eight physiological outcomes (Set 1), the 15 psychological outcomes (Set 2), and the 12 sexual functioning outcomes (Set 3). The GLMMs were implemented through SPSS's (Version 24) GENLINMIXED procedure. The GLMM represents a special class of regression model. The GLMM is 'generalised' in the sense that it can handle outcome variables with markedly non-normal distributions; the GLMM is 'mixed' in the sense that it includes both random and fixed effects. Each of the present GLMMs

will include one nominal random effect (participant), one nominal fixed effect (group: intervention, control), and one covariate (the outcome measure at baseline).

3.8.2 Statistical assumptions

The traditional ANCOVA model requires normality, homogeneity of variance, and homogeneity of regression. The GLMM 'robust statistics' option will accommodate violations of these assumptions.

3.8.3 Controlling for multiple statistical tests

In order to optimise the likelihood of convergence, a separate GLMM analysis was conducted for each of the outcome measures. The classicists argue that analysing each outcome independently of the others will inflate the familywise error rate thereby increasing the chances of incorrectly declaring statistical significance (Feise, 2002). According to this argument, the per-test alpha needs to be corrected to control inflation. For each of the three sets of outcomes in the present study, this would involve dividing the conventional per-test alpha of .05 by the number of outcomes within that set. The Set 1 GLMMs would therefore be evaluated at an adjusted alpha-level of .0063 (.05/8), the Set 2 GLMMs would be evaluated at an adjusted alpha-level of .0033 (.05/15), and the Set 3 GLMMs would be evaluated at an alpha level of .0042 (.05/12).

Opponents of the classical perspective outlined above argue that adjustments to the per-test alpha are arbitrary because the number of outcomes in a particular set of variables (8, 15, 12 in the three sets of variables analysed in the present study) is also arbitrary. In addition, the anti-classicists argue that by controlling the family-wise error, you increase the chance of a Type II error thereby decreasing the chances of finding an effective treatment (Feise, 2002). Sinclair et al (2013) endorse the anti-classical perspective by arguing that "researchers should not be punished by missing potentially meaningful findings for their willingness to explore additional information". The present research also adopts the anti-classical perspective regarding the analysis of multiple outcome variables and will therefore make no adjustments to the standard per-test alpha level of .05. The classicist can, however, compare the *p*-values obtained here

with the adjusted alpha-values computed in the previous paragraph and interpret the results accordingly.

3.8.4 Statistical power

According to G*Power, 52 participants (26 in each group) were required for an 80% chance of detecting 'large' intervention effects (f = .40) at the conventional per-test alpha-level of .05. 'Large' effects were sought because 'small to moderate' effects are of less clinical importance.

3.8.5 Testing for mediators of the intervention effect on sexual functioning.

Physiological and psychological variables at 6 weeks were tested as mediators of the intervention effect on sexual functioning at 12 weeks if (and only if) the following two conditions were satisfied: i) there was a significant intervention effect on the physiological/psychological measures at 6 weeks, and ii) there was a significant intervention effect on sexual functioning at 12 weeks. The mediation models were tested via the SPSS PROCESS module (Hayes, 2018) using the Model 4 option. In order to control for any non-normality in the data, the significance of the mediation pathways was tested with a bootstrapping procedure based on 1000 draws from the data.

3.9 Summary

This chapter outlined the study methodology. The study, consisting of two groups (intervention group and control group), conducted with the aim of whether using Fitbit with 10,000 steps/day would assist sedentary overweight and obese men to achieve greater improvements in sexual functioning over 12 weeks. It was carried out in Perth, Western Australia over a 12-week period. Participants who took part in this study attended at Curtin University to collect blood samples and anthropometric measures and they were asked to fill in a set of self-reported questionnaires, to gather data at three-time points (baseline, week 6 and 12).

In this chapter, it was offered an overview of the methods employed in this study including an explanation of study design, research aims and hypotheses, description of the participants, procedures and instruments, description of the intervention, method of data collection and

analysis, and ethical considerations. The next chapter will provide the study results and demonstrate that the methodology described in chapter three was followed.

CHAPTER 4

HYPOTHESES, DATA ANALYSIS, AND RESULTS

This chapter presents the results of the statistical analysis conducted and the interpretation of the findings. The results were arranged to answer the hypotheses using the appropriate statistical approach with the use of SPSS (version 24). This study aimed to determine the effect of increased physical activity on sexual functioning in obese and overweight males.

4.1 Hypotheses

Because the changes in the outcome measures across time are not strictly linear, intervention effects are more likely to be detected in between-group comparisons of adjusted means rather than in the Group x Time interaction (Collins & Sayer, 2001). The hypothesised intervention effects are therefore formulated in terms of between-group comparisons at 6 weeks and 12 weeks after controlling for between-group differences at baseline:

After controlling for between-group differences at baseline,

H1: The intervention group engaged in a higher level of physical activity (1 outcome: number of steps) at 6 weeks and 12 weeks compared to the control group.

H2: The intervention group experienced greater improvements in sexual functioning (12 outcomes: IIEF and MSFI total scores and their subscale scores) at 6 weeks and 12 weeks compared to the control group.

H3: The intervention group experienced greater improvements in physiological outcomes (8 outcomes: DBP, SBP, TC, TG, LDL, HDL, Glu, and Insulin) at 6 weeks and 12 weeks compared to the control group.

H4: The intervention group experienced greater improvements in psychological outcomes (15 outcomes: Self-esteem, self-esteem and relationship, body

esteem, depression, anxiety, stress, physical functioning, role limitation due to physical health problem, role limitation due to emotional problem, vitality, mental health, social functioning, bodily pain, general health, health transition) at 6 weeks and 12 weeks compared to the control group.

H5: The impact of the intervention on sexual functioning was mediated by improvements in physiological outcomes.

H6: The impact of the intervention on sexual functioning was mediated by improvements in psychological outcomes.

4.2 Data analyses

4.2.1 The statistical model

Each of the above hypotheses would normally be tested with a least squares Analysis of Covariance (ANCOVA). One or more of the statistical assumptions underlying the ANCOVA model, however, were violated in the present data. For this reason, ANCOVAs were implemented using SPSS's (Version 24) Generalised Linear Mixed Model procedure. This procedure has a 'robust statistics' option that will accommodate assumption violations.

4.2.2 Statistical power

According to G*Power (Version 3.1.9.4), at a per-test alpha-level of .05, 53 participants are required for an 80% probability of capturing a 'large' between-group (intervention, control) difference ($f = .4$).

4.3 Results

4.3.1 Testing the first hypothesis

After controlling for between-group differences at baseline, the intervention group will engage in a higher level of physical activity (as measured by the number of steps) at 6 weeks and 12 weeks compared to the control group.

Prior to testing for intervention effects, the integrity of the intervention has to be established. The intervention was designed to significantly increase the number of steps at 6 and 12 weeks compared to the control group. Testing the first hypothesis, therefore, amounts to testing the integrity of the intervention. Figure 4.3.1 plots the number of steps across time for the intervention and control groups.

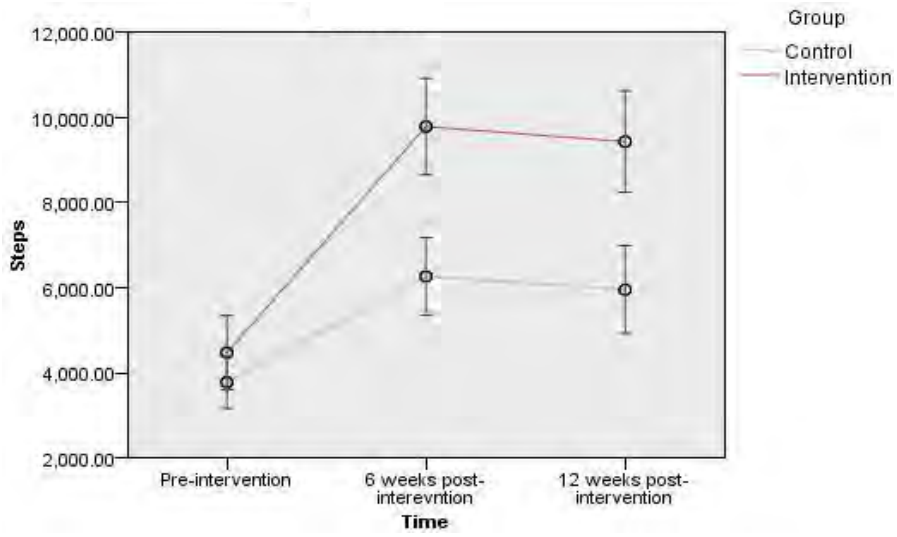


Figure 4.3.1: Number of Fitbit steps completed across time in each of the two groups

There were 26 males in the intervention group, and 27 males in the control group (N = 53) in Weeks 0 and 6, but 23 and 24 respectively at Week 12 (N = 47). At Week 0, the mean number of steps for the intervention group was 4470.27 (SD=2300.24, range = 1134 - 9318) and 3777.89 for the control group (SD =1642.2, range =1170 - 8562); at week 6, the mean number of steps for the intervention group was 9781.77 (SD=2979.19, range = 3585 – 16835.5) and 6261.31 for the control group (SD =2450.63, range =2025 - 11814); and at week 12, the mean number of steps for the intervention group was 9771.41 (SD=2966.02, range = 1865-15804) and 5970.12 for the control group (SD =2743.74, range =1267-11959).

After controlling for between-group differences at baseline, the intervention group engaged in significantly more steps at 6 weeks (F[1,50] = 23.56, p < .001) and 12 weeks (F[1,44] = 19.15, p < .001) than the control group. The integrity of the intervention is therefore established.

4.3.2 Testing the second hypothesis

After controlling for between-group differences at baseline, the intervention group will experience greater improvements in sexual functioning (12 outcomes: IIEF and MSFI total scores and their subscale scores) at 6 weeks and 12 weeks compared to the control group.

Intervention effects were tested for two sexual functioning measures and their domains: The International Index of Erectile Function (IIEF; domains: erectile function, intercourse satisfaction, orgasmic function, sexual desire, and overall satisfaction), and The Male Sexual Function Index (MSFI; domains: sexual desire, erectile function, ejaculatory function, sexual problem assessment, and sexual satisfaction. Means (*SD*s and ranges) for the IIEF and MSFI total scores, and their associated domains, are reported in Table 4.3.2

Table 4.3.2 Descriptive statistics (Means, SDs, and Ranges) for the IIEF and MSFI total scores, and subscale scores, for each group across the three assessments

	Week 0			Week 6			Week 12		
	n	Mean	*SD*	*n*	Mean	*SD*	*n*	Mean	*SD*
IIEF Total									
• Intervention	26	49.77	14.2	24	59	10.21	24	64	14.4
• Control	27	45.85	15.68	25	49.04	17.05	23	54.87	17.41
IIEF_ Erectile Function									
• Intervention	26	21.38	7.2	24	25.17	5.18	24	26.33	6.7
• Control	27	19.81	7.97	25	20.16	8.22	23	22.83	8.23
IIEF_ Intercourse Satisfaction									
• Intervention	26	8.84	3.27	24	10.62	3.14	24	11.54	3.97
• Control	27	7.59	3.48	25	8.12	4.16	23	9.26	3.74
IIEF_ Orgasmic Function									
• Intervention	26	7.5	2.16	24	8.04	2.18	24	9.04	1.92
• Control	27	6.67	3.01	25	7.6	2.69	23	7.74	2.83
IIEF_ Sexual desire									

• Intervention	26	5.77	2.08	24	7.29	1.70	24	8.29	1.87
• Control	27	5.85	2.01	25	6.72	1.93	23	7.7	1.89
IIEF_ Overall sexual satisfaction									
• Intervention	26	6.27	2.32	24	7.87	1.33	24	8.8	1.47
• Control	27	5.93	2.32	25	6.44	2.24	23	7.35	2.33
MSFI Total									
• Intervention	26	26.12	8.86	24	33.67	5.77	24	37.46	6.06
• Control	27	25.6	9.58	25	29.36	8.23	23	33.87	7.6
MSFI_ sexual desire									
• Intervention	26	3.7	1.54	24	4.92	1.44	24	5.87	1.78
• Control	27	3.57	1.55	25	4.48	1.53	23	4.96	1.74
MSFI_ Erectile Function									
• Intervention	26	7.3	2.82	24	9.46	1.95	24	10.46	2.28
• Control	27	7.48	2.5	25	8.12	2.98	23	9.6	2.57
MSFI_ Ejaculatory Function									
• Intervention	26	5.92	1.99	24	7.08	.93	24	7.46	1.02
• Control	27	5.89	2.33	25	6.32	1.8	23	6.74	1.81
MSFI_ Sexual Problem Assessment									

• Intervention	26	7.27	3.42	24	9.37	2.5	24	10.41	2.01
• Control	27	6.85	3.84	25	8.2	2.83	23	9.78	2.23
MSFI_ Satisfaction									
• Intervention	26	1.92	.98	24	2.83	.76	24	3.25	.67
• Control	27	1.81	1.11	25	2.24	.97	23	2.78	1.13

4.3.2.1 *Testing the second hypothesis in relation to the IIEF and the MSFI total scores*

The number of males in the intervention group across Weeks 0, 6, and 12, was 26, 24, and 24 respectively; for the control group, the corresponding sample sizes were 27, 25 and 23. At Week 0, the mean IIEF total score for the intervention group was 49.77 (*SD* = 14.2, range =18 - 72) and 45.85 (*SD* =15.68, range = 11 - 74) for the control group; at week 6, it was 59 (*SD* =10.21, range = 28 - 74) for the intervention group and 49.04 (*SD* = 17.05 range = 8 - 75) for the control group; at week 12, it was 64 (*SD* = 14.4, range = 14 - 75) for the intervention group and 54.87 (*SD* = 17.41, range = 5 - 75) for the control group.

At Week 0, the mean MSFI total score for the intervention group was 26.12 (*SD* = 8.86 and range = 2 - 42) and 25.6 (*SD* = 9.58, range = 10 - 42) for the control group; at week 6, it was 33.67 (*SD* = 5.77, range = 22 - 43) for the intervention group and 29.36 (*SD* = 8.23, range = 9 - 43) for the control group; at week 12, it was 37.46 (*SD* = 6.06, range = 25 - 44) for the intervention group and 33.87 (*SD* = 7.6, range = 15 - 44) for the control group.

The descriptive data reported above, and the plots of the means presented in Figures 4.3.2 suggest that, for both instruments and for groups, sexual functioning improved over the course of the study. Results from relevant statistical tests are described below.

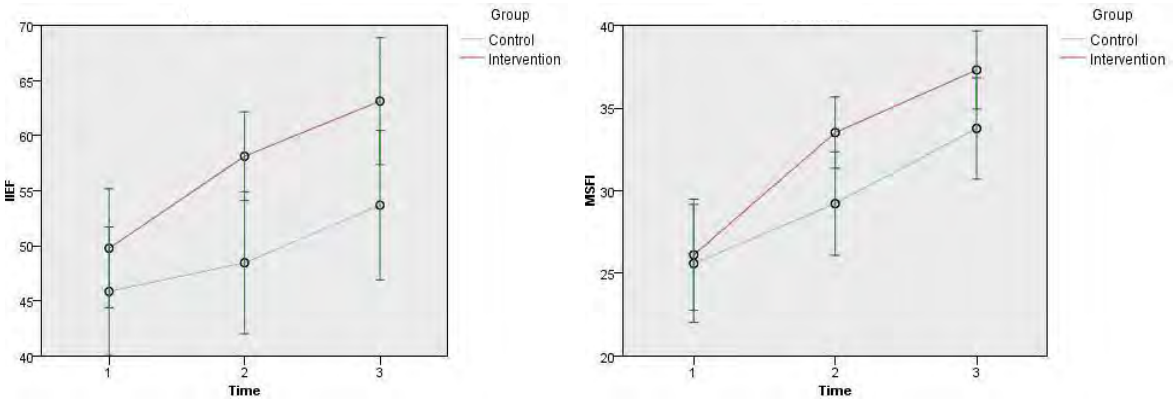


Figure 4.3.2. Mean IIEF scores (left plot) and mean MSFI scores (right plot) across time for intervention and control groups

After controlling for differences between the intervention and control group on the outcome measures at baseline, the intervention group had significantly higher scores than the control

group at 6 weeks on the IIEF (F[1,46] = 7.096, p = .011) and the MSFI (F[1,46] = 9.328, p = .004), but there were no significant between-group differences at 12 weeks for either the IIEF (F[1,44] = 3.691, p = .061) or the MSFI (F[1,44] = 3.854, p = .056).

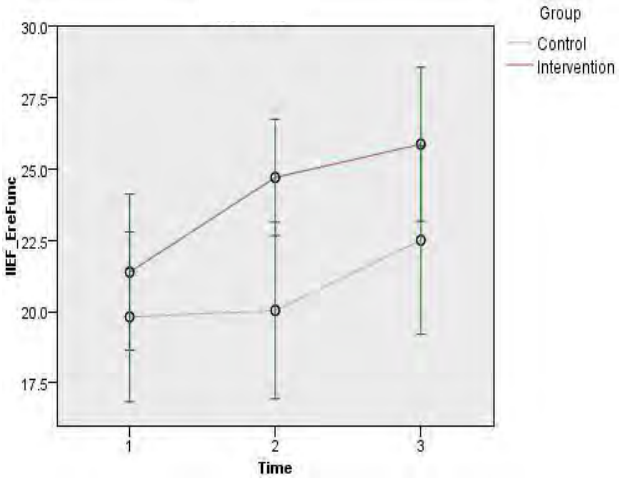
4.3.2.2 Investigating the source of the significant intervention effects observed for the IIEF and MSFI total scores

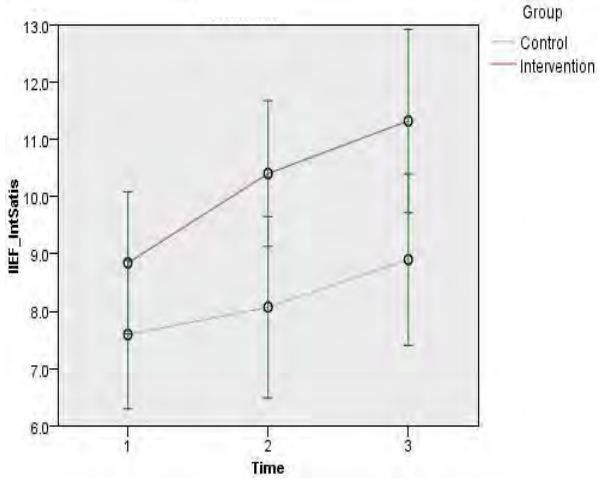
The IIEF and MSFI scales were broken down into their respective domains to locate the source of the significant intervention effects reported in the previous section. Because significant intervention effects were observed for the total IIEF and MSFI scores only at 6 weeks, but not at 12 weeks, the domain-specific statistical analysis was only conducted on the 6-week data. This strategy was invoked to reduce the Type I error rate (ad hoc analyses revealed that there were no significant intervention effects at 12 weeks on any of the IIEF and MSFI domains). The descriptive data for the IIEF and the MSFI domains are reported in Table 4.3.2 above, and the corresponding plots of the means are presented in Figure 4.3.3a and Figure 4.3.3b below.

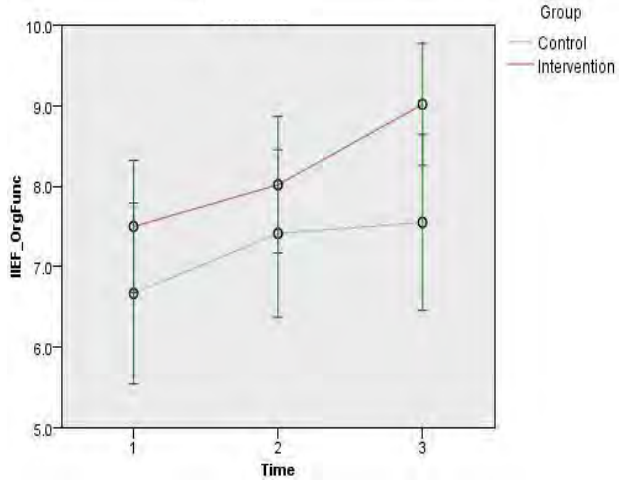
IIEF domains. After controlling for baseline differences between the intervention and control group on the respective IIEF domains, the intervention group had significantly higher scores than the control group at 6 weeks for erectile function (F[1,46] = 7.338, p =.009) and overall satisfaction (F[1,46] = 8.373, p = .006). No other between-group difference was significant (intercourse satisfaction: F[1,46] = 2.789, p = .102; orgasmic function: F[1,46] = 0.067, p =.797; sexual desire: F[1,46] = 2.930, p = .094). The significant results remained significant after controlling for the inflated familywise error rate associated with testing five outcomes (ps < .01)

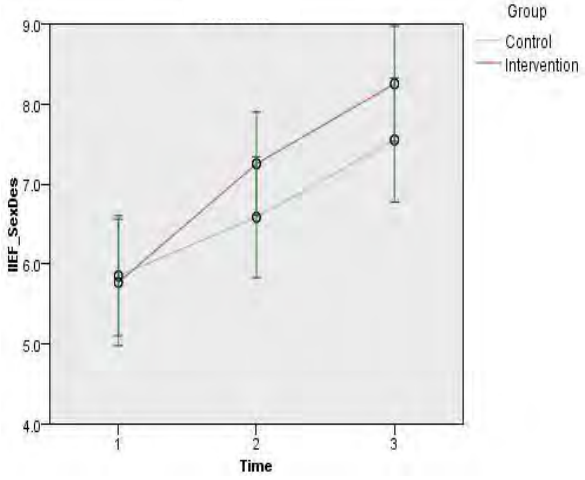
MSFI domains. After controlling for baseline between-group differences on the respective MSFI domains, the intervention group had significantly higher scores than the control group at 6 weeks for erectile function (F[1,46] = 6.875, p = .012), sexual satisfaction (F[1,46] = 6.259, p = .016), and ejaculatory function (F[1,46] = 4.686, p = .036). The significant results for erectile function and sexual satisfaction are consistent with the significant results observed for the corresponding IIEF domains. No other between-group difference was significant (sexual desire: F[1,46] = 2.689, p = .108; sexual problem assessment: F[1,46] = 3.089, p =

.085). After controlling for the inflated familywise error rate associated with testing five outcomes, however, the significant effect was rendered non-significant (*p*s > .01).


Group
Control
Intervention
IIEF_EreFunc
30.0
27.5
25.0
22.5
20.0
17.5
1
2
3
Time


Group
Control
Intervention
IIEF_IntSatis
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
1
2
3
Time


Group
Control
Intervention
IIEF_OrgFunc
10.0
9.0
8.0
7.0
6.0
5.0
1
2
3
Time


Group
Control
Intervention
IIEF_SexDes
9.0
8.0
7.0
6.0
5.0
4.0
1
2
3
Time

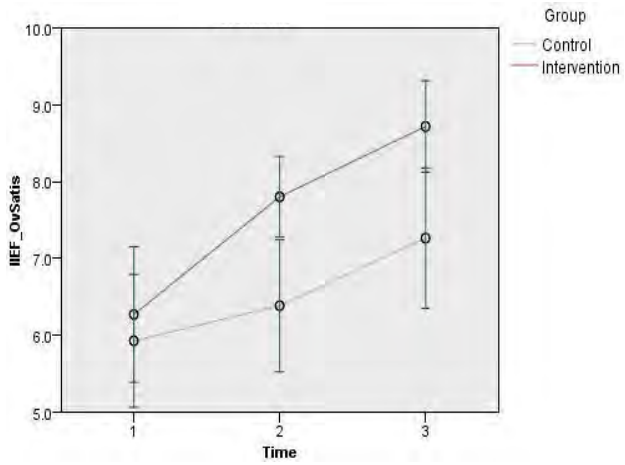
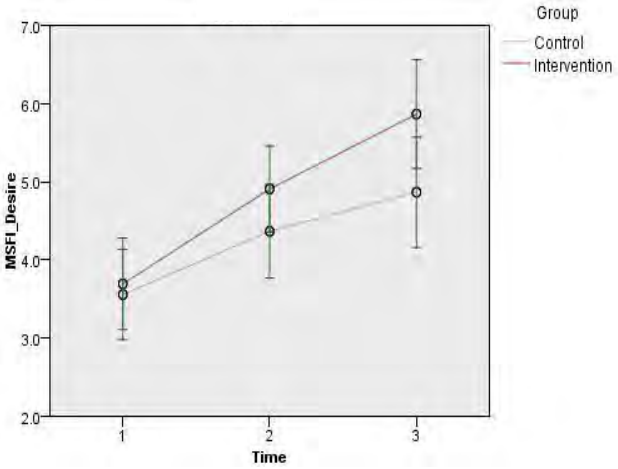
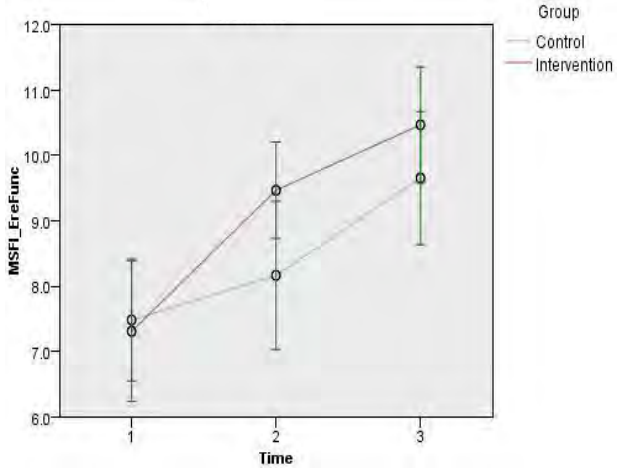
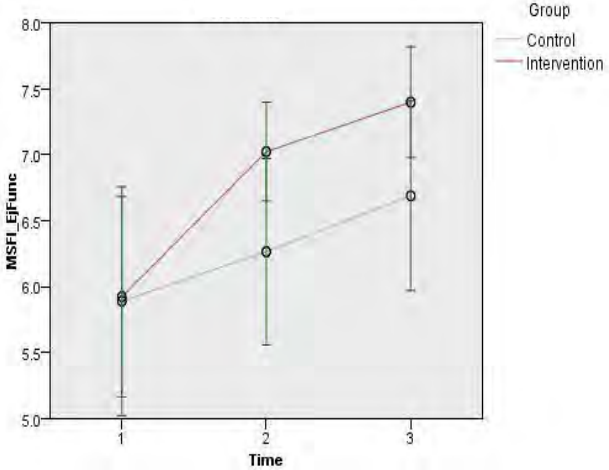
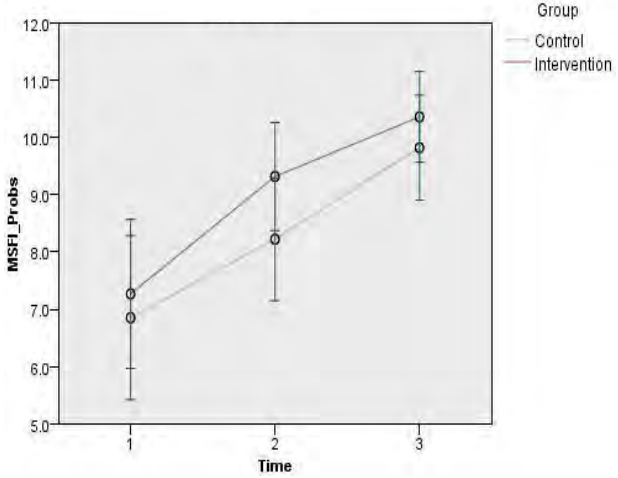


Figure 4.3.3a. IIEF domain-specific means across time for intervention and control groups. From left to right, starting on the top row: erectile function, intercourse satisfaction, orgasmic function, sexual desire, overall satisfaction


Group
Control
Intervention
MSFI_Desire
7.0
6.0
5.0
4.0
3.0
2.0
1
2
3
Time


Group
Control
Intervention
MSFI_EreFunc
12.0
11.0
10.0
9.0
8.0
7.0
6.0
1
2
3
Time


Group
Control
Intervention
MSFI_EjFunc
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1
2
3
Time


Group
Control
Intervention
MSFI_Probs
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
1
2
3
Time

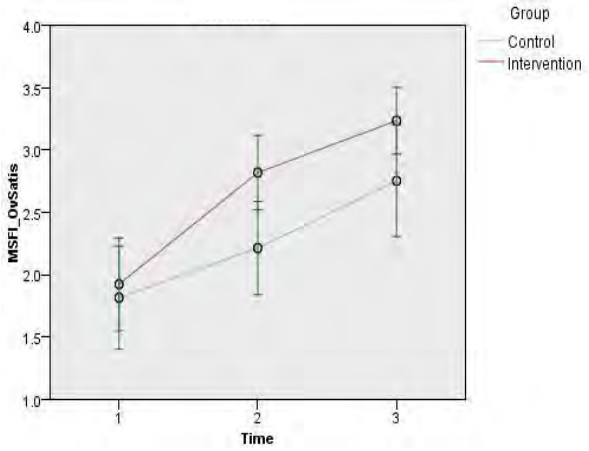


Figure 4.3.3b. MSFI domain-specific means across time for intervention and control groups. From left to right, starting on the top row: Sexual desire, erectile function, ejaculatory function, sexual problem assessment, sexual satisfaction

4.3.3 Testing the third hypothesis

After controlling for between-group differences at baseline, the intervention group will experience greater improvements in physiological outcomes (8 outcomes: DBP, SBP, TC, TG, LDL, HDL, Glu and Insulin) at 6 weeks and 12 weeks compared to the control group.

Intervention effects were tested for eight physiological outcomes: Diastolic blood pressure (DBP), systolic blood pressure (SBP), total cholesterol (TC), triglyceride (TG), low-density lipoprotein (LDL), high-density lipoprotein (HDL), blood insulin, blood glucose (Glu). Means (*SD*s and ranges) for these outcomes are reported in Table 4.3.3.

Table 4.3.3 Descriptive statistics (Means, SDs, and Ranges) for the physiological measures, for each group across the three assessments

	Week 0			Week 6			Week 12		
	n	Mean	*SD*	*n*	Mean	*SD*	*n*	Mean	*SD*
SBP (mmHg)									
• Intervention	26	117.81	22.41	23	121.22	8.78	22	121.5	12.72
• Control	27	125.78	10.19	24	125	7.03	22	127.09	11.80
DBP (mmHg)									
• Intervention	26	81.31	4.62	23	79.69	6.47	22	79.90	7.08
• Control	27	80.85	15.91	24	82.62	4.24	22	84.36	8.49
TC (mmol/L)									
• Intervention	25	7.00	4.32	23	5.64	3.01	22	5.98	3.50
• Control	26	6.75	3.28	24	5.94	2.62	22	6.39	2.90
HDL (mmol/L)									
• Intervention	25	.96	.24	23	.92	.19	22	.93	.17
• Control	26	.87	.17	24	.86	.18	22	.91	.17
LDL (mmol/L)									
• Intervention	25	4.94	4.38	23	3.62	3.02	22	3.95	3.52
• Control	26	4.81	3.28	24	3.99	2.60	22	4.39	2.90

TG (mmol/L)									
• Intervention	25	2.20	1.51	23	1.94	1.03	22	2.03	1.33
• Control	26	2.24	1.23	24	1.96	.76	22	2.24	1.19
GLU (mmol/L)									
• Intervention	25	7.13	.65	23	7.02	.68	22	7.11	.45
• Control	26	7.26	.48	24	7.26	.38	22	7.39	.48
Insulin (mu/L)									
• Intervention	25	13.68	10.86	23	12.86	5.46	22	14.74	7.23
• Control	26	19.45	15.75	24	15.60	6.69	22	20.17	17.30

After controlling for differences between the intervention and control groups at baseline on the physiological outcomes, there was only one significant between-group difference: At 12 weeks, the intervention group showed a significant reduction in diastolic blood pressure compared to the control group (p=.038). After controlling for the inflated familywise error rate associated with testing eight physiological outcomes, however, this effect was rendered non-significant ($p > .006$).

4.3.4 Testing the fourth hypothesis

After controlling for between-group differences at baseline, the intervention group will experience greater improvements in psychological outcomes (15 outcomes: Self-esteem, self-esteem and relationship, body esteem, depression, anxiety, stress, physical functioning, role limitation due to physical health problem, role limitation due to emotional problem, vitality, mental health, social functioning, bodily pain, general health, health transition) at 6 weeks and 12 weeks compared to the control group**.**

Intervention effects were tested for 15 psychological measures: Self-esteem, self-esteem and relationship, body esteem, depression, anxiety, stress, physical functioning, role limitation due to physical health problem, role limitation due to emotional problem, vitality, mental health, social functioning, bodily pain, general health, and health transition. Means (*SD*s and ranges) for these outcomes are reported in Table 4.3.4.

Table 4.3.4 Descriptive statistics (Means, SDs, and Ranges) for the psychological measures, for each group across the three assessments

	Week 0			Week 6			Week 12		
	n	Mean	*SD*	*n*	Mean	*SD*	*n*	Mean	*SD*
Self-esteem									
• Intervention	26	29.38	6.38	24	32.63	4.34	24	34.08	5.80
• Control	27	28.48	5.51	25	28.72	4.56	23	31.26	5.04
Self-esteem and Relationship									
• Intervention	26	49.81	9.99	24	57.62	8.56	24	61.42	8.27
• Control	27	45.89	12.42	25	47.08	10.53	23	51.04	11.21
Body-esteem									
• Intervention	26	70.77	14.80	24	78.54	14.68	24	81.92	14.51
• Control	27	67.22	14.85	25	72.72	14.60	23	78	15.28
Depression									
• Intervention	26	5.38	4.80	24	2.25	2.09	24	1.67	2.28
• Control	27	5.15	4.25	25	4.20	3.84	23	3.83	3.89
Anxiety									
• Intervention	26	4.27	4.09	24	2.21	2.59	24	1.46	1.69

• Control	27	5.19	3.51	25	4.04	3.56	23	2.78	3.30
Stress									
• Intervention	26	6.65	4.26	24	4.08	3.16	24	3.33	3.60
• Control	27	6.33	4.70	25	5.56	3.84	23	2.78	3.30
Physical functioning									
• Intervention	26	64.42	27.54	24	81.67	26.93	24	93.77	8.87
• Control	27	66.85	26.50	25	67.20	31.62	23	78.91	28.68
Role limitations due to physical problems									
• Intervention	26	70.19	22.24	24	82.29	16.03	24	86.72	14.07
• Control	27	74.30	22.75	25	68.50	21.46	23	82.88	14.62
Role limitations due to emotional problems									
• Intervention	26	66.99	24.77	24	81.60	17.72	24	84.72	18
• Control	27	74.38	20.14	25	68.67	22.98	23	79.71	12.26
Vitality									
• Intervention	26	57.45	16.40	24	69.01	12.29	24	75.52	18.42

• Control	27	54.17	18.01	25	60	13.62	23	68.21	16.95
Perceived mental health									
• Intervention	26	64.81	18.68	24	78.96	11.70	24	83.33	14.19
• Control	27	67.41	15.40	25	69.60	15.34	23	72.39	16.16
Social functioning									
• Intervention	26	69.71	24.79	24	81.77	16.88	24	88.54	13.25
• Control	27	69.44	24.35	25	69	20.45	23	77.17	18.71
Bodily pain									
• Intervention	26	72.69	19.26	24	84.89	16.47	24	84.48	16.61
• Control	27	69.81	21.57	25	66.20	20.78	23	80.98	19.87
General health perceptions									
• Intervention	26	60.96	21.07	24	75.41	16.21	24	77.08	16.67
• Control	27	56.48	19.65	25	58.40	15.92	23	71.08	18.40
Health transition									
• Intervention	26	59.61	17.43	24	71.87	22.50	24	85.42	20.74
• Control	27	50.92	12.94	25	56	20.77	23	68.48	20.25

After controlling for differences between the intervention and control group on the psychological outcomes at baseline, the intervention group had significantly higher outcome scores than the control group at 6 weeks for 11 of the 15 outcomes: Self-esteem (F[1,46] = 10.19, p = .003), self-esteem and relationship (F[1,46] = 13.17, p = .001), depression (F[1,46] = 8.673, p = .005), physical functioning (F[1,46] = 4.464, p =.040), role limitation due to physical health problem (F[1,46] = 9.833, p = .003), role limitation due to emotional health problem (F[1,46] = 7.675, p = .008), vitality (F[1,46] = 5.958, p = .019), mental health (F[1,46] = 9.914, p = .003), social functioning (F[1,46] = 9.109, p = .004), bodily pain (F[1,46] = 11.792, p = .001) and general health (F[1,46] = 14.183, p < .004). No other effect was significant at 6 weeks; Body esteem (F[1,46] = 0.68, p = .416), anxiety (F[1,46] = 3.538, p = .066), stress (F[1,46] = 3.471, p = .069), health transition (F[1,46] = 2.721, p = .106). After controlling for the inflated familywise error rate associated with testing 15 outcomes, however, only two intervention effects remained significant: Self-esteem and relationship, bodily pain (ps < .003)

After controlling for differences between the intervention and control group on the psychological outcomes at baseline, the intervention group had significantly higher outcome scores than the control group at 12 weeks for 6 of the 15 outcomes: Self-esteem and relationship (F[1,44] = 11.20, p = .002), depression (F[1,44] = 7.179, p = .01), physical functioning (F[1,44] = 6.981, p = .011), mental health (F[1,44] = 7.614, p = .008), social functioning (F[1,44] = 6.068, p = .018) and health transition (F[1,44] = 5.878, p = .020). No other effect was significant: Self-esteem (F[1,44] = 2.42, p = .127), body esteem (F[1,44] = 0.098, p = .756), anxiety (F[1,44] = 2.533, p = .119), stress (F[1,44] = 2.107, p = .154), role limitation due to physical health problem (F[1,44] = 1.203, p = .279), role limitation due to emotional health problem (F[1,44] = 2.968, p = .092), vitality (F[1,44] = 1.28, p = .264), bodily pain (F[1,44] = 0.160, p = .691), general health (F[1,44] = 0.716, p = .402). After controlling for the inflated familywise error rate associated with testing 15 outcomes, however, only one intervention effect remained significant: Self-esteem and relationship (p < .003).

The plot of the means for self-esteem and relationship (significant at both 6 and 12 weeks), and bodily pain (significant at 6 weeks) is presented in Figure 4.3.4 below.

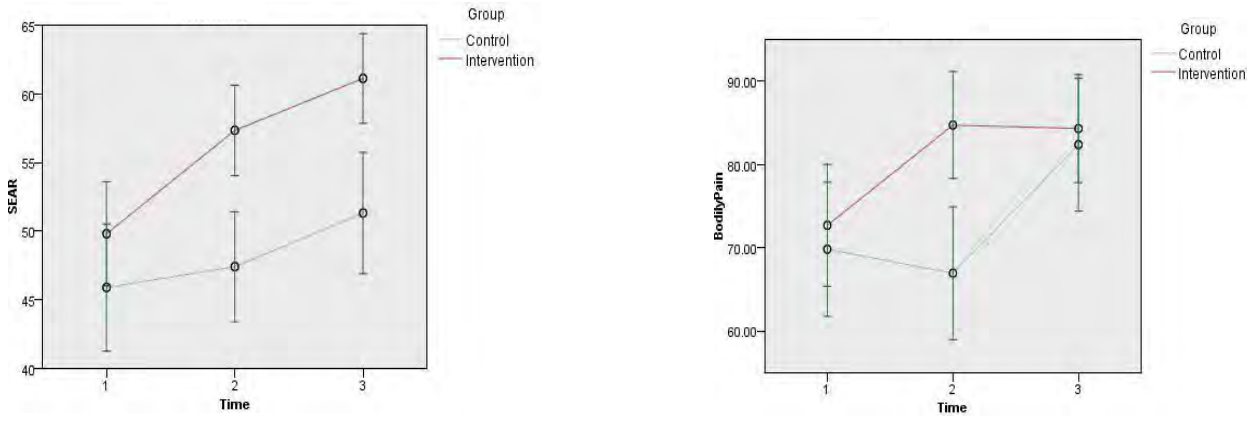


Figure 4.3.4. Mean SEAR scores (left plot) and mean bodily pain scores (right plot) across time for intervention and control groups

4.3.5 Testing the fifth and sixth hypotheses

The impact of the intervention on sexual functioning will be mediated by improvements in physiological and psychological outcomes**.**

This section attempts to determine whether any of the physiological or psychological variables mediated the effects of the intervention on sexual functioning. In order to reliably test for mediation effects, the mediation model should be longitudinal. This means that the proposed mediator should be assessed at 6 weeks while the sexual functioning measure should be assessed at 12 weeks.

The physiological variables cannot mediate intervention effects because they themselves were not affected by the intervention at 6 weeks. After controlling for the inflated familywise error rate associated with testing 15 psychological variables, two of these variables showed intervention effects at 6 weeks: Self-esteem and Relationship (SEAR), and bodily pain. These variables were therefore potential mediators of the intervention effect on sexual functioning.

There were no significant intervention effects at 12 weeks for either of the two sexual functioning measures: IIEF ($F[1,44] = 3.691$, $p = .061$), MSFI ($F[1,44] = 3.854$, $p = .056$). Because these direct effects were 'borderline significant', however, an indirect intervention effect (i.e., a mediation effect via one of the two psychological measures) is still a viable proposition (Rucker et al., 2011). The IIEF and the MSFI were therefore combined into a single latent

variable measuring sexual functioning. The solution for this model, however, failed to converge. The IIEF and the MSFI were therefore subsequently tested in separate models (see Figure 4.3.5)

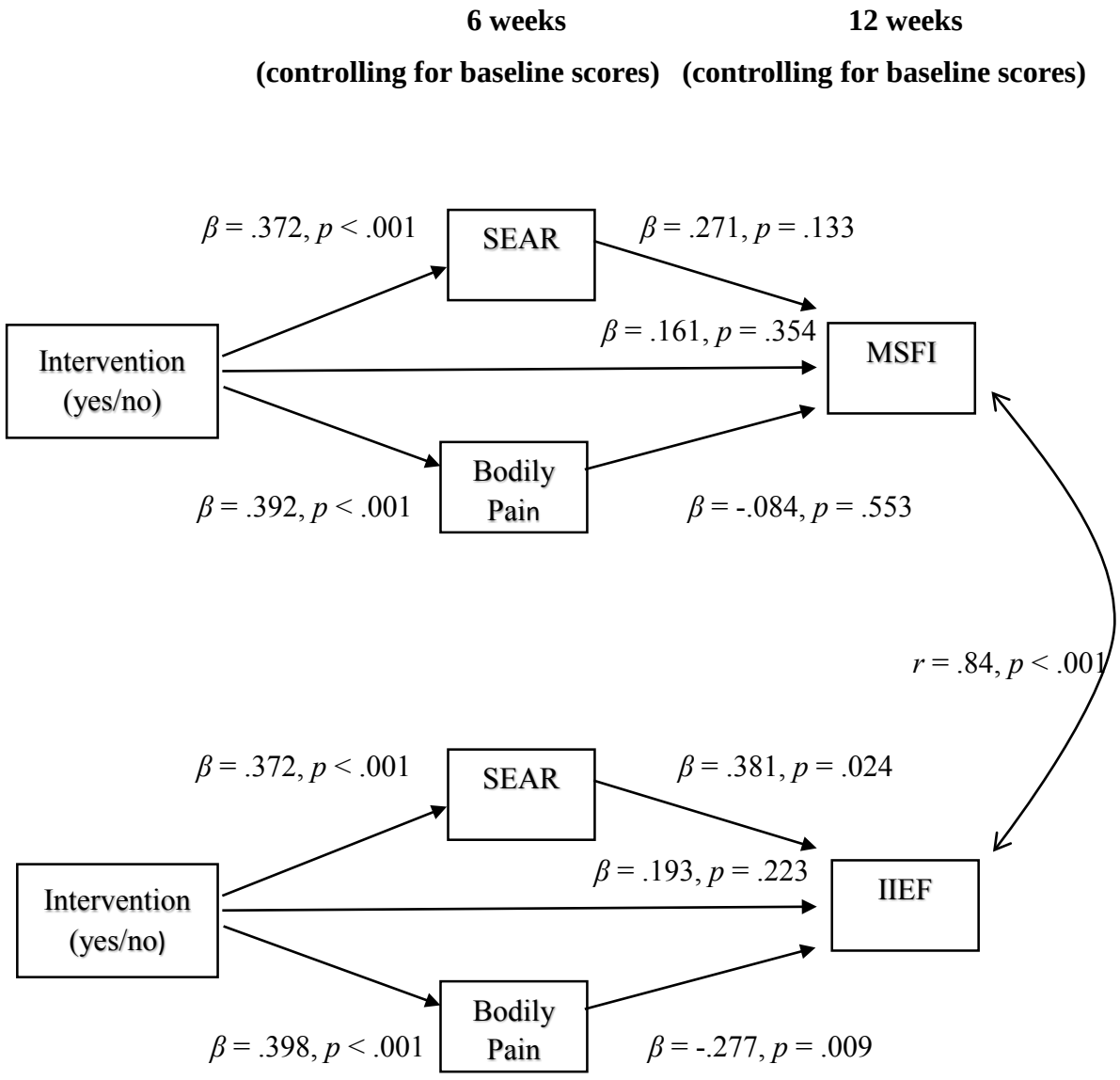


Figure 4.3.5. The path diagram of effects of physical activity on sexual functioning through psychological mediators, with path coefficients and associated *p*-values

4.3.6 Testing the mediators identified in Section 4.3.5

There were no significant mediation effects when sexual functioning was measured by the MSFI: The path coefficient for the indirect effect of the intervention on sexual functioning via SEAR was .101 (p = .146); the path coefficient for the indirect effect of the intervention on

sexual functioning via Bodily Pain was -.034 (p = .570). When sexual functioning was measured by the IIEF, however, there was a significant mediation effect: The path coefficient for the indirect effect of the intervention on sexual functioning via Bodily Pain was -.110 (p = .049). The intervention reduced bodily pain, which in turn increased sexual satisfaction. The IIEF was consistent with the MSFI in showing no indirect effect of the intervention on sexual functioning via SEAR (indirect effect = .141, p = .066). Differences in standard errors explain why an indirect effect of .141 was statistically non-significant whereas an indirect effect of .110 was statistically significant.

Note: The researcher collected BMI in three-time point of the study and looked at the effect of the intervention on BMI but there was no significant effect and there were not any differences between the two groups in week 0, 6 and 12. Therefore, it was not conducted as a mediator and not included in the hypotheses and only used in the study to determine the qualified participants and inclusion criteria.

CHAPTER 5

REVIEW OF FINDINGS AND DISCUSSION

Overview

This chapter briefly summarizes the study findings and discusses them in the context of the study hypotheses and the existing literature. This chapter also discusses other findings that, though not directly related to the research questions, are worthy of note. Finally, this chapter examines some of the study's implications for practice, theory and future research. The limitations of the study are also discussed.

Briefly, the current project was designed to determine the effect of increased physical activity on the sexual functioning of those who were overweight or obese. In addition, this study explored whether this relationship was mediated by changes in psychological factors such as self-esteem, depression, anxiety, stress, body image and overall health and/or physiological factors such as blood pressure, blood lipids, glucose and insulin. The results were arranged to answer the six hypotheses using the appropriate statistical approach.

In summary, as has already been discussed in chapter four, the intervention group engaged in more steps at week 6 and week 12 than the control group. In addition, after controlling for differences between the intervention and control group on the outcome measures at baseline, the intervention group had significantly higher scores than the control group at 6 weeks on the IIEF and the MSFI. Still, there were no significant between-group differences at 12 weeks for either the IIEF or the MSFI. The intervention group also had higher scores at 6 weeks for erectile function and overall satisfaction in IIEF, and erectile function, sexual satisfaction and ejaculatory function in MSFI. The significant results for erectile function and sexual satisfaction are in accord with the significant results observed for the corresponding IIEF domains. No other between-group difference was significant in either IIEF or MSFI. Moving on to the physiological and psychological outcome measures, there was only one significant between-group difference at 12 weeks in which the intervention group showed a significant reduction in diastolic blood pressure in physiological variables, and higher outcome scores in self-esteem, self-esteem and relationship, depression, physical functioning, role limitation due to a physical health problems, role limitation due to emotional health problems, vitality, mental health, social

functioning, bodily pain and general health at week 6, and higher outcome scores in self-esteem and relationship, depression, physical functioning, mental health, social functioning and health transition at week 12 than the control group. No other effect was significant. As was pointed out in the previous chapter, the physiological variables could not mediate intervention effects because they were not affected by the intervention at 6 weeks, Still, only self-esteem and relationship (SEAR) and bodily pain in psychological variables were potential mediators of the intervention effect on sexual functioning.

The findings are now examined and discussed in closer detail, hypothesis by hypothesis.

5.1 Hypothesis One. Summary of findings and discussions.

The initial hypothesis of this research was that the intervention group were engaged in a higher level of physical activity at week 6 and 12 compared to the control group. It was an important preliminary hypothesis to do to check that the experimental manipulation had an effect on the variable we wanted it to affect. Participants in both the intervention and the control groups wore a Fitbit and were encouraged to initially set small achievable goals like 10 minutes walks a day for the first two weeks and gradually increase the walking goals each week to reach the goal of at least 30 min/day or even more. However, the males in the intervention group accumulated significantly more total steps/day when instructed to walk 10,000 steps per day after 12 weeks. Moreover, participants in the intervention group significantly increased their walking at 12 weeks compared to baseline. As Fitbit was user-friendly and participants were motivated to walk, all the participants increased their steps. Still, the average step goal for participants in the intervention group was significantly higher than the control group in week 6 (M=9781.77 vs M=6261.31, respectively) and 12 (M=9771.41 vs 5970.12, respectively). Therefore, a 10,000- step goal and immediate feedback from using Fitbit effectively increased physical activity levels in low-active overweight and obese men. Thus, the findings of this study indicated that the intervention group engaged in significantly more steps at 6 and 12 weeks than the control group. The integrity of the intervention is therefore established. These findings are align with the previous research (Pal et al., 2011; Petri, 2016).

The World Health Organization (World Health Organization: Global Strategy on Diet) indicates that physical inactivity is related to 1.9 million deaths annually. The research found that low physical activity levels and access to energy-rich foods increase the population's risk

of overweight or obesity (Anderson et al., 2009). Therefore, physical activity has many health benefits, including improved in psychological well-being and decreased risk factors associated with obesity (Dunstan et al., 1998; Foreyt et al., 1995; Kruk, 2007; Mihalko & McAuley, 1996; Moreau et al., 2001). Consistent with the current study, the efficacy of having a step goal and using step counts such as Fitbit has been demonstrated in previous studies. They have shown that physical activity can be increased through the daily use of pedometers (Bravata et al., 2007).

Previous research confirms that pedometer step counts can motivate people to increase their physical activity by raising awareness of their current walking behaviours (Blamey & Mutrie, 2004; Rooney et al., 2003). A recent intervention study also showed that activity checkers such as Fitbit can help individuals increase their physical activity (Eysenbach et al., 2018). Shook et al. (2015) have found that individuals with high levels of physical activity had lower levels of cravings for foods than those with low levels of physical activity. Furthermore, the authors mentioned that physical activity with 7116 steps per day is related to energy balance. In addition, the four-week study conducted by Hultquist et al. (2005) compared the number of steps by participants instructed to walk 10,000 steps/day with other group walking for 30 min/day when they have given a step count device such as a pedometer. This study showed after four weeks of intervention, the 10,000 steps group averaged 10,159±292 steps/day, whereas the 30 minutes group accumulated an average of 8270±354 steps/day. In a meta-analysis study by Bravata et al. (2007) on using a pedometer, it was revealed that participants who had a step goal and were able to see their daily steps were able to increase physical activity levels compared to those who did not have a step goal. The first group in this study took an average of 2491 more steps /day compared to the second group. They also found that the first group had an average increase of around 27% compared to baseline levels. Pal et al. (2009) examined whether the daily use of step measurements such as a pedometer could increase physical activity and improve health outcomes in inactive females with overweight and obesity. In this 12-week study, the participants were randomly allocated into two groups of intervention who were given a pedometer with a step goal of 10,000 steps per day and the control group with a sealed pedometer. The intervention group were asked to record the number of steps per day. The results showed that the intervention group increased their number of steps/day by 36% at the end of the week, whereas the control group remained unchanged. Using a step measurement tool with immediate feedback may be a significant motivational factor for increasing physical activity.

5.2 Hypothesis Two. Summary of findings and discussions.

The second hypothesis in this study determined that the intervention group would experience greater improvements in sexual functioning (IIEF and MSFI total scores and their subscale scores) at week 6 and 12 compared to the control group. Related to this hypothesis, the findings showed that the intervention group experienced more significant improvements in sexual functioning compared to the control group.

The results of this study indicated that after controlling for differences between the intervention and control group on the outcome measure at baseline, the intervention group had significantly higher outcome scores than the control group at 6 weeks for total IIEF and MSFI. Erectile function and sexual satisfaction were significant at 6 weeks among five domains of IIEF, while among MSFI domains, erectile function, ejaculatory function, and sexual satisfaction were significant at 6 weeks. Sexual satisfaction only was a substantial factor in 12 weeks, comparing the intervention group with the control group.

A body of research has shown that being overweight or obese has been reported as one of the significant factors that impact the sexual functioning of both men and women negatively (Adolfsson et al., 2004; Esposito, Giugliano, Ciotola, De Sio, et al., 2008) and indicated a strong relationship between obesity and ED in men (Moore et al., 2013; Reis et al., 2010). On the other hand, the relationship between weight loss (through surgery, medication and diet) and sexual functioning in obese and overweight individuals have been indicated in several studies (Khoo et al., 2011; Thonney et al., 2010) and shown that obese and overweight individuals reported better sexual functioning after weight loss (Moore et al., 2013; Mora et al., 2013). The present study's findings showed that erectile function as one of the IIEF and MSFI domains was improving in the intervention group compared to the control one.

This finding corroborates previous studies regarding the role of physical activity in sexual functioning (Jiannine, 2018; White et al., 1990b). Laumann et al. (1999) found that increased physical activity is associated with a lower risk of erectile dysfunction. Also, Derby et al. (2000) have demonstrated that physically active men were at a 30% lower risk for developing ED than sedentary men, and a high amount of physical activity was independently associated with a lower risk of incident ED. The highest risk of developing ED was among men who remained sedentary and the lowest among those who remained active or initiated physical

activity during this time. Therefore, it seems that both ED and obesity are related to physical inactivity and hypothesized that blood flow could be increased by physical activity and improved lipid profile and affected the penile vasculature (Derby et al., 2000; White et al., 1990a). Additionally, in a study conducted by Janiszewski et al. (2009), 3941 adult males with the age of ≥20 years participated in assessing the relationship between physical activity and the relative odds of erectile dysfunction. Physical activity levels were divided into three categories of inactive (<30 min/week), moderately active (30-149 min/week), and active (≥150 min/week). The logistic regression results showed that active males had approximately 40-60% less odds of erectile dysfunction than inactive or moderately active males. The logistic regression model also showed that physical activity level was independently associated with higher odds of erectile dysfunction. The maintenance of proper erectile function is related to moderate-intensity physical activity (≥150 min/week).

Moreover, the findings have indicated that sexual satisfaction as one of the sexual functioning domains is associated with physical activity in the intervention group compared with the control group. This finding confirms the results of some previous studies. Werlinger et al. (1997) found that weight loss significantly increased sexual satisfaction and the overall perception of sexual functioning. In addition, Kolotkin et al. (2012) demonstrated that perceived sexual satisfaction increased dramatically after weight loss in obese individuals.

5.3 Hypothesis Three. Summary of findings and discussions

Hypothesis three determined that the intervention group would experience greater improvements in physiological outcomes (DBP, SBP, TC, TG, LDL, HDL, Glu, and Insulin) at week 6 and week 12 compared to the control group. To test this hypothesis, the relation between the physical activity and physiological variables (DBP, SBP, TC, TG, LDL, HDL, Glu and Insulin) were assessed between the intervention group and the control group. The findings indicated that there was only one significant reduction (in diastolic blood pressure) in the intervention group compared to the control group at 12 weeks.

In this study, participants in both the intervention and control groups increased their daily step counts by the end of the 12-week intervention period. In weight management, the intervention group can promote healthy behaviour change; however, research has shown that 10,000 steps/day is not sufficient to achieve weight loss (Saris et al., 2003). Neither group in the

present study lost weight during the intervention; therefore, these findings are consistent with previous research.

In terms of MS risk factors, this study found no changes in systolic blood pressure. However, there was a significant improvement in diastolic blood pressure in the intervention group after 12 weeks compared to the control group. As there were no significant changes to dietary intake in the intervention group at 6 or 12 weeks, it would be reasonable to conclude that improvements in diastolic blood pressure are due to increased physical activity in this group. This study's findings are consistent with other studies reporting that both short-term and long-term physical activity reduces blood pressure over time. In a meta-analysis of 26 studies (8 randomized control trials and 18 observational studies), intervention participants who had increased their steps (in randomized control trial studies by 2491 steps/day and observational studies by 2183 steps/day) had a statistically significant reduction in diastolic blood pressure of 0.3 mmHg (and systolic blood pressure of 3.8 mmHg) (Bravata et al., 2007). This reduction in diastolic blood pressure was an independent decrease in BMI. Similarly, a meta-analysis including 54 randomized controlled trials with 2419 participants demonstrated a significant reduction in diastolic blood pressure associated with aerobic exercise [-2.58(-3.35 to -1.81)], and systolic blood pressure [-3.84(-4.97 to -2.72)] (Whelton et al., 2002). Another 12-week study was conducted with overweight and obese individuals with or without hypertension in 4 groups of no exercise (control), moderate-intensity aerobic (30 min on a treadmill), resistance or combination (15 min of aerobic and 15 min of resistance) exercise training, five days/w did not show any changes on blood pressure levels when evaluating all participants in the study; however, in a subgroup of participants improving their SBP significantly, SBP has been reduced in all groups at week eight compared to baseline (aerobic: -4%, $p<0.027$; resistance: -5.1%, $p<0.04$; combination: -6.3%, $p<0.0001$). Moreover, the combination exercise group significantly decreased SBP (-6.3%, $p<0.005$) at 12 weeks compared to baseline (Ho et al., 2012).

As far as the effect of physical activity on blood lipids is concerned, previous studies have produced conflicting results. For example, some studies suggest an overall beneficial effect of physical activity on HDL and triglyceride levels but no consistent effect on total cholesterol or LDL levels (Australian Government, 2014; Henriksen, 2002; Ibanez et al., 2005; Kannan et al., 2014; Mainous et al., 2017; Thompson et al., 2001). One observational study containing 1331 individuals between 18 to 70 years old had reported no statistically significant associations between any intensity level of physical activity or sedentary behaviour and TC, HDL, LDL and

TG levels (all $p < .05$; adjusted for age, education and gender) (Crichton & Alkerwi, 2015). On the other hand, two other studies found physical activity did not affect lipid and lipoprotein levels (McMurray et al., 1995; Zonderland et al., 1990). Therefore, the results of the present study correspond well with the latter studies in such a way that increasing physical activity had no effect on TC, HDL, LDL or TG levels over the 12-week intervention period. This may be due to the short intervention period, as some studies have shown that increasing physical activity for a longer duration can improve blood lipids (Zonderland et al., 1990). It may also be because a physical activity program is less effective than one that includes dietary modifications for weight loss, as shown in other studies (Zonderland et al., 1990).

Concerning blood glucose and insulin, the results of the current study found that increasing physical activity did not significantly improve either of these outcome measures; however, these results are not in agreement with the other reports that might be the result of the short time of the current study. Previous research has shown increasing physical activity improves fasting serum glucose and insulin levels (Houmard et al., 2004; Shaw et al., 2006). A randomized controlled trial with older adults with obesity (n=136) reported an improved glucose uptake rate in the aerobic exercise group (6.5±1.27 M/I) compared to the control group (0.29±1.59 MI) over the 6-month intervention period (Davidson et al., 2009). Similarly, Hersey et al. (1994) conducted a 6-month randomized controlled trial with 52 adults aged 70-79 years. They reported that physical activity decreased plasma glucose concentration in the intervention group (178±43 vs. 166±54) compared to the control condition (138±27 vs 159±35) at baseline and 6-month period, respectively.

5.4 Hypothesis Four. Summary of findings and discussions

The fourth hypothesis determined that the intervention group would experience greater improvements in psychological outcomes (self-esteem, self-esteem and relationship, body esteem, depression, anxiety, stress, physical functioning, role limitation due to physical health problems, role limitation due to emotional problems, vitality, mental health, social functioning, bodily pain, general health, health transition) at week 6 and 12 compared to the control group.

With this hypothesis, the findings determined that the intervention group experienced more significant improvements in psychological outcomes. The results of this study indicated that the intervention group had significantly improved outcome scores than the control group at 6

weeks for self-esteem, self-esteem and relationship, depression, physical functioning, role limitation due to physical health problems, role limitation due to emotional health problems, vitality, mental health, social functioning, bodily pain and general health. In addition, there were significant differences between the intervention and control group at 12 weeks for self-esteem and relationship, depression, physical functioning, mental health, social functioning and health transition.

After controlling for differences between the intervention and control group on the outcome measure at baseline, the participants in the intervention group had significantly higher self-esteem and SEAR symptoms, lower depression symptoms and improved general health after 6 -week intervention. In addition, the intervention group had significantly higher SEAR symptoms, lower depression symptoms and improvement in some general health domains at 12 weeks. The significant Time × Group interaction effect suggests that men who received the intervention had a significantly greater reduction in depression symptoms, higher levels of improvement in self-esteem and SEAR and general health from baseline to 6 weeks compared to men in the control group. Furthermore, this improvement was maintained at the 12-week time of the intervention for depression, SEAR and some general health domains.

Results indicated that physical activity significantly directly affects depression, self-esteem, SEAR, and general health. This finding corroborates previous studies regarding the role of physical activity in mental health. Some studies have demonstrated that exercise and physical activity can effectively improve mental well-being, mainly through improved mood and self-esteem (Fox, 1999). Paffenbarger et al. (1994) showed that men who engaged in high physical activity reduced the risk of becoming depressed by 28% and moderate activity by 17%, compared with men with low physical activity. Indeed, Graft and Landers (1998) conducted a meta-analysis regarding the role of exercise therapy for clinical depression. They found that physical activity is associated with decreased risk of developing clinical depression, and was effective in treating depression.

Moreover, some studies revealed the impact of exercise and physical activity on self-esteem (Spence et al., 2005). Fox (1999) indicated positive changes in self-esteem through physical activity in randomized controlled studies. Then, it is shown that people's perceptions of their physical self can be changed by exercise and physical activity in a positive way (Fox, 1999). On the other hand, research showed that weight loss by exercise or physical activity is

associated with improving quality of life and general health (Fontaine et al., 1999). The study by Fontaine (1999) has shown that among eight domains of general health in the health survey (SF-36), vitality, general health perception and role-physical had the largest increase after weight loss. Similarly, in a study by Oh et al. (2017), 7550 Korean subjects suffering from metabolic syndrome participated in assessing the association between different types of exercise and quality of life. In their study, resistance training, flexibility and walking on the quality of life subscales were compared. The results showed that all exercise types improved the quality of life in those who did exercise compared to those who did not. Therefore, the present study's finding was in line with the previous research on the effect of physical activity on psychological factors.

5.5 Hypothesis Five. Summary of findings and discussions

Hypothesis five determined that improvements in physiological outcomes would mediate the impact of the intervention on sexual functioning. In this hypothesis, the effect of the intervention on sexual functioning was assessed by improvements in physiological outcomes. Therefore, this hypothesis aims to evaluate the association between MS risk factors and sexual function. There is a well-recognized correlation between MS and sexual dysfunction (Chughtai et al., 2011; Esposito et al., 2005); having both conditions can substantially impact the well-being of those affected. Therefore, the current analysis was to determine the association between MS risk factors [systolic and diastolic blood pressure] and sexual dysfunction in this sample of sedentary males with overweight and obesity.

Concerning blood pressure, the results of the present study showed that a change in diastolic blood pressure was not associated with a change in sexual function. However, the outcome results regarding the relationship between diastolic blood pressure and erectile function would appear to be somewhat inconsistent. The results of a cross-sectional study with 45-70- year-old healthy men showed the U-shape relationship between diastolic blood pressure and the prevalence of erectile dysfunction with the lowest point of 90mm Hg (Heikkila et al., 2017). In another study with more than 3000 participants, Spatz et al. (2013) found no association between treated hypertension and sexual activity [OR=0.86 (0.51-1.45)] and no significant relationship between treated hypertension and sexual problems [OR=1.49 (0.94-2.37)]. Our finding reflects those of Spatz et al. (2013), as there was no significant relationship between blood pressure and sexual function, but they are in contrast to several other reports (Doumas et

al., 2006; Duncan et al., 1997). The latter studies prove that overall blood pressure can be independently associated with sexual function.

Epidemiological investigations in general populations have revealed a close association between hyperlipidaemia and sexual dysfunction (Esposito et al., 2004; Howell et al., 2003). In a prospective study of 3,250 men (Wei & Macera, 1995) ranging from 26 to 83 years of age and without erectile dysfunction at their first examination, both TC and HDL were found to be strongly predictive of the onset of erectile dysfunction after controlling for age, T2D, stress level, CVD, and prostate disease. The results obtained in the present investigation disagree with those observed in previous studies supporting associations between lipid profile and sexual activity or function among individuals in the general population.

5.6 Hypothesis Six. Summary of findings and discussions

In the sixth hypothesis, the impact of the intervention on sexual functioning was mediated by improvements in psychological outcomes. With this hypothesis, findings indicated that physical activity during daily life impacts sexual functioning by improving some psychological factors in overweight and obese males. This finding corroborates the results of previous studies (Efthymiou et al., 2015; Glina et al., 2013; Strain et al., 2014). Some research indicated the relationship between weight loss, sexual functioning, and mental health. Strain et al. (2014) examined changes in BMI along with self-reported health and the impact of weight-related quality of life and depression in 105 bariatric surgery patients approximately two years after surgery. More specifically, Efthymiou et al. (2015) explored changes to BMI, sexual functioning (IIEF and FSFI), and health-related quality of life at four time points in the first year after bariatric surgery in 80 adults with obesity. BMI improved significantly along with all components of sexual functioning, except for male orgasm, and all health-related quality of life sub-scales (Efthymiou et al., 2015). A review by Glina et al. (2013) investigating modifiable risk factors to treat and prevent erectile dysfunction concluded that weight loss might improve erection functioning, either by increasing testosterone, reducing inflammation, or by enhancing self-esteem and mood, in men without comorbidities; however, co-existing conditions such as depression, diabetes, and hypertension may require additional treatments. As well as enhancing mental well-being, reductions in body weight appear to improve sexual functioning in individuals with obesity (Assimakopoulos et al., 2011; Dymek et al., 2002; Kolotkin et al., 2008; Mamplekou et al., 2005). Assimakopoulos et al. (2011) indicated that a

significant decrease in BMI was associated with a reduction in depression, and improved sexual functioning.

5.7 Implications

Over the past decade, obese and overweight people have been suffering from obesity-related health issues and reported difficulties in their sexual functioning due to obesity, more report in metabolic syndrome risk factors and psychological functioning such as high depression symptoms and low quality of general health. Anticipated improvements in this area motivate individuals to pursue treatment. Few studies explored the sexual functioning difficulties that sedentary obese individuals have. Some of these difficulties may result from the presence of obesity-related comorbidities such as hypertension, high blood pressure and type 2 diabetes, as well as dissatisfaction with depression, body image and general health. Therefore, assessing the relationship between physical activity and sexual functioning in both men and women is a good idea.

Moreover, findings from the present study confirm the need for further consideration of poor sexual functioning as a significant health problem among overweight and obese men who have experienced physiological and psychological health issues. As a sensitive topic, it is essential to train people in sexuality and sexual function and increase their awareness to be more comfortable expressing their sexual issues. The intervention may provide health professionals, psychologists, sex therapists, sex educators, sex counsellors etc. with a means of helping obese and overweight individuals who are facing sexual difficulties in their life.

The results of this study may demonstrate portable fitness devices such as Fitbit to be good health promotion tools, as they are cheap, accessible and easy to use. Activity checkers such as Fitbit is an effective tool for increasing physical activity. Therefore, health professionals may be encouraged to recommend this device as a health improvement tool. Fitbit is a user-friendly device that enables users to set step goals and provides constant reminders of them. Therefore, it can be a good tool for sedentary individuals encouraging them to adopt a more active lifestyle. Additionally, users can challenge friends and motivate each other. Furthermore, Fitbit can connect users with other users to create a network, thus providing further avenues for individuals to encourage each other. Alternatively, Fitbit users may be motivated to walk more to improve their sexual functioning and their intimate relationships.

This study highlights the fact that sexual functioning in sedentary overweight and obese men who have experienced metabolic syndrome risk factors and psychological issues has been understudied. Due to the lack of research in this area, future studies would be needed to explore further the risk factors associated with obesity and inactivity.

This study would have benefited from additional information that was missing due to time limitations. Conducting interviews with participants would be a valuable way to gain insight into the factors that contribute to any improvements in sexual functioning. This could help identify specific strategies that were effective, and provide insights into how to optimize interventions for individuals with obesity and overweight. The researcher also did not have time to interview the participants' partner to get any information on whether partners regard themselves or the participants as sexually active.

Further research should consider other aspects of one's life which could directly or indirectly affect sexual functioning.

Given the study's findings, further studies, which take these variables into account, will need to be undertaken to compare men and women with overweight and obesity and how the discussed possible mediating factors impact their sexual functioning. It is hoped that current research findings will help inform clinical practice and motivate future research studies in the area of inactivity, obesity and sexual health.

5.8 Limitations

Although this study makes an essential contribution to the literature on overweight and sexual functioning, it also has some limitations. First and foremost is that the study was concise- just 12 weeks. In addition, the smaller than anticipated sample size makes it more challenging to determine the nature of the significant relationship between all of the variables in the study, and this might present a potential type- 1 error. Still, possibly the results from the psychometric measurements on our participants are almost similar with other studies. For an 80% power sample, 96 participants were required to divide into each group, but we needed help to achieve this number. Therefore, the results of this analysis may not be generalizable to the majority of men with overweight and obesity and sexual dysfunction.

Besides, people may have declined to participate because of the topic, and there are some reasons why the sample size was small. First, they may need clarification what they are expected to do and think they are spending their time in aimless energy expenditure. Second, they may have little experience working with others in a group and may need special attention. Third, they may fail to participate as they may have been overloaded or overworked, and they don't have insufficient time to exercise. Fourth, people may not have enough trust in others to keep their information secure. Fifth, needles and repeated blood tests likely cause scarring for some individuals. Sixth, people may not see the rewards resulting from participation. Finally, as the project was to do physical activity, they may be inconvenienced with exercise, have no self-motivation to exercise, have low self-efficacy and no enjoyment of being physically active and also lack self-management skills to set personal goals for themselves.

Furthermore, the participants in the intervention group were asked to take 10,000 steps/day, but they took fewer steps than expected. This weakness limits the generalizability of the results. In addition, the methodology used in this study allowed us to examine the effect of feedback on activity levels that we were interested, and it was our H1 – a preliminary, foundational hypothesis for our research. Multiple groups with different step levels would have demanded a larger overall sample size. The changing-criterion design would have involved a more comprehensive study, with a greater risk of high dropout rates. Therefore, it would be an excellent possibility to have a different plan with a large sample size in a future study.

There have been identified barriers to assessing the sexual functioning of men, such as lack of awareness and participants' discomfort around this sensitive topic. Also, there was an absence of any focus on what this meant for the sex lives of their partners. Therefore, this study could not be generalized across both genders, as all the participants in the study were men. Therefore, future research should be conducted to better present both men and women.

Other studies suggest that sexual minority individuals are more vulnerable to specific sexual difficulties than heterosexual groups. One potential reason for excluding homosexual groups from my study is to minimize variability in the sample. By focusing on a single group of participants, I could control for potential confounds that may be introduced by differences between groups. For example, sexual orientation is associated with differences in sexual behaviour, partner preferences, and other factors that could potentially impact sexual

functioning or other outcomes of interest. By excluding homosexual men from the sample, I could reduce the variability in these factors and increase the internal validity of my findings.

However, it's worth noting that excluding certain groups from a study may also limit the generalizability of the findings Therefore, the collected data in this research was only from heterosexual people and further research is needed to examine both groups involved in homosexual and heterosexual relationships.

Participants in this study were not offered the opportunity to be interviewed to speak about their experience. Sexual behaviour and attitudes are often subject to social norms and taboos that may make it difficult for participants to disclose information about their experiences. This can be particularly true in cultures or communities where sexuality is a sensitive or taboo topic. Participants may hesitant and feel uncomfortable to disclose intimate details and sensitive experience about their sexual relationship with the researcher face to face, especially, if they feel that their responses could be linked back to them personally. One reason could be the opposite sex of participants and the researcher, which makes it more difficult. Doing an interview requires a schedule and thorough knowledge, techniques and methods of asking questions, and appropriate responses such as empathy which affects the quality of information obtained and was time-consuming, which was out of the scope of this study. Future research is recommended to do interviews considering all the appropriate structured methods.

In addition, using data based on self-reported questionnaires may have introduced bias to the results, and there was not any control over the response of the subjects in the total sample. Sexual dysfunction is considered as a sensitive subject, socially and culturally, particularly for men. Some participants in this study may have moderated their responses to make their situation seem better or worse, or they may have underreported the severity of the problem. Furthermore, we did not assess the participants for a probable diagnosis of sexual dysfunction, so it is suggested that future research consider this.

Moreover, obesity, metabolic syndrome and sexual dysfunction are all complex, multi-factorial disorders. As such, it wasn’t easy to control for the many potential confounding variables that may arise and obscure the results in a study of this nature. The researcher was dependent on the people’s honesty and was not sure if any of the participants were taking some medication,

such as Viagra, during the study and did not also collect any data on food that might affect their sexual activity, and future research should collect such information. Additionally, the participants in this research were heterosexual men, and future research should be conducted to include homosexual or transgender individuals.

Consequently, the language of the questionnaires and even during the study was English, excluding non-English speaking men. Moreover, the participants were asked to complete the questionnaires online excluding those who did not have access to an online system such as a computer or smartphone or were computer illiterate.

Besides what has been mentioned, the participants were supposed to continue their daily steps for a 3-month follow-up. Still, changing seasons occurred during the clinical trial , representing barriers continuing with physical activity behaviour change faced in the actual trial, as discussed. Therefore, options such as indoor activities could be helpful interventions that should be considered for future research. As the rate of the dropout was too much in the intervention group after finishing 12 weeks as some participants had to leave Perth due to personal issues, some were not interested in continuing, and some did not follow the accurate structure of the study, the researcher ignored to use the data from the follow-up intervention. Finally, the lack of prior research studies on this topic was another limitation. Thus, it is recommended to do further research in this area.

5.9 Conclusions

Obesity is a growing public health concern worldwide. It is a risk factor for early mortality, greater morbidity, and chronic diseases such as heart disease, hypertension, stroke, type 2 diabetes, and metabolic syndrome, and it negatively impacts mental health (Cook et al., 2003; Lechleitner, 2008; McLaren et al., 2008; Weiss et al., 2004; Wit et al., 2010), and leads to poorer quality of life (Residori et al., 2003; Sturm & Wells, 2001). Moreover, being obese or sedentary has an adverse impact on the sexual functioning of both men and women due to their effects on psychological and physiological factors. Given that weight loss through diet modification or increasing physical activity may benefit these psychological and physiological factors, their sexual functioning may improve. Therefore, although both weight gain and a sedentary lifestyle have been associated with sexual dysfunction, there is little research investigating the associations between obesity and sexual functioning or physical activity and

sexual functioning. This is a major gap in the current literature and needs to be addressed before efficacious interventions for improving sexual functioning can be developed.

A growing body of research has shown the advantages and influence of physical activity in health promotion and improvements in physiological and psychological risk factors. Obesity and inactivity lifestyle share common risk factors with sexual functioning. A study suggests that obesity and physical inactivity are associated with sexual dysfunction (Derby et al., 2000). Weight gain and an inactivity lifestyle may result in a greater risk of sexual dysfunction. From a public health perspective, it is very crucial to identify these modifiable weights and physical inactivity- related correlates to prevent sexual dysfunction in men.

Physical activity has many health benefits, is vital in reducing the risk of severe health conditions, and can improve mental health regardless of its impact on weight (Li et al., 2014). While the use of physical activity in sedentary overweight/obese individuals is an emerging field of investigation, preliminary research suggests a relationship between physical activity and improved sexual functioning. Therefore, health researchers need to examine the effect of physical activity on the sexual functioning of overweight and obese individuals. In addition, there is an additional need to identify the possible mechanisms operating when physical activity impacts health in terms of physiological and psychological factors. Nonetheless, there has been a shortage of studies investigating the influence of physical activity on sexual functioning in obese and overweight individuals. Also, there have been no such studies examining the effectiveness of physical activity during daily life on sexual functioning by improving psychological conditions (depression, anxiety, stress, self-esteem, and body image) and physiological factors (blood pressure, lipids, glucose and insulin) in sedentary overweight/obese individuals. Therefore, interventions that aim to increase physical activity, and raise awareness of obesity and comorbidities with sexual functioning are necessary.

The current study was designed to determine the effectiveness of such an intervention, conducted over 12 weeks, by evaluating changes in metabolic syndrome risk factors and critical self-reported psychological outcome measures and sexual functioning.

Taken together, the information obtained from this study may enhance the awareness and knowledge of clinicians and practitioners and encourage them to motivate and train their clients

to be more physically active to improve their physiological and psychological well-being and consequently have a better sexual life.

References

Adolfsson, B., Elofsson, S., Rössner, S., & Undén, A.-l. (2004). Are sexual dissatisfaction and sexual abuse associated with obesity? A population-based study. *Obesity Research*, *12*(10), 1702-1709. https://doi.org/http://dx.doi.org/10.1038/oby.2004.211

Agnieszka, B., & Ehud, U. (2006). The Obesity epidemic and its cardiovascular consequences. *Clinica Trials*, *21*, 353-360.

Ahmed, A., Alnaama, A., Shams, K., & Salem, M. (2011). Prevalence and risk factors of erectile dysfunction among patients attending primary health care centres in Qatar/Prévalence du dysfonctionnement érectile et facteurs de risque chez les patients des centres de soins de santé primaires au Qatar. *Eastern Mediterranean Health Journal*, *17*(7), 587-592. https://doi.org/10.26719/2011.17.7.587

Akhondi, M. M., Dadkhah, A., Bagherpour, A., Ardakani, Z. B., Kamali, K., Binaafar, S., Kosari, H., & Ghorbani, B. (2011). Study of body image in fertile and infertile men. *Journal of Reproduction and Infertility*, *12*(4), 295-298.

Ali, S. (2010). Sildenafil citrate in the treatment of erectile dysfunction associated with hypertension. *Journal of Basic & Applied Sciences*, *6*(1), n/a.

American Diabetes Association, National Institute of Diabetes, Digestive and Kidney Diseases: The prevention or delay of type 2 diabetes (Position Statement). Diabetes Care 26 (Suppl. 1):S62–S69, 2003.

Andersen, I., Heitman, B. L., & Wagner, G. (2008). Obesity and Sexual Dysfunction in Younger Danish Men. *Journal of Sexual Medicine*, *5*(9), 2053-2060. https://doi.org/10.1111/j.1743-6109.2008.00920.x

Anderson, L. M., Quinn, T. A., Glanz, K., Ramirez, G., Kahwati, L. C., Johnson, D. B., Buchanan, L. R., Archer, W. R., Chattopadhyay, S., Kalra, G. P., & Katz, D. L. (2009). The effectiveness of worksite nutrition and physical activity interventions for controlling employee overweight and obesity: a systematic review. *Am J Prev Med*, *37*(4), 340-357. https://doi.org/10.1016/j.amepre.2009.07.003

Anonymous. (1993). National Institute of Health (NIH) Consensus Conference. Impotence: NIH Consensus Development Panel on Impotence. *JAMA*, *270(1)*, 83-90. https://doi.org/10.1001/jama.1993.03510010089036.

Ar, F.-M., Lodnert, G., Bränholm, I. B., & Ks, F.-M. (1997). On life satisfaction in male erectile dysfunction. *International Journal of Impotence Research*, *9*(3), 141. https://doi.org/10.1038/sj.ijir.3900269

Aranda, P., Ruilope, L. M., Calvo, C., Luque, M., Coca, A., & Gil De Miguel, Á. (2004). Erectile dysfunction in essential arterial hypertension and effects of sildenafil: results of a Spanish national study. *American Journal of Hypertension*, *17*(2), 139-145. https://doi.org/10.1016/j.amjhyper.2003.09.006

Aschkenazi, S., & Goldberg, R. (2009). Female sexual function and the pelvic floor. In (Vol. 4, pp. 165-178). London: Informa Healthcare.

Assimakopoulos, K., Karaivazoglou, K., Panayiotopoulos, S., Hyphantis, T., Iconomou, G., & Kalfarentzos, F. (2011). Bariatric surgery is associated with reduced depressive symptoms and better sexual function in obese female patients: A one-year follow-up study. *Obesity Surgery*, *21*(3), 362-366. https://doi.org/http://dx.doi.org/10.1007/s11695-010-0303-z

Atlantis, E., & Baker, M. (2008). Obesity effects on depression: systematic review of epidemiological studies. *International Journal of Obesity*, *32*(6), 881. https://doi.org/10.1038/ijo.2008.54

Australian Institute of Health and Welfare. (2012). *Canberra*.

Australian Institute of Health and Welfare. Chronic disease and associated risk factor in Australia, 2006. In: Australian Institute of Health and Welfare (ed). Australian Institute of Health and Welfare: Canberra, 2006. .

Awad, H., Salem, A., Gadalla, A., Wafa, N. A. E., & Mohamed, O. A. (2009). Erectile function in men with diabetes type 2: correlation with glycemic control. *International Journal of Impotence Research*, *22*(1), 36. https://doi.org/10.1038/ijir.2009.39

Bacon, C. G., Mittleman, M. A., Kawachi, I., Giovannucci, E., & et al. (2003). Sexual function in men older than 50 years of age: Results from the health professionals follow-up study. *Annals International Medicine*, *139*(3), 161-168. http://search.proquest.com/docview/222251287?accountid=10382 http://link.library.curtin.edu.au/openurl??url_ver=Z39.88-2004&rft_val_fmt=info:ofi/fmt:kev:mtx:journal&genre=article&sid=ProQ:ProQ%3Ahealthcompleteshell&atitle=Sexual+function+in+men+older+than+50+years+of+age%3A+Results+from+the+health+professionals+follow-up+study&title=Annals+of+Internal+Medicine&issn=00034819&date=2003-08-05&volume=139&issue=3&spage=161&au=Bacon%2C+Constance+G%3BMittleman%2C+Murray+A%3BKawachi%2C+Ichiro%3BGiovannucci%2C+Edward%3Bet+al&isbn=&jtitle=Annals+of+Internal+Medicine&btitle=&rft_id=info:eric/&rft_id=info:doi/

Barlow, D. H. (1986). Causes of Sexual Dysfunction: The Role of Anxiety and Cognitive Interference. *Journal of Consulting and Clinical Psychology*, *54*(2), 140-148. https://doi.org/10.1037/0022-006X.54.2.140

Basson, R. (2006). Sexual Desire and Arousal Disorders in Women. *The New England Journal of Medicine*, *354*(14), 1497-1506. https://doi.org/10.1056/NEJMcp050154

Biddle, S. (2016). Physical activity and mental health: evidence is growing. *World psychiatry : official journal of the World Psychiatric Association (WPA)*, *15*(2), 176-177. https://doi.org/10.1002/wps.20331

Biro, F., Striegel-Moore, R. H., Franko, D. L., Padgett, J., & Bean, J. (2006). Self-esteem in adolescent females. *Journal of Adolescent Health*, *39*(4), 501-507. https://doi.org/10.1016/j.jadohealth.2006.03.010

Blamey, A., & Mutrie, N. (2004). Changing the individual to promote health-enhancing physical activity: the difficulties of producing evidence and translating it into practice. *J Sports Sci*, *22*(8), 741-754. https://doi.org/10.1080/02640410410001712449

Blascovich, J., & Tomaka, J. (1993). Measures of Self-Esteem. *Pp. 115-160 in J.P. Robinson, P.R. Shaver, and L.S. Wrightsman (eds).*

Bleidorn, W., Arslan, R. C., Denissen, J. J. A., Rentfrow, P. J., Gebauer, J. E., Potter, J., & Gosling, S. D. (2016). Age and Gender Differences in Self-Esteem-A Cross-Cultural Window. *J Pers Soc Psychol*, *111*(3), 396-410. https://doi.org/10.1037/pspp0000078

Böhm, M., Baumhäkel, M., Probstfield, J. L., Schmieder, R., Yusuf, S., Zhao, F., & Koon, T. (2007). Sexual function, satisfaction, and association of erectile dysfunction with cardiovascular disease and risk factors in cardiovascular high-risk patients: Substudy of the ONgoing Telmisartan Alone and in Combination with Ramipril Global Endpoint Trial/Telmisartan Randomized AssessmeNT Study in ACE-INtolerant Subjects with Cardiovascular Disease (ONTARGET/TRANSCEND). *American Heart Journal*, *154*(1), 94-101. https://doi.org/http://dx.doi.org/10.1016/j.ahj.2007.03.024

Boyle, F. M., Cook, M. D., Purdie, D. M., Najman, J. M., & Dunne, M. P. (2003). Sexual dysfunction in the Australian population. *Australian Family Physician*, *32*(11), 951-954.

Bravata, D. M., Smith-Spangler, C., Sundaram, V., Gienger, A. L., Lin, N., Lewis, R., Stave, C. D., Olkin, I., & Sirard, J. R. (2007). Using Pedometers to Increase Physical Activity and Improve HealthA Systematic Review. *JAMA*, *298*(19), 2296-2304. https://doi.org/10.1001/jama.298.19.2296

Cappelleri, J. C., Althof, S. E., Siegel, R. L., Shpilsky, A., Bell, S. S., & Duttagupta, S. (2004). Development and validation of the Self-Esteem And Relationship (SEAR) questionnaire in erectile dysfunction. *International Journal of Impotence Research*, *16*(1), 30-38. https://doi.org/10.1038/sj.ijir.3901095

Carmichael, A., Sue-Ling, H., & Johnston, D. (2001). Quality of Life After the Magenstrasse and Mill Procedure for Morbid Obesity. *Including Laparoscopy and Allied Care*, *11*(6), 708-715. https://doi.org/10.1381/09608920160558641

Carraca, E., Markland, D., Silva, M., Coutinho, S., Vieira, P., Minderico, C., Sardinha, L., & Teixeira, P. (2012). Physical activity predicts changes in body image during obesity treatment in women. *Medical Science and Sports Exercise*, *44*(8), 1604-1612. https://doi.org/10.1249/MSS.0b013e31824d922a

Cheng, J. Y. W., & Ng, E. M. L. (2007). Body mass index, physical activity and erectile dysfunction: An U-shaped relationship from population-based study. *International Journal of Obesity*, *31*(10), 1571. https://doi.org/10.1038/sj.ijo.0803639

Cheng, J. Y. W., Ng, E. M. L., Ko, J. S. N., & Chen, R. Y. L. (2006). Physical activity and erectile dysfunction: meta-analysis of population-based studies. *International Journal of Impotence Research*, *19*(3), 245. https://doi.org/10.1038/sj.ijir.3901521

Cheriyan, J. (2009). *Hypertension*. Oxford : OUP Oxford.

Cheung, B. M., & Thomas, G. N. (2007). The metabolic syndrome and vascular disease in Asia. *Cardiovasc Hematol Disord Drug Targets*, *7*(2), 79-85.

Chiesa, A. D., Pfiffner, D., Meier, B., & Hess, O. M. (2003). Sexual activity in hypertensive men. *Journal of Human Hypertension*, *17*(8), 515. https://doi.org/10.1038/sj.jhh.1001580

Choi, K. B., Jang, S. H., Lee, M. Y., & Kim, K. H. (2011). Sexual life and self-esteem in married elderly. *Archives of Gerontology Geriatrics*, *53*(1), E17-E20. https://doi.org/10.1016/j.archger.2010.08.011

Chughtai, K. B., Lee, E. R., Te, A. A., & Kaplan, A. S. (2011). Metabolic syndrome and sexual dysfunction. *Current Opinion in Urology*, *21*(6), 514-518. https://doi.org/10.1097/MOU.0b013e32834b8681

Chung, W. S., Sohn, J. H., & Park, Y. Y. (1999). Is obesity an underlying factor in erectile dysfunction? *Eur Urol*, *36*(1), 68-70. https://doi.org/10.1159/000019929

Collins, L. M., & Sayer, A. G. E. (2001). *New methods for the analysis of change* [doi:10.1037/10409-000]. American Psychological Association. https://doi.org/10.1037/10409-000

Connor, M., Maserejian, N. N., Derogatis, L., Meston, C. M., Gerstenberger, E., & Rosen, R. C. (2011). Sexual Desire, Distress, and Associated Factors in Premenopausal Women: Preliminary Findings from the Hypoactive Sexual Desire Disorder Registry for Women. *Journal of Sex and Marital Therapy*, *37*(3), 176-189. https://doi.org/10.1080/0092623X.2011.560533

Cook, S., Hugli, O., Egli, M., Vollenweider, P., Nicod, P., Scherrer, U., Burcelin, R., & Thorens, B. (2003). Clustering of cardiovascular risk factors mimicking the human metabolic syndrome X in eNOS null mice. *Swiss Medical Weekly*, *133*(25-26), 360-363.

Cooper, R. (2014). *Diagnosing the Diagnostic and Statistical Manual of Mental Disorders : Fifth Edition* (5th ed.. ed.). London : Karnac Books.

Cornelissen, A. V., Buys, A. R., & Smart, A. N. (2013). Endurance exercise beneficially affects ambulatory blood pressure: a systematic review and meta-analysis. *Journal of Hypertension*, *31*(4), 639-648. https://doi.org/10.1097/HJH.0b013e32835ca964

Corona, G., Mannucci, E., Schulman, C., Petrone, L., Mansani, R., Cilotti, A., Balercia, G., Chiarini, V., Forti, G., & Maggi, M. (2006). Psychobiologic Correlates of the Metabolic Syndrome and Associated Sexual Dysfunction. *European Urology*, *50*(3), 595-604. https://doi.org/10.1016/j.eururo.2006.02.053

Craft, L., & Landers, D. (1998). The effect of exercise on clinical depression and depression resulting from mental illness: A meta-analysis. *Journal of Sport & Exercise Psychology*, *20*(4), 339-357. https://doi.org/10.1123/jsep.20.4.339

Craig, C., Marshall, A. L., Sjoestroem, M., Bauman, A., Booth, M., Ainsworth, B., Pratt, M., Ekelund, U., Yngve, A., Sallis, J., & Oja, P. (2003). International Physical Activity Questionnaire: 12-Country Reliability and Validity. *Medicine & Science in Sports & Exercise*, *35*(8), 1381-1395.

Crichton, G. E., & Alkerwi, A. a. (2015). Physical activity, sedentary behavior time and lipid levels in the Observation of Cardiovascular Risk Factors in Luxembourg study. *Lipids in health and disease*, *14*, 87-87. https://doi.org/10.1186/s12944-015-0085-3

Dabrowska, J., Drosdzol, A., Skrzypulec, V., & Plinta, R. (2010). Physical activity and sexuality in perimenopausal women. *European Journal of Contraception Reproductive Health Care*, *15*(6), 423-432. https://doi.org/10.3109/13625187.2010.529968

Dahn, J. R., Penedo, F. J., Molton, I., Lopez, L., Schneiderman, N., & Antoni, M. H. (2005). Physical activity and sexual functioning after radiotherapy for prostate cancer:

Beneficial effects for patients undergoing external beam radiotherapy. *Urology*, *65*(5), 953-958. https://doi.org/10.1016/j.urology.2004.11.029

Davidson, L. E., Hudson, R., Kilpatrick, K., Kuk, J. L., McMillan, K., Janiszewski, P. M., Lee, S., Lam, M., & Ross, R. (2009). Effects of Exercise Modality on Insulin Resistance and Functional Limitation in Older Adults: A Randomized Controlled Trial. *Archives of Internal Medicine*, *169*(2), 122-131. https://doi.org/10.1001/archinternmed.2008.558

de Boer, B. J., Bots, M. L., Nijeholt, A. A. B. L. a., Moors, J. P. C., Pieters, H. M., & Verheij, T. J. M. (2004). Erectile dysfunction in primary care: prevalence and patient characteristics. The ENIGMA study. *International Journal of Impotence Research*, *16*(4), 358-364. https://doi.org/http://dx.doi.org/10.1038/sj.ijir.3901155

DeLamater, J., & Karraker, A. (2009). Sexual functioning in older adults [journal article]. *Current Psychiatry Reports*, *11*(1), 6-11. https://doi.org/10.1007/s11920-009-0002-4

Derby, C. A., Mohr, B. A., Goldstein, I., Feldman, H. A., Johannes, C. B., & McKinlay, J. B. (2000). Modifiable risk factors and erectile dysfunction: can lifestyle changes modify risk? *Urology*, *56*(2), 302-306. https://doi.org/10.1016/S0090-4295(00)00614-2

Dhindsa, S., Miller, M. G., McWhirter, C. L., Mager, D. E., Ghanim, H., Chaudhuri, A., & Dandona, P. (2010). Testosterone concentrations in diabetic and nondiabetic obese men. *Diabetes care*, *33*(6), 1186. https://doi.org/10.2337/dc09-1649

Diaz-Arjonilla, M., Schwarcz, M., Swerdloff, R. S., & Wang, C. (2008). Obesity, low testosterone levels and erectile dysfunction. *International Journal of Impotence Research*, *21*(2), 89. https://doi.org/10.1038/ijir.2008.42

Diaz, K. M., & Shimbo, D. (2013). Physical activity and the prevention of hypertension. *Current Hypertension Reports*, *15*(6), 659-668. https://doi.org/10.1007/s11906-013-0386-8

Doumas, M., Tsakiris, A., Douma, S., Hounta, A., Papadopoulos, A., Tsiodras, S., Paraskeuakou, G., Antoniou, V., & Giamarellou, H. (2005). Determinants of erectile dysfunction in patients with essential hypertension. In (Vol. 18, pp. A143-A143).

Doumas, M., Tsiodras, S., Tsakiris, A., Douma, S., Chounta, A., Papadopoulos, A., Kanellakopoulou, K., & Giamarellou, H. (2006). Female sexual dysfunction in essential hypertension: a common problem being uncovered. *Journal of Hypertension*, *24*(12), 2387-2392. https://doi.org/10.1097/01.hjh.0000251898.40002.5b

Duncan, L., Lewis, C., Jenkins, P., & Pearson, T. A. (1997). Does hypertension and its pharmacotherapy affect the quality of sexual function in women? *Circulation*, *96*(8), 3339-3339.

Dunn, P. R. C. G. I. H. K. (2000). Satisfaction in the Sex Life of a General Population Sample. *Journal of Sex & Marital Therapy*, *26*(2), 141-151. https://doi.org/10.1080/009262300278542

Dunstan, D. W., Puddey, I. B., Beilin, L. J., Burke, V., Morton, A. R., & Stanton, K. G. (1998). Effects of a short-term circuit weight training program on glycaemic control in NIDDM. *Diabetes Res Clin Pract*, *40*(1), 53-61. https://doi.org/10.1016/S0168-8227(98)00027-8

Dymek, M. P., Le Grange, D., Neven, K., & Alverdy, J. (2002). Quality of life after gastric bypass surgery: A cross-sectional study. *Obesity Research*, *10*(11), 1135-1142.

Eberly, L. E., Prineas, R., Cohen, J. D., Vazquez, G., Zhi, X., Neaton, J. D., & Kuller, L. H. (2006). Metabolic syndrome: risk factor distribution and 18-year mortality in the multiple risk factor intervention trial. *Diabetes care*, *29*(1), 123. https://doi.org/10.2337/diacare.29.01.06.dc05-1320

Efthymiou, V., Hyphantis, T., Karaivazoglou, K., Gourzis, P., Alexandrides, T. K., Kalfarentzos, F., & Assimakopoulos, K. (2015). The effect of bariatric surgery on patient HRQOL and sexual health during a 1-year postoperative period. *Obesity Surgery*, *25*(2), 310-318. https://doi.org/10.1007/s11695-014-1384-x

Egger, G., Donovan, R., Giles-Corti, B., Bull, F., & Swinburn, B. (2001). Developing national physical activity guidelines for Australians. *Australian and New Zealand Journal of Public Health*, *25*(6), 561-563.

Ein-Dor, T., & Hirschberger, G. (2012). Sexual healing: Daily diary evidence that sex relieves stress for men and women in satisfying relationships. *Journal of Social and Personal Relationships*, *29*(1), 126-139. https://doi.org/10.1177/0265407511431185

Ekkekakis, P. (2003). Pleasure and displeasure from the body: Perspectives from exercise. *Cogn Emot*, *17*(2), 213-239. https://doi.org/10.1080/02699930302292

Esposito, K., Ciotola, M., Giugliano, F., Bisogni, C., Schisano, B., Autorino, R., Cobellis, L., Sio, M. D., Colacurci, N., & Giugliano, D. (2007). Association of body weight with sexual function in women. *International Journal of Impotence Research*, *19*(4), 353. https://doi.org/10.1038/sj.ijir.3901548

Esposito, K., Ciotola, M., Marfella, R., Tommaso, D. D., Cobellis, L., & Giugliano, D. (2005). The metabolic syndrome: a cause of sexual dysfunction in women. *International Journal of Impotence Research*, *17*(3), 224. https://doi.org/10.1038/sj.ijir.3901310

Esposito, K., & Giugliano, D. (2005). Obesity, the metabolic syndrome, and sexual dysfunction. *International Journal of Impotence Research*, *17*(5), 391. https://doi.org/10.1038/sj.ijir.3901333

Esposito, K., Giugliano, F., Ciotola, M., De Sio, M., D'Armiento, M., & Giugliano, D. (2008). Obesity and sexual dysfunction, male and female. *International Journal of Iimpotence Research*, *20*(4), 358-365. https://doi.org/http://dx.doi.org/10.1038/ijir.2008.9

Esposito, K., Giugliano, F., Di Palo, C., Giugliano, G., Marfella, R., D'Andrea, F., D'Armiento, M., & Giugliano, D. (2004). Effect of lifestyle changes on erectile dysfunction in obese men - A randomized controlled trial. *JAMA*, *291*(24), 2978-2984.

Esposito, K., Maiorino, M. I., Bellastella, G., Giugliano, F., Romano, M., & Giugliano, D. (2010). Determinants of female sexual dysfunction in type 2 diabetes. *International Journal of Impotence Research*, *22*(3), 179-184. https://doi.org/http://dx.doi.org/10.1038/ijir.2010.6

Eysenbach, G., Lyons, E., Dominick, G., Hartman, S. J., Nelson, S. H., & Weiner, L. S. (2018). Patterns of Fitbit Use and Activity Levels Throughout a Physical Activity Intervention: Exploratory Analysis from a Randomized Controlled Trial. *JMIR mHealth and uHealth*, *6*(2). https://doi.org/10.2196/mhealth.8503

Feise, R. (2002). Do multiple outcome measures require p-value adjustment? *BMC Medical Research Methodology*, *2*(1), 8. https://doi.org/10.1186/1471-2288-2-8

Feldman, H. A., Goldstein, I., Hatzichristou, D. G., Krane, R. J., & McKinlay, J. B. (1994). Impotence and its medical and psychosocial correlates: results of the Massachusetts Male Aging Study. *Journal of Urology*, *151*(1), 54-61.

Feldman, H. A., Johannes, C. B., Derby, C. A., Kleinman, K. P., Mohr, B. A., Araujo, A. B., & McKinlay, J. B. (2000). Erectile Dysfunction and Coronary Risk Factors: Prospective Results from the Massachusetts Male Aging Study. *Preventive Medicine*, *30*(4), 328-338. https://doi.org/10.1006/pmed.2000.0643

Figueira, F. R., Umpierre, D., Cureau, F. V., Zucatti, A. T. N., Dalzochio, M. B., Leitão, C. B., & Schaan, B. D. (2014). Association between physical activity advice only or structured exercise training with blood pressure levels in patients with type 2 diabetes: a systematic review and meta-analysis. *Sports medicine (Auckland, N.Z.)*, *44*(11), 1557-1572. https://doi.org/10.1007/s40279-014-0226-2

Fogelholm, M. (2008). How physical activity can work? *International Journal of Pediatric Obesity*, *3*, 10-14. https://doi.org/10.1080/17477160801896481

Fogelholm, M. (2010). Physical activity, fitness and fatness: relations to mortality, morbidity and disease risk factors. A systematic review. *Obesity Reviews*, *11*(3), 202-221. https://doi.org/http://dx.doi.org/10.1111/j.1467-789X.2009.00653.x

Fogelholm, M., Stallknecht, B., & van Baak, M. (2006). ECSS position statement: Exercise and obesity. *European Journal of Sport Science*, *6*(1), 15-24. https://doi.org/http://dx.doi.org/10.1080/17461390600563085

Fontaine, K. R., Barofsky, I., Andersen, R. E., Bartlett, S. J., Wiersema, L., Cheskin, L. J., & Franckowiak, S. C. (1999). Impact of weight loss on health-related quality of life. *Quality of Life Research*, *8*(3), 275-277.

Foreyt, J. P., Brunner, R. L., Goodrick, G. K., St Jeor, S. T., & Miller, G. D. (1995). Psychological correlates of reported physical activity in normal-weight and obese adults: the Reno diet-heart study. *Int J Obes Relat Metab Disord*, *19 Suppl 4*, S69-72.

Fox, K. R. (1999). The influence of physical activity on mental well-being. *Public Health Nutrition*, *2*(3a), 411-418. https://doi.org/10.1017/S1368980099000567

Franz, M. J., Bantle, J. P., Beebe, C. A., Brunzell, J. D., Chiasson, J.-L., Garg, A., Holzmeister, L. A., Hoogwerf, B., Mayer-Davis, E., Mooradian, A. D., Purnell, J. Q., & Wheeler, M. (2002). Evidence-based nutrition principles and recommendations for the treatment and prevention of diabetes and related complications. *Diabetes care*, *25*(1), 148-198.

Frohlich, P., & Meston, C. (2002). Sexual functioning and self-reported depressive symptoms among college women. *Journal of Sex Research*, *39*(4), 321-325.

Fung, M. M., Bettencourt, R., & Barrett-Connor, E. (2004). Heart disease risk factors predict erectile dysfunction 25 years later: The Rancho Bernardo Study: The Rancho Bernardo Study. *Journal of the American College of Cardiology*, *43*(8), 1405-1411. https://doi.org/10.1016/j.jacc.2003.11.041

Garcia-Cruz, E., Piqueras, M., Huguet, J., Perez-Marquez, M., Gosalbez, D., Peri, L., Izquierdo, L., Luque, P., Ribal, M. J., & Alcaraz, A. (2012). Hypertension, dyslipidemia and overweight are related to lower testosterone levels in a cohort of men undergoing prostate biopsy. *International Journal of Impotence Research*, *24*(3), 110. https://doi.org/10.1038/ijir.2011.55

Ginsberg, H. N., & MacCallum, P. R. (2009). The obesity, metabolic syndrome, and type 2 diabetes mellitus pandemic: Part I. Increased cardiovascular disease risk and the importance of atherogenic dyslipidemia in persons with the metabolic syndrome and type 2 diabetes mellitus. *Journal of the cardiometabolic syndrome*, *4*(2), 113-119. https://doi.org/10.1111/j.1559-4572.2008.00044.x

Glina, S., Sharlip, I. D., & Hellstrom, W. J. (2013). Modifying risk factors to prevent and treat erectile dysfunction. *J SEX MED*, *10*(1), 115-119. https://doi.org/10.1111/j.1743-6109.2012.02816.x

Gonen, B., Halverson, J. D., & Schonfeld, G. (1983). Lipoprotein levels in morbidly obese patients with massive, surgically-induced weight loss. *Metabolism*, *32*(5), 492-496. https://doi.org/10.1016/0026-0495(83)90012-4

Goodson, P., Buhi, E. R., & Dunsmore, S. C. (2006). Self-esteem and adolescent sexual behaviors, attitudes, and intentions: a systematic review. *Journal of Adolescent Health*, *38*(3), 310-319. https://doi.org/10.1016/j.jadohealth.2005.05.026

Government, Australian. (2014). Australian's physical activity and sedentary behavior guidelines for adults. Department of Health: Canberra.

Grewal, G. S., Gill, J. S., Sidi, H., Gurpreet, K., Jambunathan, S. T., Suffee, N. J., Midin, M., Jaafar, N. R. N., & Das, S. (2014). Prevalence and risk factors of female sexual dysfunction among healthcare personnel in malaysia. *Comprehensive Psychiatrics*, *55*, S17-S22. https://doi.org/10.1016/j.comppsych.2013.01.009

Grievink, L., Alberts, J. F., O'Niel, J., & Gerstenbluth, I. (2004). Waist circumference as a measurement of obesity in the Netherlands Antilles; associations with hypertension and diabetes mellitus. *Eur J Clin Nutr*, *58*(8), 1159-1165. https://doi.org/10.1038/sj.ejcn.1601944

Grundy, S. M., Cleeman, J. I., Daniels, S. R., Donato, K. A., Eckel, R. H., Franklin, B. A., Gordon, D. J., Krauss, R. M., Savage, P. J., Smith, S. C., Spertus, J. A., & Costa, F. (2005). Diagnosis and Management of the Metabolic Syndrome. *Circulation*, *112*(17), 2735-2752. https://doi.org/doi:10.1161/CIRCULATIONAHA.105.169404

Hakim, L. S., & Goldstein, I. (1996). Diabetic sexual dysfunction. *Endocrinology and Metabolism Clinics North America*, *25*(2), 379-400.

Han, T. S., Tajar, A., O'Neill, T. W., Jiang, M., Bartfai, G., Boonen, S., Casanueva, F., Finn, J. D., Forti, G., Giwercman, A., Huhtaniemi, I. T., Kula, K., Pendleton, N., Punab, M., Silman, A. J., Vanderschueren, D., Lean, M. E. J., & Wu, F. C. W. (2011). Impaired quality of life and sexual function in overweight and obese men: the European Male Ageing Study. *European Journal of Endocrinology*, *164*(6), 1003-1011. https://doi.org/10.1530/EJE-10-1129

Harris, M. F. (2013). The metabolic syndrome. *Australian Family Physician*, *42*(8), 524-527.

Hayes, A. F. a. (2018). *Introduction to mediation, moderation, and conditional process analysis : a regression-based approach / Andrew F. Hayes* (Second edition.. ed.). New York, New York : The Guilford Press.

Hegde, S. M., & Solomon, S. D. (2015). Influence of Physical Activity on Hypertension and Cardiac Structure and Function. *Current Hypertension Reports*, *17*(10), 77-77. https://doi.org/10.1007/s11906-015-0588-3

Heikkila, A., Kaipia, A., Venermo, M., Kautiainen, H., & Korhonen, P. (2017). Relationship of Blood Pressure and Erectile Dysfunction in Men Without Previously Diagnosed Hypertension. *J SEX MED*, *14*(11), 1336-1341. https://doi.org/10.1016/j.jsxm.2017.09.007

Helle´nius, M.-L., de Faire, U., Berglund, B., Hamsten, A., & Krakau, I. (1993). Diet and exercise are equally effective in reducing risk for cardiovascular disease. Results of a randomized controlled study in men with slightly to moderately raised cardiovascular risk factors. *Atherosclerosis*, *103*(1), 81-91. https://doi.org/10.1016/0021-9150(93)90042-S

Henriksen, E. J. (2002). Invited review: Effects of acute exercise and exercise training on insulin resistance. *J Appl Physiol (1985)*, *93*(2), 788-796. https://doi.org/10.1152/japplphysiol.01219.2001

Hersey, W. C., Graves, J. E., Pollock, M. L., Gingerich, R., Shireman, R. B., Heath, G. W., Spierto, F., McCole, S. D., & Hagberg, J. M. (1994). Endurance exercise training improves body composition and plasma insulin responses in 70- to 79-year-old men and women. *Metabolism*, *43*(7), 847-854. https://doi.org/10.1016/0026-0495(94)90265-8

Ho, S., Radavelli-Bagatini, S., Dhaliwal, S., Hills, A., & Pal, S. (2012). Resistance, aerobic and combination training on vascular function in overweight and obese adults.

Houmard, J., Tanner, C., Slentz, C., & Duscha, B. (2004). Effect of the volume and intensity of exercise training on insulin sensitivity. *Journal of Applied Physiology*, *96*(1), 101-106. https://doi.org/10.1152/japplphysiol.00707.2003

Howard, J. R. (2010). *Helping people with sexual problems / Jane R. Howard*. East Hawthorn, Vic. : IP Communications.

Howell, S., Hoffman, K., Bartel, L., Schwandt, M., Morris, J., & Fritz, J. (2003). Normal hematologic and serum clinical chemistry values for captive chimpanzees (Pan troglodytes). *Comparative Med.*, *53*(4), 413-423. https://doi.org/10.3766/jaaa.15.10.6

Hsiao, W., Shrewsberry, A. B., Moses, K. A., Johnson, T. V., Cai, A. W., Stuhldreher, P., Dusseault, B., & Ritenour, C. W. M. (2012). Exercise is Associated with Better Erectile Function in Men Under 40 as Evaluated by the International Index of Erectile Function.

Journal of Sexual Medicine, *9*(2), 524-530. https://doi.org/10.1111/j.1743-6109.2011.02560.x

Hultquist, C. N., Albright, C., & Thompson, D. L. (2005). Comparison of walking recommendations in previously inactive women. *MED SCI SPORTS EXERC*, *37*(4), 676-683. https://doi.org/10.1249/01.MSS.0000158993.39760.1B

Ibanez, J., Izquierdo, M., Arguelles, I., Forga, L., Larrion, J. L., Garcia-Unciti, M., Idoate, F., & Gorostiaga, E. M. (2005). Twice-weekly progressive resistance training decreases abdominal fat and improves insulin sensitivity in older men with type 2 diabetes. *Diabetes care*, *28*(3), 662-667. https://doi.org/10.2337/diacare.28.3.662

Jakicic, J. M., Rogers, R. J., Davis, K. K., & Collins, K. A. (2018). Role of Physical Activity and Exercise in Treating Patients with Overweight and Obesity. *Clinical chemistry*, *64*(1), 99-107. https://doi.org/10.1373/clinchem.2017.272443

Janiszewski, P. M., Janssen, I., & Ross, R. (2009). Abdominal obesity and physical inactivity are associated with erectile dysfunction independent of body mass index. *J SEX MED*, *6*(7), 1990-1998. https://doi.org/10.1111/j.1743-6109.2009.01302.x

Järvholm, K., Olbers, T., Marcus, C., Mårild, S., Gronowitz, E., Friberg, P., Johnsson, P., & Flodmark, C.-E. (2012). Short-term psychological outcomes in severely obese adolescents after bariatric surgery. *Obesity (Silver Spring, Md.)*, *20*(2), 318. https://doi.org/10.1038/oby.2011.310

Jean-Pierre, D., & Isabelle, L. (2006). Abdominal obesity and metabolic syndrome. *Nature*, *444*(7121), 881. https://doi.org/10.1038/nature05488

Jeong, J. Y., Lee, S., Kang, Y. W., Jang, S. N., Choi, Y., & Kim, D. H. (2011). Relationship between ED and depression among middle-aged and elderly men in Korea: Hallym aging study. *International Journal of Impotence Research*, *23*(5), 227-234. https://doi.org/10.1038/ijir.2011.32

Jiannine, L. (2018). An investigation of the relationship between physical fitness, self-concept, and sexual functioning [Original Article]. *Journal of Education and Health Promotion*, *7*(1), 57-57. https://doi.org/10.4103/jehp.jehp_157_17

Jones, T. H. (2007). Testosterone Associations with Erectile Dysfunction, Diabetes, and the Metabolic Syndrome. *European Urology Supplements*, *6*(16), 847-857. https://doi.org/10.1016/j.eursup.2007.07.002

Kannan, U., Vasudevan, K., Balasubramaniam, K., Yerrabelli, D., Shanmugavel, K., & John, N. A. (2014). Effect of exercise intensity on lipid profile in sedentary obese adults.

Journal of clinical and diagnostic research : JCDR, *8*(7), BC08-BC10. https://doi.org/10.7860/JCDR/2014/8519.4611

Kaplan, H. S. (1974). *The new sex therapy / Helen Singer Kaplan*. London : Ballière Tindall.

Kashdan, T., Adams, L., Savostyanova, A., Ferssizidis, P., McKnight, P., & Nezlek, J. (2011). Effects of social anxiety and depressive symptoms on the frequency and quality of sexual activity: A daily process approach. *Behaviour Research Therapy*, *49*(5), 352-360. https://doi.org/10.1016/j.brat.2011.03.004

Kaukua, J., Pekkarinen, T., Sane, T., & Mustajoki, P. (2003). Sex hormones and sexual function in obese men losing weight. *Obesity Research*, *11*(6), 689-694. https://doi.org/10.1038/oby.2003.98

Kaya, B., Unal, S., Ozenli, Y., Gursoy, N., Tekiner, S., & Kafkasli, A. (2006). Anxiety, depression and sexual dysfunction in women with chronic pelvic pain. *Sexual and Relationship Therapy*, *21*(2), 187-196. https://doi.org/10.1080/14681990500359897

Kennedy, S. H., Dickens, S. E., Eisfeld, B. S., & Bagby, R. M. (1999). Sexual dysfunction before antidepressant therapy in major depression. *Journal of Affective Disorders*, *56*(2), 201-208. https://doi.org/10.1016/S0165-0327(99)00050-6

Khoo. (2010). Effects of a low-energy diet on sexual function and lower urinary tract symptoms in obese men. *International Journal of Obesity*, *34*(9), 1396. https://doi.org/10.1038/ijo.2010.76

Khoo, Piantadosi, C., Duncan, R., Worthley, S. G., Jenkins, A., Noakes, M., Worthley, M. I., Lange, K., & Wittert, G. A. (2011). Comparing effects of a low-energy diet and a high-protein low-fat diet on sexual and endothelial function, urinary tract symptoms, and inflammation in obese diabetic men. *The journal of sexual medicine*, *8*(10), 2868-2875. https://doi.org/10.1111/j.1743-6109.2011.02417.x

Khoo, J., Ling, P. S., Tan, J., Teo, A., Ng, H. L., Chen, R. Y. T., Tay, T. L., Tan, E., & Cheong, M. (2013). Comparing the effects of meal replacements with reduced-fat diet on weight, sexual and endothelial function, testosterone and quality of life in obese Asian men. *International Journal of Impotence Research*, *26*(2), 61. https://doi.org/10.1038/ijir.2013.36

Khoo, J., Ling, P. s., Tan, J., Teo, A., Ng, H. l., Chen, R. Y. t., Tay, T. l., Tan, E., & Cheong, M. (2014). Comparing the effects of meal replacements with reduced-fat diet on weight, sexual and endothelial function, testosterone and quality of life in obese Asian men. *International Journal of Impotence Research*, *26*(2), 61-66. https://doi.org/http://dx.doi.org/10.1038/ijir.2013.36

Kilic, E., Taycan, O., Belli, A. K., & Ozmen, M. (2007). The effect of permanent ostomy on body image, self-esteem, marital adjustment, and sexual functioning. *Turk Psikiyatri Derg*, *18*(4), 302-310. (Kalici Ostomi Ameliyatinin Beden Algisi, Benlik Saygisi, Es Uyumu ve Cinsel Islevler Uzerine Etkisi.)

Kim, K. K., Kang, H. C., Kim, S. S., & Youn, B. B. (2006). Influence of weight reduction by sibutramine on female sexual function. *International Journal of Obesity*, *30*(5), 758. https://doi.org/10.1038/sj.ijo.0803198

Kim, O., & Jeon, H. O. (2013). Gender differences in factors influencing sexual satisfaction in Korean older adults. *Archives of Gerontology Geriatrics*, *56*(2), 321-326. https://doi.org/10.1016/j.archger.2012.10.009

Kolotkin, Binks, M., Crosby, R. D., Østbye, T., Mitchell, J. E., & Hartley, G. (2008). Improvements in sexual quality of life after moderate weight loss. *International Journal of Impotence Research*, *20*(5), 487-492. https://doi.org/http://dx.doi.org/10.1038/ijir.2008.32

Kolotkin, Zunker, C., & Østbye, T. (2012). Sexual functioning and obesity: A review. In (Vol. 20, pp. 2325-2333). Oxford, UK.

Kolotkin, R., Binks, M., Crosby, R., Ostbye, T., Gress, R., & Adams, T. (2006). Obesity and Sexual Quality of Life*. *Obesity*, *14*(3), 472-479. https://doi.org/10.1038/oby.2006.62

Kolotkin, R. L., Crosby, R. D., Gress, R. E., Hunt, S. C., & Adams, T. D. (2009). Two-year changes in health-related quality of life in gastric bypass patients compared with severely obese controls. *Surgery for Obesity and Related Diseases*, *5*(2), 250-256. https://doi.org/10.1016/j.soard.2009.01.009

Korfage, I. J., Pluijm, S., Roobol, M., Dohle, G. R., Schröder, F. H., & Essink-Bot, M.-L. (2009). Erectile Dysfunction and Mental Health in a General Population of Older Men. *J SEX MED*, *6*(2), 505-512. https://doi.org/10.1111/j.1743-6109.2008.01111.x

Krane, R. J., Goldstein, I., & Saenz De Tejada, I. (1989). Impotence. *New England Journal of Medicine*, *321*(24), 1648-1659.

Kratzik, C. W., Schatzl, G., Lunglmayr, G., Rucklinger, E., & Huber, J. (2005). The impact of age, body mass index and testosterone on erectile dysfunction. *J Urol*, *174*(1), 240-243. https://doi.org/10.1097/01.ju.0000162049.95483.51

Kruk, J. (2007). Physical activity in the prevention of the most frequent chronic diseases: an analysis of the recent evidence. *Asian Pac J Cancer Prev*, *8*(3), 325-338.

Kubzansky, L., Gilthorpe, M., & Goodman, E. (2012). A Prospective Study of Psychological Distress and Weight Status in Adolescents/Young Adults. *Annals of Behavioral Medicine*, *43*(2), 219-228. https://doi.org/10.1007/s12160-011-9323-8

Kupelian, V., Page, S. T., Araujo, A. B., Travison, T. G., Bremner, W. J., & McKinlay, J. B. (2006). Low sex hormone-binding globulin, total testosterone, and symptomatic androgen deficiency are associated with development of the metabolic syndrome in nonobese men. *The Journal of clinical endocrinology and metabolism*, *91*(3), 843.

Lachowsky, M. (2002). Menopause: loss of self-esteem? *International Congress Series*, *1229*, 25-30. https://doi.org/10.1016/S0531-5131(01)00472-1

Lakka, T. A., & Laaksonen, D. E. (2007). Physical activity in prevention and treatment of the metabolic syndrome. *Appl Physiol Nutr Metab*, *32*(1), 76-88. https://doi.org/10.1139/h06-113

Larsen, Wagner, G., & Heitmann, B. L. (2007). Sexual function and obesity. *International Journal of Obesity*, *31*(8), 1189-1198. https://doi.org/http://dx.doi.org/10.1038/sj.ijo.0803604 Sexual dysfunction in the United States - Prevalence and predictors, 537-544 6 (1999).

Laumann, E., Paik, A., & Rosen, R. (1999). Sexual dysfunction in the United States: Prevalence and predictors. *JAMA*, *281*(6), 537-544.

Laurent, S. M., & Simons, A. D. (2009). Sexual dysfunction in depression and anxiety: Conceptualizing sexual dysfunction as part of an internalizing dimension. In *Clinical Psychology Review* (Vol. 29, pp. 573-585).

Lechleitner, M. (2008). Obesity and the Metabolic Syndrome in the Elderly - A Mini-Review. *Gerontology*, *54*(5), 253-259. https://doi.org/10.1159/000161734

Ledda, A. (2000). Diabetes, hypertension and erectile dysfunction. *Curr. Med. Res. Opin.*, *16*, S17-S20.

Lee, J., Kim, Y., & Jeon, J. Y. (2016). Association between physical activity and the prevalence of metabolic syndrome: from the Korean National Health and Nutrition Examination Survey, 1999–2012. *SpringerPlus*, *5*(1), 1870. https://doi.org/10.1186/s40064-016-3514-5

Lewis, R. W., Fugl-Meyer, K. S., Bosch, R., Fugl-Meyer, A. R., Laumann, E. O., Lizza, E., & Martin-Morales, A. (2004). Epidemiology/Risk Factors of Sexual Dysfunction. *The journal of sexual medicine*, *1*(1), 35-39. https://doi.org/10.1111/j.1743-6109.2004.10106.x

Li, Y., Xu, Z., & Liu, S. (2014). Physical activity, self-esteem, and mental health students from ethnic minorities attending colleges in China. *SOC BEHAV PERSONAL*, *42*(4), 529-537.

Lovibond, S. H., & Lovibond, P. F. (1996). *Manual for the depression anxiety stress scales*. Psychology Foundation of Australia.

Mainous, A. G., Tanner, R. J., Anton, S. D., Jo, A., & Luetke, M. C. (2017). Physical Activity and Abnormal Blood Glucose Among Healthy Weight Adults. *American Journal of Preventive Medicine*, *53*(1), 42-47. https://doi.org/10.1016/j.amepre.2016.11.027

Mamplekou, E., Komesidou, V., Bissias, C., Papakonstantinou, A., & Melissas, J. (2005). Psychological Condition and Quality of Life in Patients with Morbid Obesity Before and After Surgical Weight Loss. *Including Laparoscopy and Allied Care*, *15*(8), 1177-1184. https://doi.org/10.1381/0960892055002356

Martinez-Jabaloyas, J. M., Moncada, I., Rodriguez-Vela, L., Gutierrez, P. R., & Chaves, J. (2010). [Evaluation of self-esteem in males with erectile dysfunction treated with viagra. Analysis of a Spanish patients group selected from a multicenter, international study]. *Actas Urol Esp*, *34*(8), 699-707. (Evaluacion de la autoestima en varones con disfuncion erectil tratados con sildenafilo. Analisis de un grupo de pacientes espanoles procedentes de un estudio multicentrico internacional.)

Masters, W. H. (1970). *Human sexual inadequacy / William H. Masters, Virginia E. Johnson*. London : Churchill.

McCabe, M., Althof, S. E., Assalian, P., Chevret-Measson, M., Leiblum, S. R., Simonelli, C., & Wylie, K. (2010). Psychological and interpersonal dimensions of sexual function and dysfunction. *The journal of sexual medicine*, *7*(2), 327-336. https://doi.org/10.1111/j.1743-6109.2009.01618.x

McCabe, M., & Connaughton, C. (2014). How the Prevalence Rates of Male Sexual Dysfunction Vary Using Different Criteria. *International Journal of Sexual Health*, *26*(3), 229.

McClure, A., Tanski, S., Kingsbury, J., Gerrard, M., & Sargent, J. D. (2010). Characteristics Associated With Low Self-Esteem Among US Adolescents. *Academic Pediatrics*, *10*(4), 238-244.

McCrea, R., Berger, Y., & King, M. (2012). Body mass index and common mental disorders: exploring the shape of the association and its moderation by age, gender and education. *International Journal of Obesity*, *36*(3), 414-421. https://doi.org/10.1038/ijo.2011.65

McLaren, L., Beck, C., Patten, S., Fick, G., & Adair, C. (2008). The relationship between body mass index and mental health. *The International Journal for Research in Social and Genetic Epidemiology and Mental Health Services*, *43*(1), 63-71. https://doi.org/10.1007/s00127-007-0269-x

McMurray, R. G., Harrell, J. S., Levine, A. A., & Gansky, S. A. (1995). Childhood obesity elevates blood pressure and total cholesterol independent of physical activity. *Int J Obes Relat Metab Disord*, *19*(12), 881-886.

Metwally, M., Li, T. C., & Ledger, W. L. (2007). The impact of obesity on female reproductive function. In (Vol. 8, pp. 515-523). Oxford, UK.

Mezones-Holguin, E., Crdova-Marcelo, W., Lau-Chu-Fon, F., Aguilar-Silva, C., Morales-Cabrera, J., Bolaos-Daz, R., Prez-Lpez, F. R., & Chedraui, P. (2011). Association between sexual function and depression in sexually active, mid-aged, Peruvian women. *Climacteric,*, *14*(6), 654-660. https://doi.org/10.3109/13697137.2011.575480

Mihalko, S. L., & McAuley, E. (1996). Strength Training Effects on Subjective Well-Being and Physical Function in the Elderly. *Journal of aging and physical activity*, *4*(1), 56-68. https://doi.org/10.1123/japa.4.1.56

Mikhail, N. (2006). Does Testosterone Have a Role in Erectile Function? *The American Journal of Medicine*, *119*(5), 373-382. https://doi.org/10.1016/j.amjmed.2005.07.042

Miner, M., Esposito, K., Guay, A., Montorsi, P., & Goldstein, I. (2012). Cardiometabolic Risk and Female Sexual Health: The Princeton III Summary (CME). *The Journal of Sexual Medicine*, *9*(3), 641-651. https://doi.org/10.1111/j.1743-6109.2012.02649.x

Moel, J., Buttner, M., O'Hara, M., Stuart, S., & Gorman, L. (2010). Sexual function in the postpartum period: effects of maternal depression and interpersonal psychotherapy treatment. *Official Journal of the Section on Women's Health of the World Psychiatric Association*, *13*(6), 495-504. https://doi.org/10.1007/s00737-010-0168-0

Mokdad, A., Ford, E., Bowman, B., & Nelson, D. (2000). Diabetes trends in the U.S.: 1900-1998. *Diabetes care*, *23*(9), 1278-1283. https://doi.org/10.2337/diacare.23.9.1278

Moore, R. H., Sarwer, D. B., Lavenberg, J. A., Lane, I. B., Evans, J. L., Volger, S., & Wadden, T. A. (2013). Relationship between sexual function and quality of life in obese persons seeking weight reduction. *Obesity*, *21*(10), 1966-1974. https://doi.org/http://dx.doi.org/10.1002/oby.20398

Mora, M., Aranda, G. B., de Hollanda, A., Flores, L., Puig-domingo, M., & Vidal, J. (2013). Weight loss is a major contributor to improved sexual function after bariatric surgery. *Surgery Endoscopy*, *27*(9), 3197-3204. https://doi.org/http://dx.doi.org/10.1007/s00464-013-2890-y

Moreau, K. L., Degarmo, R., Langley, J., McMahon, C., Howley, E. T., Bassett, D. R., & Thompson, D. L. (2001). Increasing daily walking lowers blood pressure in

postmenopausal women. *MED SCI SPORTS EXERC*, *33*(11), 1825-1831. https://doi.org/10.1097/00005768-200111000-00005

Mykletun, A., Dahl, A. A., O' Leary, M. P., & Fosså, S. D. (2006). Assessment of male sexual function by the Brief Sexual Function Inventory. *BJU International*, *97*(2), 316-323. https://doi.org/10.1111/j.1464-410X.2005.05904.x

Oh, S. H., Son, S. H., Kang, S. H., Kim, D.-K., Seo, K. M., & Lee, S. Y. (2017). Relationship Between Types of Exercise and Quality of Life in a Korean Metabolic Syndrome Population: A Cross-Sectional Study. *Metab Syndr Relat Disord*, *15*(4), 199-205. https://doi.org/10.1089/met.2016.0151

Okeahialam, B., & Obeka, N. (2006). Sexual Dysfunction in Female Hypertensives. *Journal of the National Medical Association*, *98*(4), 638-640.

Paffenbarger, R. S., Jr., Lee, I. M., & Leung, R. (1994). Physical activity and personal characteristics associated with depression and suicide in American college men. *Acta Psychiatr Scand Suppl*, *377*, 16-22.

Pal, S., Cheng, C., Egger, G., Binns, C., & Donovan, R. (2009). Using pedometers to increase physical activity in overweight and obese women: a pilot study.

Pal, S., Cheng, C., & Ho, S. (2011). The effect of two different health messages on physical activity levels and health in sedentary overweight, middle-aged women. *BMC Public Health*, *11*. https://doi.org/10.1186/1471-2458-11-204

Paluska, S., & Schwenk, T. (2000). Physical Activity and Mental Health. *Sports Medicine*, *29*(3), 167-180. https://doi.org/10.2165/00007256-200029030-00003

Petri, W. (2016). The role of physical activity and exercise in obesity and weight management : Time for critical appraisal. *Journal of Sport and Health Science （JSHS）*, *5*(2), 151-154. https://doi.org/10.1016/j.jshs.2016.04.001

Pinnock, C. B., Stapleton, A. M. F., & Marshall, V. R. (1999). Erectile dysfunction in the community: A prevalence study. *Medical Journal of Australia*, *171*(7), 353-357. https://doi.org/10.5694/j.1326-5377.1999.tb123691.x

Ponholzer, A., Temml, C., Marszalek, M., Mock, K., Rauchenwald, M., & Madersbacher, S. (2006). Vascular risk factors and erectile dysfunction in healthy men. In (Vol. 5, pp. 101-101).

Power, M. L., & Schulkin, J. (2008). Sex differences in fat storage, fat metabolism, and the health risks from obesity: possible evolutionary origins. *British Journal of Nutrition*, *99*(5), 931-940. https://doi.org/10.1017/S0007114507853347

Ravnskov, U. (2002). Is atherosclerosis caused by high cholesterol? *QJM: An International Journal of Medicine*, *95*(6), 397-403.

Reid, R., Abramson, B. L., Blake, J., Desindes, S., Dodin, S., Johnston, S., Rowe, T., Sodhi, N., Wilks, P., Wolfman, W., & Soares, C. N. (2014). Managing Menopause Abstract and Summary Statement. *Journal of Obstetrics and Gynaecology Canada*, *36*(9), S1-S5. https://doi.org/10.1016/S1701-2163(15)30456-4

Reis, L. O., Favaro, W. J., Barreiro, G. C., De Oliveira, L. C., Chaim, E. A., Fregonesi, A., & Ferreira, U. (2010). Erectile dysfunction and hormonal imbalance in morbidly obese male is reversed after gastric bypass surgery: a prospective randomized controlled trial. *International Journal of Andrology*, *33*(5), 736-744. https://doi.org/10.1111/j.1365-2605.2009.01017.x

Repousi, N., Masana, M. F., Sanchez-Niubo, A., Haro, J. M., & Tyrovolas, S. (2018). Depression and metabolic syndrome in the older population: A review of evidence. *Journal of Affective Disorders*, *237*, 56-64. https://doi.org/10.1016/j.jad.2018.04.102

Residori, L., García-Lorda, P., Flancbaum, L., Pi-Sunyer, F., & Laferrère, B. (2003). Prevalence of Co-morbidities in Obese Patients before Bariatric Surgery: Effect of Race. *Including Laparoscopy and Allied Care*, *13*(3), 333-340. https://doi.org/10.1381/096089203765887615

Richters, J., Smith, A. M. A., Grulich, A. E., De Visser, R. O., & Rissel, C. E. (2003). Sexual difficulties in a representative sample of adults. *Australian and New Zealand Journal of Public Health*, *27*(2), 164-170.

Rooney, B., Smalley, K., Larson, J., & Havens, S. (2003). Is knowing enough? Increasing physical activity by wearing a pedometer. *WMJ : official publication of the State Medical Society of Wisconsin*, *102*, 31-36.

Rosen, Wing, R. R., Schneider, S., Wadden, T. A., Foster, G. D., West, D. S., Kitabchi, A. E., Brancati, F. L., Maschak-Carey, B. J., Bahnson, J. L., Lewis, C. E., & Gendrano, I. I. I. I. N. (2009). Erectile dysfunction in type 2 diabetic men: Relationship to exercise fitness and cardiovascular risk factors in the look AHEAD trial. *Journal of Sexual Medicine*, *6*(5), 1414-1422. https://doi.org/http://dx.doi.org/10.1111/j.1743-6109.2008.01209.x

Rosen, C. B. J. H. S. L. C. M. R. S. D. F. R. D. A. R. (2000). The Female Sexual Function Index (FSFI): A Multidimensional Self-Report Instrument for the Assessment of Female Sexual Function. *Journal of Sex & Marital Therapy*, *26*(2), 191-208. https://doi.org/10.1080/009262300278597

Rosen, R. C., Cappelleri, J. C., & Iii, N. G. (2002). The International Index of Erectile Function (IIEF): a state-of-the-science review. *International Journal of Impotence Research*, *14*(4), 226. https://doi.org/10.1038/sj.ijir.3900857

Rosenberg, M. (1965). Society and the adolescent self-image. *Princeton, NJ: Princeton University Press*.

Rosenthal, M. (2013). METABOLIC SYNDROME. *Managed Healthcare Executive*, *23*(8), 20-22.

Rossi, L. A., Dikareva, S. A., Bacon, S. S., & Daskalopoulou, S. S. (2012). The impact of physical activity on mortality in patients with high blood pressure: a systematic review. *Journal of Hypertension*, *30*(7), 1277-1288. https://doi.org/10.1097/HJH.0b013e3283544669

Rowland, D. L., McNabney, S. M., & Mann, A. R. (2017). Sexual Function, Obesity, and Weight Loss in Men and Women. *Sexual Medicine Reviews*, *5*(3), 323-338. https://doi.org/10.1016/j.sxmr.2017.03.006

Royal Australian College of General Practitioners National Standing Committee. (2006). Overweight and obesity. *Victoria,*, pp 1-5.

Rucker, D. D., Preacher, K. J., Tormala, Z. L., & Petty, R. E. (2011). Mediation Analysis in Social Psychology: Current Practices and New Recommendations: Mediation Analysis in Social Psychology. *Social and personality psychology compass*, *5*(6), 359-371. https://doi.org/10.1111/j.1751-9004.2011.00355.x

Saris, W. H., Blair, S. N., van Baak, M. A., Eaton, S. B., Davies, P. S., Di Pietro, L., Fogelholm, M., Rissanen, A., Schoeller, D., Swinburn, B., Tremblay, A., Westerterp, K. R., & Wyatt, H. (2003). How much physical activity is enough to prevent unhealthy weight gain? Outcome of the IASO 1st Stock Conference and consensus statement. *Obes Rev*, *4*(2), 101-114.

Sarwer, Lavery, M., & Spitzer, J. C. (2012). A review of the relationships between extreme obesity, quality of life, and sexual function. *OBES SURG*, *22*(4), 668-676. https://doi.org/10.2337/diacare.17.5.382.

http://dx.doi.org/10.1007/s11695-012-0588-1

Sayuk, G. S., Gott, B. M., Nix, B. D., & Lustman, P. J. (2011). Improvement in sexual functioning in patients with type 2 diabetes and depression treated with bupropion. *Diabetes care*, *34*(2), 332. https://doi.org/10.2337/dc10-1714

Schulz, K. F., Altman, D. G., & Moher, D. (2010). CONSORT 2010 Statement: Updated guidelines for reporting parallel group randomised trials. *Journal of Clinical Epidemiology*, *63*(8), 834-840. https://doi.org/10.1016/j.jclinepi.2010.02.005

Scordo, K., & Pickett, K. (2015). Managing hypertention: Piecing together the guidelines. *Nursing*, *45*(1), 28.

Seal, B. N., Bradford, A., & Meston, C. M. (2009). The association between body esteem and sexual desire among college women. *Archives of Sexual Behavior*, *38*(5), 866-872. https://doi.org/10.1007/s10508-008-9467-1

Seen Heng, Y., Sidi, H., Nik Jaafar, N. R., Razali, R., & Ram, H. (2013). Phases of female sexual response cycle among M alaysian women with Infertility: A factor analysis study. *Asia-Pacific Psychiatry*, *5*, 50-54. https://doi.org/10.1111/appy.12044

Shackelford, T. K. (2001). Self-esteem in marriage. *Personality and Individual Differences*, *30*(3), 371-390. https://doi.org/10.1016/S0191-8869(00)00023-4

Shamloul, R., & Ghanem, H. (2013). Erectile dysfunction. *Lancet*, *381*(9861), 153-165. https://doi.org/http://dx.doi.org/10.1016/S0140-6736(12)60520-0

Shaw, K., Gennat, H., O'Rourke, P., & Del Mar, C. (2006). Exercise for overweight or obesity. *Cochrane Database Systematic Review*(4), Cd003817. https://doi.org/10.1002/14651858.CD003817.pub3

Shin, J.-A., Lee, J.-H., Lim, S.-Y., Ha, H.-S., Kwon, H.-S., Park, Y.-M., Lee, W.-C., Kang, M.-I., Yim, H.-W., Yoon, K.-H., & Son, H.-Y. (2013). Metabolic syndrome as a predictor of type 2 diabetes, and its clinical interpretations and usefulness. *Journal of diabetes investigation*, *4*(4), 334-343. https://doi.org/10.1111/jdi.12075

Shook, R. P., Hand, G. A., Drenowatz, C., Hebert, J. R., Paluch, A. E., Blundell, J. E., Hill, J. O., Katzmarzyk, P. T., Church, T. S., & Blair, S. N. (2015). Low levels of physical activity are associated with dysregulation of energy intake and fat mass gain over 1 year. *Am J Clin Nutr*, *102*(6), 1332-1338. https://doi.org/10.3945/ajcn.115.115360

Sinclair, J., Taylor, P., & Hobbs, S. (2013). Alpha level adjustments for multiple dependent variable analyses and their applicability – A review. *International Journal of Sport Science and Engineering*, *7*.

Slavin, J. L. (2005). Dietary fiber and body weight. In (Vol. 21, pp. 411-418). Kidlington: ELSEVIER SCI Ltd.

Sowers, K., & Sowers, J. (1999). Obesity, hypertension, and vascular disease. *Current Hypertension Reports*, *1*(2), 140-144. https://doi.org/10.1007/s11906-999-0009-6

Spatz, S. E., Canavan, E. M., Desai, M. M., Krumholz, M. H., & Lindau, T. S. (2013). Sexual activity and function among middle-aged and older men and women with hypertension. *Journal of Hypertension*, *31*(6), 1096-1105. https://doi.org/10.1097/HJH.0b013e32835fdefa

Spence, J., McGannon, K., & Poon, P. (2005). The Effect of Exercise on Global Self-Esteem: A Quantitative Review. *Journal of Sport & Exercise Psychology*, *27*(3), 311-334. https://doi.org/10.1123/jsep.27.3.311

Stapleton, P. A., Goodwill, A. G., James, M. E., Brock, R. W., & Frisbee, J. C. (2010). Hypercholesterolemia and microvascular dysfunction: interventional strategies. *Journal of Inflammation*, *7*(1), 54. https://doi.org/10.1186/1476-9255-7-54

Stenberg, Å., Heimer, G., Ulmsten, U., & Cnattingius, S. (1996). Prevalence of genitourinary and other climacteric symptoms in 61-year-old women. *Maturitas*, *24*(1), 31-36. https://doi.org/10.1016/0378-5122(95)00996-5

Strain, G. W., Kolotkin, R. L., Dakin, G. F., Gagner, M., Inabnet, W. B., Christos, P., Saif, T., Crosby, R., & Pomp, A. (2014). The effects of weight loss after bariatric surgery on health-related quality of life and depression. *Nutrition Diabetes*, *4*, e132. https://doi.org/10.1038/nutd.2014.29

Sturm, R., & Wells, K. (2001). Does obesity contribute as much to morbidity as poverty or smoking? *Public Health*, *115*(3), 229-235. https://doi.org/10.1038/sj.ph.1900764

Sullivan, P. W., Morrato, E. H., Ghushchyan, V., Wyatt, H. R., & Hill, J. O. (2005). Obesity, inactivity, and the prevalence of diabetes and diabetes-related cardiovascular comorbidities in the U.S., 2000-2002. *Diabetes care*, *28*(7), 1599-1603. https://doi.org/10.2337/diacare.28.7.1599

Thompson, P. D., Crouse, S. F., Goodpaster, B., Kelley, D., Moyna, N., & Pescatello, L. (2001). The acute versus the chronic response to exercise. *MED SCI SPORTS EXERC*, *33*(6 Suppl), S438-445; discussion S452-433. https://doi.org/10.1097/00005768-200106001-00012

Thonney, B., Pataky, Z., Badel, S., Bobbioni-Harsch, E., & Golay, A. (2010). The relationship between weight loss and psychosocial functioning among bariatric surgery patients. *American Journal of Surgery*, *199*(2), 183-188. https://doi.org/10.1016/j.amjsurg.2008.12.028

Tremayne, P., & Norton, W. (2017). Sexuality and the older woman. *British journal of nursing (Mark Allen Publishing)*, *26*(14), 819-824. https://doi.org/10.12968/bjon.2017.26.14.819

Tsai, Y.-J., Wu, M.-P., & Hsu, Y.-W. (2014). Emerging health problems among women: Inactivity, obesity, and metabolic syndrome. *Gynecology and Minimally Invasive Therapy*, *3*(1), 12-14. https://doi.org/10.1016/j.gmit.2013.07.005

Tudor-Locke, C., & Bassett, Jr. (2004). How many steps/day are enough? Preliminary pedometer indices for public health. *Sports Medicine*, *34*(1), 1-8.

Turi, B. C., Codogno, J. S., Fernandes, R. A., & Monteiro, H. L. (2016). Low levels of physical activity and metabolic syndrome: cross-sectional study in the Brazilian public health system. *Cien Saude Colet*, *21*(4), 1043-1050. https://doi.org/10.1590/1413-81232015214.23042015

U.S. Department of Health and Human Services: Surgeon General's report on physical activity and health [article online], 1996. Available from http://www. cdc.gov/nccdphp/sgr/sgr.htm. Accessed 15 January 2005.

U.S. Department of Health and Human Services: The Surgeon General's Call to Action to Prevent and Decrease Overweight and Obesity. Rockville, MD, Public Health Service, Office of the Surgeon General, 2001.

Urbaniak GC, Plous S. Research Randomizer (Version 4.0) Computer software. 2013 http://www.randomizer.org/ (Accessed 16 March 2015).

Vrentzos, B. S. P., Paraskevas, B. S. P., & Mikhailidis, B. S. P. (2007). Dyslipidemia as a Risk Factor for Erectile Dysfunction. *Current Medicinal Chemistry*, *14*(16), 1765-1770. https://doi.org/10.2174/092986707781058931

Watkins, J., Christie, C., & Chally, P. (2008). Relationship Between Body Image and Body Mass Index in College Men. *Journal of American College Health*, *57*(1), 95-100. https://doi.org/10.3200/JACH.57.1.95-100

Wei, M., & Macera, C. (1995). TOTAL CHOLESTEROL AND HIGH-DENSITY-LIPOPROTEIN CHOLESTEROL AS IMPORTANT PREDICTORS OF ERECTILE DYSFUNCTION - REPLY. *American Journal of Epidemiology*, *142*(11), 1246-1247.

Weiss, R., Dziura, J., Burgert, T. S., Tamborlane, W. V., Taksali, S. E., Yeckel, C. W., Allen, K., Lopes, M., Savoye, M., Morrison, J., Sherwin, R. S., & Caprio, S. (2004). Obesity and the Metabolic Syndrome in Children and Adolescents. *The New England Journal of Medicine*, *350*(23), 2362-. https://doi.org/10.1056/NEJMoa031049

Werlinger, K., King, T., M. Clark, M., Pera, V., & Wincze, J. (1997). Perceived changes in sexual functioning and body image following weight loss in an obese female population: A pilot study. *Journal of Sex & Marital Therapy*, *23*, 74-78. https://doi.org/10.1080/00926239708404419

Whelton, S., Chin, A., & Xin, X. (2002). Review: Aerobic exercise reduces systolic and diastolic blood pressure in adults / Commentary. *ACP Journal Club*, *137*(3), 109.

White, Case, D. A., McWhirter, D., & Mattison, A. M. (1990b). Enhanced sexual behavior in exercising men. *Arch Sex Behav*, *19*(3), 193-209. https://doi.org/10.1007/BF01541546

White, D. K., Tudor-Locke, C., Felson, D. T., Gross, K. D., Niu, J., Nevitt, M., Lewis, C. E., Torner, J., & Neogi, T. (2012). Walking to meet physical activity guidelines in knee osteoarthritis: Is 10,000 steps enough? *Archives of Physical Medicine and Rehabilitation*. https://doi.org/10.1016/j.apmr.2012.11.038

Williamson, D. F., Madans, J., Anda, R. F., Kleinman, J. C., Kahn, H. S., & Byers, T. (1993). Recreational physical activity and ten-year weight change in a US national cohort. *International Journal of Obesity and Related Metabolic Disorder*, *17*(5), 279-286.

Wit, d. L. M., Straten, v. A., Luppino, F., Penninx, B. W. J. H., Zitman, F., & Cuijpers, P. (2010). Depression and obesity: A meta-analysis of community based studies. *Psychiatry Research*, *178*(2), 230-235.

Woertman, L., & Van Den Brink, F. (2012). Body Image and Female Sexual Functioning and Behavior: A Review. *Journal of Sex Research*, *49*(2-3), 184-211. https://doi.org/10.1080/00224499.2012.658586

World Health Organisation. Overweight, age-standardized. estimates by country. Online database. Geneva, Switzerland. WHO: 2017. http://apps.who.int/gho/data/view.main.CTRY2430A?lang=en. (Accessed 3 April 2017).

World Health Organization. (2012). Sexual Health.

World Health Organization. (2015a). *Obesity and overweight, media center.*

World Health Organization. (2015b). Physical activity.http://www.who.int/dietphysicalactivity/pa/en/index.html.

World Health Organization. (Geneva, 2006). Defining sexual health: Report of a technical consultation on sexual health, 28-31 January 2002. In: World Health Organization (ed). *Sexual health document series:*, pp 1-30.

World Health Organization. Obesity and overweight 2018. Geneva, S. W. H., www.wpro.who.int/mediacentre/factsheets/, O. A. f., & 22., o. e. A. J. .

World Health Organization: Global Strategy on Diet, P. A., and Health. 2006 [http://www.who.int/dietphysicalactivity/en/index.html], 28 August 2009.

Yaylali, G. F., Tekekoglu, S., & Akin, F. (2010). Sexual dysfunction in obese and overweight women. *International Journal of Impotence Research*, *22*(4), 220-226. https://doi.org/http://dx.doi.org/10.1038/ijir.2010.7

Yildiz, H., & Bölüktas, R. P. (2015). Evaluation of sexual dysfunction in males with diabetes. *Sex Disability*, *33*(2), 187-205. https://doi.org/10.1111/dme.12177http://dx.doi.org/10.1007/s11195-015-9397-5

Yousef Abdulah Al, T. (2009). Should an inquiry about sexual health, as a reflection of vascular health, be part of routine physicals for young men? Results from an outpatient study. *International Journal of Impotence Research*, *21*(6), 362. https://doi.org/10.1038/ijir.2009.36

Zonderland, M. L., Erich, W. B., Erkelens, D. W., Kortlandt, W., Wit, J. M., Huisveld, I. A., & De Ridder, C. M. (1990). Plasma lipids and apoproteins, body fat distribution and body fatness in early pubertal children. *International Journal of Obesity*, *14*(12), 1039-1046.

Appendix A

Two review papers

International Journal of Sexual Health

ISSN: 1931-7611 (Print) 1931-762X (Online) Journal homepage: https://www.tandfonline.com/loi/wijs20

Does Metabolic Syndrome Impair Sexual Functioning in Adults With Overweight and Obesity?

Saeideh Botlani Esfahani & Sebely Pal

To cite this article: Saeideh Botlani Esfahani & Sebely Pal (2019) Does Metabolic Syndrome Impair Sexual Functioning in Adults With Overweight and Obesity?, International Journal of Sexual Health, 31:2, 170-185, DOI: 10.1080/19317611.2019.1611688

To link to this article: https://doi.org/10.1080/19317611.2019.1611688

INTERNATIONAL JOURNAL OF SEXUAL HEALTH
2019, VOL. 31, NO. 2, 170–185
https://doi.org/10.1080/19317611.2019.1611688

Does Metabolic Syndrome Impair Sexual Functioning in Adults With Overweight and Obesity?

Saeideh Botlani Esfahani and Sebely Pal

School of Public Health, Faculty of Health Sciences, Curtin University, Perth, Australia

ABSTRACT

Objectives: Obesity is a growing public health concern worldwide, and results in increased risk of cardiovascular disease, type 2 diabetes, metabolic syndrome, insulin resistance, dyslipidemia, hypertension, and reduced sex hormone production. Previous research suggests that obesity may contribute to sexual dysfunction. This review aims to determine the relationship between obesity and sexual dysfunction, and ascertain the associated cardiometabolic conditions that may contribute to impaired sexual functioning in individuals with obesity. *Methods:* Literature searches were conducted through PubMed and Embase from 1980 to 2016, to identify original research articles, reviews including systematic reviews and meta-analyses, using the search terms: obese, obesity, overweight, sexual function, sexual dysfunction, metabolic syndrome, CVD, T2D, hormones and weight loss. *Results:* This review found that individuals with obesity and cardiometabolic comorbidities were more likely to report the greatest degree or sexual dysfunction and/or reduction in sexual quality of life, compared to those without. *Conclusions:* Current evidence supports an association between sexual dysfunction and factors associated with obesity, such as reduced insulin sensitivity, dyslipidaemia, hypertension, and low oestrogen or testosterone. To establish efficacious treatments, research examining the impact of weight loss on the conditions associated with obesity, such as hypertension, reduced insulin sensitivity, dyslipidaemia, and low sex hormones and sexual functioning in individuals with overweight and obesity should be a priority.

ARTICLE HISTORY
Received 17 July 2018
Revised 19 March 2019
Accepted 20 April 2019

KEYWORDS
Metabolic syndrome; obesity; overweight; sexual dysfunction; sexual functioning

Introduction

Obesity is a growing public health concern worldwide, affecting both developed and developing countries. In 2014, the global estimate of overweight and obesity in adults was approximately 1.9 billion (World Health Organisation [WHO], 2015). Overweight and obesity increase the risk of a number of chronic diseases, such as cardiovascular disease (CVD), hypertension, stroke, Type 2 diabetes (T2D), and the metabolic syndrome (MS), itself a risk factor for the aforementioned conditions (Australian Institute of Health and Welfare, 2006; Lechleitner, 2008; Royal Australian College of General Practitioners National Standing Committee, 2006; Tsai, Wu, & Hsu, 2014). Research has also shown excessive body weight to be associated with sexual dysfunction, although this has not been investigated extensively (Esposito et al., 2008; Larsen, Wagner, & Heitmann, 2007).

Proper sexual functioning is an integral component of health (WHO, 2006). Physiologically, sexual functioning is broadly defined in terms of reproductive function, as well as the frequency of desire, arousal, lubrication, orgasm, pain, satisfaction, as well as the effect of sex hormones testosterone and estrogen (DeLamater & Karraker, 2009; Rosen, 2000; Rosen, Cappelleri, & Iii, 2002). Global epidemiological data shows the prevalence of sexual dysfunction to be approximately 40–45% in women and 20–30% in men (Aschkenazi & Goldberg, 2009; Lewis et al., 2004). In addition, an association may exist between obesity and sexual dysfunction; this association may be facilitated by the concomitant increase in mental health problems often associated with obesity, such as low self-esteem (Esfahani & Pal, 2018), however this complex

CONTACT Sebely Pal S.Pal@curtin.edu.au School of Public Health, Faculty of Health Sciences, Curtin University, GPO Box U1987, Perth, WA 6845, Australia

interrelationship warrants a separate, more detailed discussion. Therefore, a better understanding of the effect of obesity and MS (eg. hypertension, dyslipidemia, and insulin resistance) on sex hormone production and sexual functioning in adults with overweight and obesity is necessary. The aim of this review is to examine the relationship between overweight and/or obesity and sexual functioning, and to determine the impact of the associated metabolic changes on sexual functioning. Literature searches were conducted through PubMed and Embase from 1980 to 2016, to identify original research articles, reviews including systematic reviews and meta-analyses, using the following search terms: *obese*, *obesity*, *overweight*, *sexual function*, *sexual dysfunction*, *metabolic syndrome*, *CVD*, *T2D*, *hormones*, and *weight loss*. Articles were selected based on the title and abstract and/or the full text article.

Definition of sexual dysfunction

Currently, there is no universally recognized definition of sexual dysfunction (Boyle, Cook, Purdie, Najman, & Dunne, 2003; Lewis et al., 2004), without which accurate prevalence rates are difficult to determine (Lewis et al., 2004). To establish such a definition, an International Consultation Committee was assembled, consisting of over 200 multidisciplinary experts in urology and sexual medicine from 60 countries; these consultations resulted in the following criteria of male and female sexual dysfunction (Lewis et al., 2004):

- *Sexual desire dysfunction:* Diminished sexual interest or desire, sexual thoughts and fantasies, more common in females
- *Persistent sexual arousal dysfunction:* Spontaneous, intrusive, and unwanted genital arousal in the absence of sexual desire.
- *Orgasmic dysfunction:* The lack, delay, or significantly diminished quality of orgasmic sensation.
- *Sexual aversion:* Extreme disgust and/or anxiety in response to anticipated or attempted sexual activity.
- *Sexual arousal disorder in females:* The presence of genital sexual arousal dysfunction, subjective sexual arousal dysfunction, or both. Genital sexual arousal: absent or impaired genital arousal; subjective sexual arousal dysfunction: absent or diminished feelings of sexual arousal or pleasure.
- *Dyspareunia in females:* Pain that persists or recurs with complete or attempted vaginal penetration.
- *Vaginismus in females:* Persistent or recurrent difficulty with vaginal penetration, despite the willingness to do so.
- *Erectile dysfunction in males:* The inability to attain and/or maintain penile erection sufficient for sexual activity.
- *Early ejaculation in males:* Ejaculation before or shortly after sexual stimulation, and occurring earlier than desired.
- *Delayed ejaculation in males:* Unwonted delay in attaining orgasm during sexual activity.
- *Anejaculation in males:* The absence of ejaculation during sexual stimulation.

During their consultations, the Committee identified the International Index of Erectile Functioning (IIEF; Rosen et al., 2002) and the Female Sexual Function Index (FSFI; Rosen, 2000) as comprehensive, well-validated indices for classification of the severity of sexual dysfunction (Lewis et al., 2004). Although there are several other validated instruments available to assess sexual functioning, this review focusses on the IIEF and the FSFI only to allow for consistent cross-referencing between studies, where possible.

Prevalence of sexual dysfunction

Based on the above criteria, the Committee then reviewed evidence-based reports to determine the global prevalence of sexual dysfunction. The results of this review, supported by the WHO (Fugl-Meyer et al., 2004; Lewis et al., 2004), show that globally, approximately 40–45% of women and 20–30% of men reported at least one sexual dysfunction (Lewis et al., 2004). In women,

- Prevalence of low sexual desire was 17–55%, increasing with age.
- Prevalence of arousal and lubrication disorders was 8–15% in nonsexually active, which increased to 21–28% in sexually active.
- Prevalence of orgasmic dysfunction varied by region. Western societies had a rate of 25% in 18–74 year old females, while Nordic countries

reported an 80% prevalence in the same age group.
- Global approximations of vaginismus were difficult to determine, however the Committee were able to report a rate of 6% in Morocco and Sweden.
- Although an approximate global rate of dyspareunia was not determined, prevalence was between 18 and 20% in British and Australian studies.

Research in men primarily focused upon erectile dysfunction; however the Committee assessed epidemiological studies on other male sexual dysfunctions, as follows (Lewis et al., 2004):

- The prevalence of erectile dysfunction for men under 40 years was 1–9%, for men aged 40–59 this ranged from 2–9% to 20–30%, for men aged 60–69 it was 20–40%, and for men aged in the 70s and 80s it was 50–75%.
- The global prevalence of early ejaculation ranged from 9% to 31%.
- There was limited epidemiological data on orgasmic dysfunction in males, although for men in France and the United States the prevalence was 7%.
- There was a lack of evidence for the prevalence of genital pain in men, therefore no approximate global rate was determined.

The above-mentioned prevalence rates reveal sexual dysfunction to be a significant public health issue. In addition, according to an Australian survey of general practice patients, 57.8% of men (McCabe & Connaughton, 2014) and 41% of women experienced sexual dysfunction (Dunn et al., 2000). Furthermore, the Australian Study of Health and Relationships found lack of desire, early ejaculation, and anxiety about sexual performance to be the most common sexual dysfunctions in men, whereas lack of sexual desire and orgasmic dysfunction were common in women (Richters, Smith, Grulich, De Visser, & Rissel, 2003). Boyle et al. (2003) conducted a study of sexual dysfunction in the Australian population with 1,793 male (n = 876) and female (n = 908) participants aged 18–59 years, and reported prevalence rates of 55% in men and 60% in women. Specifically, 42% of men and 41% of women reported one to two symptoms of sexual dysfunction, and 13% of men and 20% of women reported three or more symptoms (Boyle et al., 2003). Only 6% of participants with sexual dysfunction had sought help, a behavior that was more common in older respondents (Boyle et al., 2003).

Assessing sexual function

International index of erectile function

As noted above, the International Consultation Committee identified the IIEF as a well-validated measure of sexual functioning in men (Lewis et al., 2004). The IIEF, developed by Rosen et al. (2002), measures male sexual functioning by the following five domains—erectile function, orgasmic function, sexual desire, intercourse satisfaction, and overall sexual satisfaction—to produce an overall sexual functioning score. This instrument demonstrated a high level of specificity and sensitivity when used to assess sildenafil (Viagra) treatment for patients with erectile dysfunction; in addition, a high degree of internal consistency, discriminant validity, and test–retest reliability that was observed across all five domains (Rosen et al., 2002).

Female sexual functioning index

Similarly, the International Consultation Committee identified the FSFI as a well-validated, appropriate measure of sexual functioning in women (Lewis et al., 2004). Also developed by Rosen et al. (2000), the FSFI measures female sexual functioning by the following six domains—desire, arousal, lubrication, orgasm, satisfaction, and pain—to produce an overall sexual functioning score. When assessed for internal and test–retest reliability, discriminant validity, and divergent validity, the FSFI showed a high degree of validity in each component (Rosen et al., 2000).

Association with obesity

Prevalence of sexual dysfunction in individuals with overweight and obesity

Limited academic literature exists investigating the relationship between body weight and sexual functioning (Kolotkin et al., 2006). Larsen et al. (2007) reviewed the available medical literature concerning

sexual functioning and obesity from 1966 onwards and found no evidence that sexual dysfunction causes obesity, however there is strong evidence to indicate that obesity can cause sexual dysfunction, particularly erectile dysfunction. Evidence of an association between obesity and sexual dysfunction in women is beginning to emerge. For example, multinational data examining associations between several cardiometabolic risks in women (MS, hypertension, dyslipidemia, T2D, and obesity) and sexual dysfunction reported that women with cardiometabolic risk factors are more likely to experience sexual dysfunction than those without such risk factors (Miner, Esposito, Guay, Montorsi, & Goldstein, 2012). In addition, a recent study by Cortelazzi et al. (2013) showed that 75% of women with T2D (body mass index [BMI] = 29.7) experienced sexual dysfunction compared to 52% in women without T2D (control group; BMI = 25.9); severe sexual dysfunction was more than double for women with T2D compared control (26% vs. 11.5%).

Other studies have resulted in similar findings. To investigate the association between sexual quality of life and obesity, Kolotkin et al. (2006) conducted a cross-sectional prevalence study with prospective weight loss treatment candidates, who were either patients awaiting gastric bypass surgery ($n = 500$; mean BMI = 41.3kg/m^2), participants on a wait list for an intensive weight loss program ($n = 500$; mean BMI = 47.1kg/m^2), or a control group ($n = 286$; mean BMI = 43.6kg/m^2). Results showed a statistically significant negative association between sexual quality of life and BMI ($p < .001$) (Kolotkin et al., 2006). By sex, women reported greater sexual dysfunction than men, and of the three groups, surgery patients reported the greatest sexual dysfunction, whereas individuals who opted for the weight loss program reported sexual quality of life greater than or equal to the control group (Kolotkin et al., 2006). These results demonstrate the reduced quality of life and/or impairment in sexual functioning experienced by individuals with obesity, however more research is required to substantiate these associations.

Weight loss

Given this association of obesity with sexual dysfunction, investigating the effect of weight loss on sexual dysfunction in individuals with obesity is necessary. A review of the beneficial effects of weight management on sexual functioning produced inconclusive results (Larsen et al., 2007), however some of the included studies found individuals with overweight and obesity to report better sexual functioning after weight loss (Moore et al., 2013; Mora et al., 2013). A study 2-year by Kolotkin et al. (2008) with 187 patients undergoing weight loss treatment—consisting of meetings with a dietitian, personalized diets, exercise regime, and medication—measured sexual quality of life as well as BMI and found reductions in BMI to be significantly associated with improvements in sexual quality of life ($p < .0001$). This study reported a mean weight loss of 13.1% of baseline body weight over the trial period, though the greatest reduction occurred at three months (Kolotkin et al., 2008). This study may have benefited from the identification of a possible psychopathological pathway between weight loss and improved sexual quality of life; therefore this factor cannot be eliminated as confounder. Nevertheless, this research demonstrates the benefits of weight loss by dietary and physical activity intervention on sexual functioning (Kolotkin et al., 2008).

Similar results have been found in studies of obesity and sexual dysfunction in men (as assessed by the IIEF). For example, male sexual functioning was reported to improve postphysical activity (Hsiao et al., 2011) and dietary (Khoo, Piantadosi, Worthley, & Wittert, 2010) weight loss interventions. Evidence has also been found to demonstrate that men with obesity and erectile dysfunction experienced improved sexual functioning following lifestyle modifications for weight loss (Esposito et al., 2004). An 8-month study in men with overweight and obesity reported increased levels in testosterone, sex-hormone-binding globulin, high-density lipoprotein-cholesterol as well as decreased levels of insulin and leptin, after 17 kg weight loss following bariatric surgery (Kaukua, Pekkarinen, Sane, & Mustajoki, 2003). In addition, a 2-year study of male bariatric patients reported improvement in erectile functioning following 24 kg weight loss compared to men in the wait-list control group (Reis et al., 2010).

Prospective studies investigating the relationship between weight loss and female sexual functioning were less abundant, although there is some evidence of an association between treatment for obesity and/or MS and improved sexual functioning in women (Miner et al., 2012). Kim et al. (2006) investigated this issue in 46 women with overweight and obesity receiving daily doses of 10 mg sibutramine along with behavioral therapy over 8 weeks, and measured sexual functioning using the FSFI. Results showed reductions body weight to be significantly associated with improvements in sexual functioning, specifically in arousal and orgasm scores ($p < 0.05$) (Kim et al., 2006). Women participating in a 2-year weight reduction trial, combining medication with dietary counselling, reported improvements in sexual quality of life after 3 months, following a mean weight loss of 11.7% of initial body weight (Kolotkin et al., 2008). Improvements were substantial across all domains (e.g., sexual attractiveness, desire, performance, enjoyment of being seen undressed, and avoidance of sexual encounters; Kolotkin et al., 2008). In addition, 32.2% of women who achieved a healthy weight (i.e., BMI $< 30\,kg/m^2$) following weight loss surgery reported a significant improvement in sexual desire, arousal, lubrication, satisfaction, and total sexual function as well as a decrease in pain during intercourse, as assessed by the FSFI (Assimakopoulos et al., 2011).

Standalone dietary treatments for individuals with obesity and sexual dysfunction have been trialed in a relatively small number of studies, and mainly with male participants. Khoo (2010) investigated the impact of low-energy weight loss diet on the sexual functioning of males with T2D compared to males without T2D, and a standard diet control ($n = 26$, 25, and 26, respectively), by measuring changes to weight, waist circumference, insulin sensitivity, plasma testosterone, erectile functioning, sexual desire, and lower-urinary tract symptoms. Weight loss was associated with increased insulin sensitivity, erectile functioning, sexual desire, and plasma testosterone in participants both with and without T2D, however participants with T2D reported a greater improvement in erectile functioning than those without T2D (Khoo, 2010).

Further work by Khoo et al. (2011, 2014) followed up this research with two further studies investigating the effects of dietary interventions on sexual function in men with obesity. One compared a high-protein, carbohydrate-reduced, low-fat diet to a low-energy diet and examined changes to sexual and endothelial function, inflammation, and urinary tract symptoms in a 1-year study with 31 men with obesity and T2D (Khoo et al., 2011). The results show that diet-induced weight loss can improve sexual, endothelial, and urinary function in this subgroup (Khoo et al., 2011). In addition, the high-protein, carbohydrate-reduced, low-fat diet group sustained these benefits for 1 year, as well as decreased systemic inflammation (Khoo et al., 2011). The other study compared the effects of a partial meal replacement plan with a conventional reduced-fat diet on weight, testosterone, sexual, and endothelial function, and quality of life in Asian men with obesity (Khoo et al., 2014). The initial 12-week intervention resulted in significant reductions in weight (4.2 ± 0.8 kg), and waist circumference (4.6 ± 0.7 cm) in the meal replacement group, compared the fat-reduced diet group (2.5 ± 0.4 kg, 2.6 ± 0.5 cm; Khoo et al., 2014). Erectile function, sexual desire, testosterone, endothelial function, and quality of life all showed greater improvements in the meal replacement group compared to the conventional diet group (Khoo et al., 2014). In addition, improvements in weight, waist circumference and erectile function were maintained after all participants were switched to (or stayed following) the conventional fat-reduced diet for a further 28 weeks (Khoo et al., 2014).

Studies examining the effect of diet on sexual functioning in women are scarce. Giugliano et al. (2010) conducted a cross-sectional study investigating the relationship between a Mediterranean-style diet and sexual function in women with overweight and obesity and T2D. The results showed that women with the highest FSFI scores had lower BMI, waist circumference, a lower prevalence of MS, better blood glucose and blood lipids, and higher physical activity levels, compared to women with the lowest scores (Giugliano et al., 2010). Although these results provide some evidence of the benefits of diet

and/or weight loss on sexual functioning in women with obesity and/or T2D, the paucity of studies with women in this area demonstrates the need for further research.

Although the evidence is scarce, some studies suggest that there may be a relationship between increased physical activity and improvement of sexual functioning (Bacon et al., 2003; Esposito & Giugliano, 2005; Esposito et al., 2004). A review of obesity and sexual function reported that individuals with obesity are less likely to be physically active than healthier-weight individuals (Larsen et al., 2007). An epidemiological study showed increased physical activity to be associated with lower risk of erectile dysfunction (Laumann, Paik, & Rosen, 1999); meanwhile a prospective study found both obesity and physical inactivity to be associated with sexual dysfunction (Derby et al., 2000). Esposito et al. (2008) evaluated the effect of weight loss and increased physical activity on erectile dysfunction in men with obesity and found sexual function improved in one-third of the men after 2 years; however the study failed to determine whether improved sexual functioning was due to weight loss or an increase in physical activity. Fewer studies have examined the effect of physical activity and sexual function in women. Dabrowska et al. (2010) assessed self-reported physical activity and sexuality in premenopausal Polish women, and reported that impaired sexual functioning was less frequent among women with moderate and high physical activity. This provides some indication of the positive impact of physical activity and/or weight loss, via various intervention methods, on sexual functioning in both men and women, however further research should examine the effects of alternative weight management methods on these variables.

Sexual dysfunction and sex hormones

There is limited research into the relationship between obesity and the sex hormones, however fat accumulation is known to impact men and women in different ways (Power & Schulkin, 2008). A strong association exists between sexual dysfunction and low testosterone in men, and low estrogen in women (Basson, 2006; Jones, 2007), however there is limited evidence of the effects of excess body weight on testosterone/estrogen production (Basson, 2006; Dhindsa et al., 2010; Diaz-Arjonilla et al., 2008; Yaylali, Tekekoglu, & Akin, 2010). Observational research has shown testosterone to be lower in men with obesity, although clear evidence of the etiology is yet to be determined (Diaz-Arjonilla et al., 2008). Given that testosterone is positively associated with erectile functioning, it has been suggested that low testosterone may act as a contributing factor for erectile dysfunction in obese males (Jones, 2007; Larsen et al., 2007; Mikhail, 2006). Some studies have reported erectile functioning and testosterone to be negatively correlated with BMI (Diaz-Arjonilla et al., 2008; Kratzik, Schatzl, Lunglmayr, Rucklinger, & Huber, 2005), although there are no interventional studies investigating the effect of weight loss on these variables in men with obesity.

Evidence of the effect of obesity on estrogen and sexual functioning is very limited (Basson, 2006). Research in women of healthy weight has shown low estrogen levels to be associated with vaginal atrophy and reduced vaginal blood circulation (indicating reduced arousal), which negatively impact sexual functioning (Basson, 2006; Stenberg, Heimer, Ulmsten, & Cnattingius, 1996). Research has also shown that sexual functioning in women with obesity is typically poorer than those of healthy weight (Kolotkin, Crosby, Gress, Hunt, & Adams, 2009; Metwally, Li, & Ledger, 2007). In a case-control study investigating sexual dysfunction in women with overweight, Yaylali et al. (2010) found reduced sexual functioning to be associated with increased BMI, although there was no significant association between estradiol and BMI. The impact obesity has on estrogen production and the effect this has on sexual functioning, as well as whether weight loss can improve estrogen levels and/or improve sexual functioning, are issues in need of further research.

The metabolic syndrome

Insulin resistance and sexual functioning

Insulin is necessary for the regulation of carbohydrate and fat metabolism, allowing liver, muscle,

and fat tissues to use glucose from the blood. A reduction in insulin sensitivity decreases glucose uptake and raises blood-sugar levels, which can lead to metabolic complications such as the MS and T2D (Esposito et al., 2008). Obesity is a significant risk factor for such metabolic conditions (Esposito et al., 2008; Grievink, Alberts, O'Niel, & Gerstenbluth, 2004), therefore it is important to determine if sexual functioning is influenced by the MS or T2D. This section will examine the possibility of an association between these metabolic conditions and sexual functioning.

There is limited research into the relationship between insulin resistance and sexual functioning, despite individuals with obesity being at greater risk of both of these conditions (Esposito et al., 2008; Kolotkin et al., 2006). Esposito et al. conducted a review that highlighted an association between sexual dysfunction and the MS in both males and females and found that in men, the MS was identified as a risk factor for erectile dysfunction. An earlier uncontrolled prospective study supported this finding, such that 29% of males with sexual dysfunction also had the MS, and of these 96% had erectile dysfunction, 40% had hypoactive sexual disorder, 23% experienced premature ejaculation, and 5% experienced delayed ejaculation (Corona et al., 2006). Hypogonadism—indicating lower levels of circulating testosterone and is associated with erectile dysfunction—was also shown to be a risk factor for the MS (Esposito et al., 2008; Kupelian et al., 2006). This evidence suggests that male sexual function was associated with insulin resistance, and demonstrates a relationship between male sexual dysfunction and the MS.

Although there is limited research examining the relationship between sexual functioning and insulin sensitivity in relation to the MS or T2D in general, there is less research in relation to females in particular (Enzlin, Mathieu, Van Den Bruel, Vanderschueren, & Demyttenaere, 2003; Esposito et al., 2005). However the above-mentioned review identified a link between female sexual dysfunction and the MS as a condition associated with obesity (Esposito et al., 2008). A case-control study (n=100) conducted to determine whether the MS was associated female sexual dysfunction—as assessed by the FSFI and included such measures as cholesterol, triglyceride, glucose, and C-reactive protein—found women with the MS to report lower FSFI scores compared to their controls (Esposito et al., 2005). In particular, women with the MS reported lower arousal, lubrication, orgasm, and satisfaction scores when compared to their controls (Esposito et al., 2005). Furthermore, sexual dysfunction was found to be positively correlated with the severity of the MS (Esposito et al., 2005). Although these results suggest an association, the influence of the MS on female sexual functioning needs to be substantiated by randomized controlled trials.

The relationship between sexual functioning and insulin resistance—a characteristic of T2D—can also be examined by investigating the association between sexual functioning and T2D (Esposito et al., 2008). Research by Sayuk et al. (2011) in patients with T2D demonstrated a positive association between sexual dysfunction and T2D and hyperglycaemia, demonstrating a connection between insulin resistance and sexual dysfunction and providing further evidence of the magnitude of this condition in individuals with obesity, a population who already at a greater risk of impaired sexual functioning (Kolotkin et al., 2006).

Insulin resistance and sexual functioning in males

Research has demonstrated a connection between insulin sensitivity and sexual functioning in men. A cross-sectional study of 376 male T2D patients found 83% suffered from erectile dysfunction during the course of their disease (AlMogbel, 2014). Insulin resistance is closely associated with the MS; sexual dysfunction is evident in males with this condition (Corona et al., 2006; Esposito et al., 2005), specifically an increased severity of erectile dysfunction (Corona et al., 2006). Esposito et al. (2005) investigated the prevalence of erectile dysfunction in men with the MS (n = 100) and found a positive association between erectile dysfunction and severity of the MS; in addition, higher IIEF scores were positively associated with better endothelial functioning (Esposito et al., 2005). Furthermore, the symptoms of hypogonadism such as low testosterone and a tendency to weight gain may exacerbate

sexual dysfunction and in men with the MS (Corona et al., 2006; Dhindsa et al., 2010; Mikhail, 2006). This is particularly important for individuals with obesity, who are at greater risk for erectile dysfunction as well as the MS.

T2D is relatively common in individuals with obesity (Australian Institute of Health and Welfare, 2006). Research has shown that men with T2D are at an increased risk for erectile dysfunction (Awad, Salem, Gadalla, Wafa, & Mohamed, 2009). Age, hyperglycaemia, and the presence of the MS, hypertension, and/or dyslipidemia are also significant risk factors for erectile dysfunction in males with T2D (Giugliano et al., 2004); specifically, poor glycemic control (Awad et al., 2009). Impairment of erectile function may be a consequence of the vasculopathy associated with poor blood glucose control in men with T2D, resulting in damage to the nerves and blood vessels regulating blood flow to the penis (Yildiz & Bölüktas, 2015).

Insulin resistance and sexual functioning in females

Although there is some evidence of sexual dysfunction in women with obesity, there is limited research into the effect of MS and/or T2D and female sexual functioning (Esposito et al., 2005; Rutherford & Collier, 2005); however, the risk of sexual dysfunction appears to be greater in women with obesity compared to a healthy weight cohort (Yaylali et al., 2010). In a previously cited case-control study, Esposito et al (2005) investigated the impact of MS on sexual functioning in 100 women with obesity and the MS and reported that women with these conditions had lower sexual functioning—as assessed by the FSFI—compared to age- and BMI-matched controls, although a causal relationship was not established. In a separate study, Esposito et al. (2007) investigated this issue in 59 women with obesity and the MS, 31 of whom participated in a dietary weight loss intervention, compared to controls ($n = 28$) over 2 years and found the intervention group to have significant improvements in sexual functioning ($p = 0.01$), whereas the control FSFI scores remained stable. Furthermore, insulin sensitivity improved in the intervention group, although correlations with sexual functioning improvements were not conducted (Esposito et al., 2007). While the mechanisms remain unclear, this research provides strong evidence of the positive influence of weight loss - via dietary changes - on female sexual functioning and insulin sensitivity.

Rutherford and Collier (2005) reviewed the available literature and noted that a reduction in vaginal vasocongestion—associated with reduced nitric oxide and necessary for tumescence—resulted from diabetic vascular disease. In addition, this reduction in vaginal vasocongestion had repercussions on female sexual functioning, resulting in dyspareunia and reduced clitoral sensation (Rutherford & Collier, 2005). Furthermore, these researchers found evidence of reduced sex hormone-binding globulin as well as serum androgen excess in females with T2D but noted improved sexual functioning following hormone replacement therapy (Rutherford & Collier, 2005). Decreased sexual activity and sexual satisfaction in women with T2D have been associated with decreased clitoral blood flow, resulting from damage to the vascular and autonomic nervous system (Cortelazzi et al., 2013). Although the research investigating possible relationships is minimal, the existing evidence illustrates the impact such metabolic conditions can have on female sexual functioning.

Dyslipidemia and sexual functioning

Dyslipidemia (elevated cholesterol) is a risk factor for atherosclerosis (narrowed and inflexible arteries), and can lead to heart attack, stroke, and other CVDs (Ravnskov, 2002). Although the link between obesity and dyslipidemia is well-established, there is limited research into the effect of dyslipidemia on sexual functioning (Gonen, Halverson, & Schonfeld, 1983). Some research exists investigating this association in males but was notably lacking in females.

Dyslipidemia and sexual functioning in males

To determine the relationship between testosterone deficiency and cardiovascular risk factors, Garcia-Cruz et al. (2012) conducted a study with 384 prostate biopsy patients and found low

testosterone to be associated with hypertension, dyslipidemia, T2D, and overweight, although the nature of the relationship was not explained. Other research examining obesity and sexual functioning has observed an association between erectile dysfunction and dyslipidemia (Larsen et al., 2007; Vrentzos, Paraskevas, & Mikhailidis, 2007), which may diminish erectile function by impairing endothelial and smooth muscle cells of the penis (Vrentzos, Paraskevas, & Mikhailidis, 2007). A review by Vrentzos et al. (2007) found a notable prevalence of erectile dysfunction in men with dyslipidemia, and identified dyslipidemia as a significant risk factor, suggesting that it may reduce nitric oxide in the penile and vascular tissue. In addition, these investigators found high total cholesterol and reduced high density lipoprotein (cholesterol) to impair endothelial function, which was associated with an increased risk of erectile dysfunction; whereas oxidized low density lipoprotein impaired the relaxation response of the corpus cavernosum (Vrentzos et al., 2007).

Interestingly, a review by Larsen et al. (2007) identified dyslipidemia as a common condition in men with erectile dysfunction, noting that hypolipidemic medications also had the potential to cause erectile dysfunction, although this effect was only recorded in smaller studies in the review (Larsen et al., 2007). Four possible mechanisms explaining the relationship between erectile dysfunction and hypolipidemic medications have been postulated (Vrentzos et al., 2007):

1. They may reduce blood pressure;
2. Erectile dysfunction may be a side effect;
3. Reduced cholesterol synthesis may inhibit testosterone synthesis, resulting in erectile dysfunction;
4. Confounding factors may influence the relationship, including other CVD risk factors.

Although questions remain regarding the impact of hypolipidemic medications on erectile function, it is critical that alternative methods of improving lipid profiles, such as dietary measures, are investigated to determine the impact on sexual functioning in men with dyslipidemia.

Dyslipidemia and sexual functioning in females

Among the limited literature available, an association between dyslipidemia and female sexual dysfunction has been reported. An investigation of the prevalence of sexual dysfunction in women with overweight or obesity and T2D (n = 595; Esposito et al., 2010) found dyslipidemia to be significantly associated with female sexual dysfunction, although other possible covariates were not examined. On the other hand, earlier studies reported contradictory results. For example, in a case-control study of Jordanian women with and without T2D (n = 1137), Ali (2008) failed to demonstrate a relationship between dyslipidemia and total female sexual dysfunction scores, however the FSFI scores were not significantly different when comparing cases to controls.

Hypertension and sexual functioning

Obesity and hypertension contribute significantly to CVD risk (Sowers & Sowers, 1999). Hypertension also contributes to sexual dysfunction in men and women, although far less is known of the impact in women, compared to men (Doumas et al., 2005; Duncan, Lewis, Jenkins, & Pearson, 1997; Yousef Abdulah Al, 2009).

Hypertension and sexual functioning in males

Unlike associations between other conditions of the MS and erectile functioning, a considerable amount of research has been reported regarding the relationship between hypertension and erectile dysfunction (Doumas et al., 2005; Esposito et al., 2010; Larsen et al., 2007; Ledda, 2000; Yousef Abdulah Al, 2009). Because hypertension and other metabolic complications coexist, this research typically includes observations of metabolic conditions, such as T2D. For example, Feldman et al. (Feldman, Goldstein, Hatzichristou, Krane, & McKinlay, 1994) found that hypertension and T2D were both independent risk factors for erectile dysfunction. Subanalysis showed that erectile dysfunction in men aged between 40 and 70 years was 52%, whereas in younger men with T2D the prevalence of impotence was 75%, most likely due to the

relaxation of the penile smooth muscle (Feldman et al., 1994; Hakim & Goldstein, 1996; Ledda, 2000).

Doumas et al. (2005) investigated the effect of hypertension duration and severity on erectile function in a study with participants aged 31–65 years ($n = 358$), which showed duration of hypertension to significantly impair erectile function ($p < .0001$), and reported the following: prevalence of erectile dysfunction was 14% for participants with hypertension for up to 3 years; 28% for those with hypertension for 3 to 6 years; and 60% for those with hypertension for more than 6 years. The severity of hypertension was also associated with erectile dysfunction, such that 24% of participants with Stage 1 hypertension were effected, whereas for participants with Stage 2 it was 44.6%, with the strength of the relationship increasing with age (Doumas et al., 2005).

In light of this, it is important to determine if other vascular risk factors may contribute to erectile dysfunction. Using data from the free voluntary annual health screening service in Vienna, Ponholzer et al. (2006) investigated vascular risk factors in men aged 30–59 years ($n = 1519$) and found no association between erectile functioning and blood pressure, BMI, and waist/hip ratio, however age ($p < .01$), total cholesterol ($p < .04$), and low density lipoprotein ($p < .01$) were significantly associated with erectile dysfunction. It should be noted that these results may have been due to the relatively low mean age of the sample (42.9 ± 7.9 years) (Ponholzer et al., 2006).

Although antihypertensive medications (AHT) may successfully treat hypertension, documented side-effects include negative effects on sexual wellbeing (Chiesa, Pfiffner, Meier, & Hess, 2003; Duncan et al., 1997). To examine this, Chiesa et al. (2003) evaluated the side effects of a newer AHT (Valsartan), on sexual activity in men with hypertension, mean age of 54 years ($n = 2202$), compared to controls who received either β-blockers, angiotensin converting enzyme inhibitors, calcium-channel blockers, or diuretics. Blood pressure decreased significantly for all groups; the conventional AHTs used in the control group resulted in reduced sexual activity, whereas patients treated with the newer AHT medication reported increased sexual activity (Chiesa et al., 2003). It may be that conventional AHTs reduce blood pressure to the extent that there is insufficient pressure to fill small caliber pelvic blood vessels, resulting in impaired erectile functioning (Okeahialam & Obeka, 2006).

To determine if the impact of conventional AHTs on erectile functioning could be countered, Aranda et al. (2004) studied the effect of sildenafil administration and reported improved erectile functioning in hypertensive patients. According to the Sexual Health Inventory for Men, sildenafil improved erectile functioning in 83.2% of 975 participants with hypertension and erectile dysfunction as it appears to inhibit phosphodiesterose-5 in the corpus cavernosum, thereby increasing penile response to sexual stimulation (Ali, 2010). Another study examining this medication reported that sildenafil significantly improved erectile functioning, orgasmic functioning, intercourse satisfaction, and overall satisfaction compared to controls ($p < .0001$) (Ali, 2010). This latter result may be explained by the fact that sildenafil users need to take this medication when they anticipate sexual activity. Therefore, alternative treatments for hypertension such as weight loss need to be explored to determine the safety and efficacy of this measure as an alternative to AHTs and/or sildenafil.

Hypertension and sexual functioning in females

There has been less research investigating the effect of hypertension on female sexual functioning, compared to research conducted regarding these issues in males. One study reported a lower libido in women with hypertension when compared to those without (Okeahialam & Obeka, 2006). The 2-year Treatment of Mild Hypertension Study investigated the impact of AHTs on sexual functioning in men ($n = 557$) and women ($n = 345$) with hypertension receiving either Acebutolol, Amlodipine maleate, Chlorthalidone, Doxazosin maleate, or Enalapril maleate, compared to a placebo (Grimm et al., 1997). Less than 5% of women reported sexual dysfunction at baseline, with no statistically significant results compared to controls, or patients receiving the AHTs; therefore no association

between female sexual functioning and hypertension could be established (Grimm et al., 1997). The use of a nonvalidated questionnaire to determine female sexual functioning may have been a limiting factor in this study (Grimm et al., 1997).

Okeahialam and Obeka (2006) conducted an investigation in Nigeria with newly diagnosed, untreated patients with hypertension ($n = 44$), as well as patients being treated for hypertension with the diuretic thiazide ($n = 29$), compared to normotensive controls ($n = 43$). Female sexual dysfunction was reported by 13.6% of newly diagnosed patients, 17.2% of treated patients, and 4.7% of normotensive patients and demonstrates a slightly higher risk of impaired sexual functioning in both treated and nontreated women with hypertension (Okeahialam & Obeka, 2006). These researchers postulated that AHTs may not improve this issue in women, such that the reduction in blood flow may result in insufficient pressure to fill the pelvic cavity, thereby reducing the vaginal mucus secretion required for penetration (Okeahialam & Obeka, 2006). In contrast, a case-control study by Duncan et al (1997) compared women with mild hypertension ($n = 107$), both medicated ($n = 67$) and nonmedicated ($n = 37$) to normotensive controls ($n = 107$) and found that all participants with hypertension in the study had significantly greater sexual dysfunction compared to controls, with no significant differences between scores for medicated and nonmedicated hypertensive participants. Based on this data, diuretic treatment may not be a viable option for women with hypertension and sexual dysfunction, therefore alternative treatments need to be investigated for women with these conditions.

In summary

As this review shows, there has been a greater research emphasis on sexual dysfunction in men than in women, therefore the following summarisation should be interpreted in like manner. The title *metabolic syndrome* refers to a collection of factors, including obesity, dyslipidemia, hypertension, and hyperglycemia (which we have referred to as *insulin resistance*, as this factor is responsible for high blood glucose levels). Nonetheless, it is becoming increasingly apparent that the detrimental effect of excessive weight gain on metabolic syndrome risk factors may also result in a concomitant decline in sexual functioning. More specifically, studies have found that individuals with obesity and cardiometabolic comorbidities reported the greatest degree or sexual dysfunction and/or reduction in sexual quality of life, compared to those without. A small number of studies have examined the effects of various weight management treatments on sexual dysfunction and found a reduction in BMI to be associated with improvements in sexual functioning. A smaller number of studies have investigated increased physical activity on sexual dysfunction, either in combination with a weight management program or as a standalone treatment, and reported improvements in sexual functioning following treatment.

According to the available literature, the effect of obesity on the production of sex hormones has not been studied to any great extent, however obesity has been associated with low circulating testosterone in men, a factor itself associated with erectile dysfunction. The multifactorial nature of the metabolic syndrome, often a complication of obesity and includes a reduced sensitivity to the hormone insulin, suggests that there are various other possible pathways between obesity and sexual dysfunction.

Insulin resistance has been associated with impaired sexual functioning, specifically erectile dysfunction, and it has been speculated that this may be due to the vasculopathy related to the poor regulation of blood glucose resulting from this condition. Similarly, there has been the suggestion that a reduction in the vasocongestion required for adequate sexual functioning in women may be associated with T2D—itself a consequence of prolonged insulin resistance—and the vascular damage that can occur with this condition. In addition, dyslipidemia has been associated with impaired erectile function, and it has been surmised that this may be due to either the diminished endothelial function associated with this condition, or to damage to the smooth muscle of the penis; whereas a relationship between dyslipidemia and sexual dysfunction in women with obesity is yet to be established.

Furthermore, a relatively large number of studies have demonstrated a significant association between hypertension and erectile dysfunction; however, while the use of AHTs results in a reduction in blood pressure, these medications have also been shown to produce varying effects on erectile function. The evidence of an association between hypertension and sexual dysfunction in women is less abundant. Nonetheless, it is possible that hypertension may result in reduced blood flow to the pelvic cavity and thus impair sexual functioning in women; in addition, AHTs do not appear to improve sexual functioning in women with this condition.

Clearly there is a complex interplay between the factors that comprise both MS and sexual dysfunction; so much so that all of the possible pathways between the all of the elements of these two conditions have yet to be firmly established. Conversely, MS may also be an aggregation of risk factors for sexual dysfunction, however further research is needed to clarify these issues.

Conclusion

Obesity has become a global epidemic and is associated with a number of chronic diseases, including the MS and related disorders, as well as sexual dysfunction. The relationship between sexual dysfunction and obesity is highly complex. Although there is strong evidence to support an association between these two factors, analysis of the relationship between sexual dysfunction and factors associated with obesity, such as reduced insulin sensitivity, dyslipidemia, hypertension, and low estrogen or testosterone, is limited. Regardless of the mediating mechanisms, there is some evidence to indicate that losing weight can improve sexual functioning in individuals with overweight and obesity suffering from sexual dysfunction, although the most efficacious weight loss method is yet to be determined.

Importance

Implications for future research and clinical practice

The dearth of evidence highlighted in this review demonstrates that more research is needed to elucidate the impact of obesity—and its metabolic consequences—on sexual functioning and to illustrate the complex interplay between these conditions. Furthermore, to establish efficacious treatment options, research examining the impact of weight loss on the conditions associated with obesity, such as hypertension, reduced insulin sensitivity, dyslipidemia, and low sex hormones and sexual functioning in men and women with overweight and obesity should be a priority. As well as bariatric surgery and pharmaceutical treatments, dietary weight management and/or physical activity programs should be trialed to establish options best suited to the hormonal and metabolic consequences of obesity and their effect on sexual functioning. The outcomes of this research may have important public health policy and practice implications and could place sexual functioning higher on the public health agenda in the treatment and prevention of obesity.

Acknowledgements

Monica Jane provided writing assistance in the preparation of this manuscript.

Disclosure statement

The authors declare no conflict of interest.

References

Abu Ali, R. M., Al Hajeri, R. M., Khader, Y. S., Shegem, N. S., & Ajlouni, K. M. (2008). Sexual dysfunction in Jordanian diabetic women. *Diabetes Care*, *31*(8), 1580. doi:10.2337/dc08-0081

Ali, S. (2010). Sildenafil citrate in the treatment of erectile dysfunction associated with hypertension. *Journal of Basic & Applied Sciences*, *6*(1), n/a.

AlMogbel, T. A. (2014). Erectile dysfunction and other sexual activity dysfunctions among Saudi type 2 diabetic patients. *International Journal of Health Sciences*, *8*(4), 347–359.

Aranda, P., Ruilope, L. M., Calvo, C., Luque, M., Coca, A., & Gil De Miguel, Á. (2004). Erectile dysfunction in essential arterial hypertension and effects of sildenafil: results of a Spanish national study. *American Journal of Hypertension*, *17*(2), 139–145. doi:10.1016/j.amjhyper.2003.09.006

Aschkenazi, S., & Goldberg, R. (2009). Female sexual function and the pelvic floor. *Expert Review of Obstetrics & Gynecology*. *4*(2),165–178. London: Informa Healthcare. doi:10.1586/17474108.4.2.165

Assimakopoulos, K., Karaivazoglou, K., Panayiotopoulos, S., Hyphantis, T., Iconomou, G., & Kalfarentzos, F. (2011). Bariatric surgery is associated with reduced depressive symptoms and better sexual function in obese female patients: A one-year follow-up study. *Obesity Surgery*, *21*(3), 362–366. doi:10.1007/s11695-010-0303-z

Australian Institute of Health and Welfare. (2006). *Chronic disease and associated risk factors in Australia, 2006*. Canberra: Australian Government.

Awad, H., Salem, A., Gadalla, A., Wafa, N. A. E., & Mohamed, O. A. (2009). Erectile function in men with diabetes type 2: Correlation with glycemic control. *International Journal of Impotence Research*, *22*(1), 36. doi:10.1038/ijir.2009.39

Bacon, C. G., Mittleman, M. A., Kawachi, I., Giovannucci, E., Glasser, DB, & Rimm, EB. (2003). Sexual function in men older than 50 years of age: Results from the health professionals follow-up study. *Annals of Internal Medicine*, *139*(3), 161–168. doi:10.7326/0003-4819-139-3-200308050-00005

Basson, R. (2006). Sexual desire and arousal disorders in women. *The New England Journal of Medicine*, *354*(14), 1497–1506. doi:10.1056/NEJMcp050154

Boyle, F. M., Cook, M. D., Purdie, D. M., Najman, J. M., & Dunne, M. P. (2003). Sexual dysfunction in the Australian population. *Australian Family Physician*, *32*(11), 951–954.

Chiesa, A. D., Pfiffner, D., Meier, B., & Hess, O. M. (2003). Sexual activity in hypertensive men. *Journal of Human Hypertension*, *17*(8), 515. doi:10.1038/sj.jhh.1001580

Corona, G., Mannucci, E., Schulman, C., Petrone, L., Mansani, R., Cilotti, A., … Maggi, M. (2006). Psychobiologic correlates of the metabolic syndrome and associated sexual dysfunction. *European Urology*, *50*(3), 595–604. doi:10.1016/j.eururo.2006.02.053

Cortelazzi, D., Marconi, A., Guazzi, M., Cristina, M., Zecchini, B., Veronelli, A., … Pontiroli, A. E. (2013). Sexual dysfunction in pre-menopausal diabetic women: clinical, metabolic, psychological, cardiovascular, and neurophysiologic correlates. *Acta Diabetologica*, *50*(6), 911–917. doi:10.1007/s00592-013-0482-x

Dabrowska, J., Drosdzol, A., Skrzypulec, V., & Plinta, R. (2010). Physical activity and sexuality in perimenopausal women. *European Journal of Contraception & Reproductive Health Care*, *15*(6), 423–432. doi:10.3109/13625187.2010.529968

DeLamater, J., & Karraker, A. (2009). Sexual functioning in older adults. *Current Psychiatry Reports*, *11*(1), 6–11. doi:10.1007/s11920-009-0002-4

Derby, C. A., Mohr, B. A., Goldstein, I., Feldman, H. A., Johannes, C. B., & McKinlay, J. B. (2000). Modifiable risk factors and erectile dysfunction: can lifestyle changes modify risk? *Urology*, *56*(2), 302–306. doi:10.1016/S0090-4295(00)00614-2

Dhindsa, S., Miller, M. G., McWhirter, C. L., Mager, D. E., Ghanim, H., Chaudhuri, A., & Dandona, P. (2010). Testosterone concentrations in diabetic and nondiabetic obese men. *Diabetes Care*, *33*(6), 1186. doi:10.2337/dc09-1649

Diaz-Arjonilla, M., Schwarcz, M., Swerdloff, R. S., & Wang, C. (2008). Obesity, low testosterone levels and erectile dysfunction. *International Journal of Impotence Research*, *21*(2), 89. doi:10.1038/ijir.2008.42

Doumas, M., Tsakiris, A., Douma, S., Hounta, A., Papadopoulos, A., Tsiodras, S., … Giamarellou, H. (2005). Determinants of erectile dysfunction in patients with essential hypertension. *American Journal of Hypertension*, *18*(5), A143–A143. doi:10.1016/j.amjhyper.2005.03.397

Dunn, K. M., Croft, P. R., & Hacket, G. I. (2000). Satisfaction in the sex life of a general population sample. *Journal of Sex & Marital Therapy*, *26*(2), 141–151. doi:10.1080/009262300278542

Duncan, L., Lewis, C., Jenkins, P., & Pearson, T. A. (1997). Does hypertension and its pharmacotherapy affect the quality of sexual function in women? *Circulation*, *96*(8), 3339–3339.

Enzlin, P., Mathieu, C., Van Den Bruel, A., Vanderschueren, D., & Demyttenaere, K. (2003). Prevalence and predictors of sexual dysfunction in patients with type 1 diabetes. *Diabetes Care*, *26*(2), 409.

Esfahani, S. B., & Pal, S. (2018). Obesity, mental health, and sexual dysfunction: A critical review. *Health Psychology Open*, *5*(2), 2055102918786867.

Esposito, K., Ciotola, M., Giugliano, F., Schisano, B., Autorino, R., Iuliano, S., … Giugliano, D. (2007). Mediterranean diet improves sexual function in women with the metabolic syndrome. *International Journal of Impotence Research*, *19*(5), 486. doi:10.1038/sj.ijir.3901555

Esposito, K., Ciotola, M., Marfella, R., Tommaso, D. D., Cobellis, L., & Giugliano, D. (2005). The metabolic syndrome: a cause of sexual dysfunction in women. *International Journal of Impotence Research*, *17*(3), 224. doi:10.1038/sj.ijir.3901310

Esposito, K., & Giugliano, D. (2005). Obesity, the metabolic syndrome, and sexual dysfunction. *International Journal of Impotence Research*, *17*(5), 391. doi:10.1038/sj.ijir.3901333

Esposito, K., Giugliano, F., Ciotola, M., De Sio, M., D'Armiento, M., & Giugliano, D. (2008). Obesity and sexual dysfunction, male and female. *International Journal of Impotence Research*, *20*(4), 358–365. doi:10.1038/ijir.2008.9

Esposito, K., Giugliano, F., Di Palo, C., Giugliano, G., Marfella, R., D'Andrea, F., … Giugliano, D. (2004). Effect of lifestyle changes on erectile dysfunction in obese men – A randomized controlled trial. *Journal of the American Medical Association*, *291*(24), 2978–2984. doi:10.1001/jama.291.24.2978

Esposito, K., Maiorino, M. I., Bellastella, G., Giugliano, F., Romano, M., & Giugliano, D. (2010). Determinants of female sexual dysfunction in type 2 diabetes. *International Journal of Impotence Research*, *22*(3), 179–184. doi:10.1038/ijir.2010.6

Feldman, H. A., Goldstein, I., Hatzichristou, D. G., Krane, R. J., & McKinlay, J. B. (1994). Impotence and its medical and psychosocial correlates: Results of the Massachusetts Male Aging Study. *The Journal of Urologu, 151*(1), 54–61. doi:10.1016/S0022-5347(17)34871-1

Fugl-Meyer, K. S., Lewis, R., Bosch, R., Fugl-Meyer, A. R., Laumann, E. O., Lizza, E., & Martin-Morales, A. (2004). Definitions, classification, and epidemiology of sexual dysfunction. In T. Lue, F. Giuliano, S. Khoury, F. Montorsi, & R. Rosen (Eds.), *Sexual medicine Volume 1: Sexual dysfunction in men and women* (pp. 1–36). Paris: Health Publications.

Garcia-Cruz, E., Piqueras, M., Huguet, J., Perez-Marquez, M., Gosalbez, D., Peri, L., … Alcaraz, A. (2012). Hypertension, dyslipidemia and overweight are related to lower testosterone levels in a cohort of men undergoing prostate biopsy. *International Journal of Impotence Research, 24*(3), 110. doi:10.1038/ijir.2011.55

Giugliano, F., Esposito, K., Di Palo, C., Ciotola, M., Giugliano, G., Marfella, R., … Giugliano, D. (2004). Erectile dysfunction associates with endothelial dysfunction and raised proinflammatory cytokine levels in obese men. *Journal of Endocrinological Investigation, 27*(7), 665–669. doi:10.1007/BF03347500

Giugliano, F., Maiorino, M. I., Di Palo, C., Autorino, R., De Sio, M., Giugliano, D., & Esposito, K. (2010). Adherence to Mediterranean diet and sexual function in women with type 2 diabetes. *The Journal of Sexual Medicine, 7*(5), 1883–1890. doi:10.1111/j.1743-6109.2010.01714.x

Gonen, B., Halverson, J. D., & Schonfeld, G. (1983). Lipoprotein levels in morbidly obese patients with massive, surgically-induced weight loss. *Metabolism, 32*(5), 492–496. doi:10.1016/0026-0495(83)90012-4

Grievink, L., Alberts, J. F., O'Niel, J., & Gerstenbluth, I. (2004). Waist circumference as a measurement of obesity in the Netherlands Antilles; associations with hypertension and diabetes mellitus. *European Journal of Clinical Nutrition, 58*(8), 1159–1165. doi:10.1038/sj.ejcn.1601944

Grimm, R. H., Grandits, G. A., Prineas, R. J., McDonald, R. H., Lewis, C. E., Flack, J. M., … Elmer, P. J. (1997). Long-term effects on sexual function of five antihypertensive drugs and nutritional hygienic treatment in hypertensive men and women. Treatment of Mild Hypertension Study (TOMHS). *Hypertension, 29*(1 Pt 1), 8. doi:10.1161/01.HYP.29.1.8

Hakim, L. S., & Goldstein, I. (1996). Diabetic sexual dysfunction. *Endocrinology Metabolism Clinics of North America, 25*(2), 379–400. doi:10.1016/S0889-8529(05)70329-7

Hsiao, W., Shrewsberry, A. B., Moses, K. A., Johnson, T. V., Cai, A. W., Stuhldreher, P., … Ritenour, C. W. M. (2011). Exercise is associated with better erectile function in men under 40 as evaluated by the International Index of Erectile Function. *The Journal of Sexual Medicine, 9*(2), 1–7. doi:10.1111/j.1743-6109.2011.02560.x

Jones, T. H. (2007). Testosterone associations with erectile dysfunction, diabetes, and the metabolic syndrome. *European Urology Supplements, 6*(16), 847–857. doi:10.1016/j.eursup.2007.07.002

Kaukua, J., Pekkarinen, T., Sane, T., & Mustajoki, P. (2003). Sex hormones and sexual function in obese men losing weight. *Obesity Research, 11*(6), 689–694. doi:10.1038/oby.2003.98

Khoo, J., Piantadosi, C., Worthley, S., & Wittert, G. A. (2010). Effects of a low-energy diet on sexual function and lower urinary tract symptoms in obese men. *International Journal of Obesity, 34*(9), 1396. doi:10.1038/ijo.2010.76

Khoo, J., Ling, P. s., Tan, J., Teo, A., Ng, H. l., Chen, R. Y. t., … Cheong, M. (2014). Comparing the effects of meal replacements with reduced-fat diet on weight, sexual and endothelial function, testosterone and quality of life in obese Asian men. *International Journal of Impotence Research, 26*(2), 61–66. doi:10.1038/ijir.2013.36

Khoo, J., Piantadosi, C., Duncan, R., Worthley, S. G., Jenkins, A., Noakes, M., … Wittert, G. A. (2011). Comparing effects of a low-energy diet and a high-protein low-fat diet on sexual and endothelial function, urinary tract symptoms, and inflammation in obese diabetic men. *The Journal of Sexual Medicine, 8*(10), 2868–2875. doi:10.1111/j.1743-6109.2011.02417.x

Kim, K. K., Kang, H. C., Kim, S. S., & Youn, B. B. (2006). Influence of weight reduction by sibutramine on female sexual function. *International Journal of Obesity, 30*(5), 758. doi:10.1038/sj.ijo.0803198

Kolotkin, RL., Binks, M., Crosby, R. D., Østbye, T., Mitchell, J. E., & Hartley, G. (2008). Improvements in sexual quality of life after moderate weight loss. *International Journal of Impotence Research, 20*(5), 487–492. doi:10.1038/ijir.2008.32

Kolotkin, R., Binks, M., Crosby, R., Ostbye, T., Gress, R., & Adams, T. (2006). Obesity and sexual quality of life*. *Obesity, 14*(3), 472–479. doi:10.1038/oby.2006.62

Kolotkin, R. L., Crosby, R. D., Gress, R. E., Hunt, S. C., & Adams, T. D. (2009). Two-year changes in health-related quality of life in gastric bypass patients compared with severely obese controls. *Surgery for Obesity and Related Diseases, 5*(2), 250–256. doi:10.1016/j.soard.2009.01.009

Kratzik, C. W., Schatzl, G., Lunglmayr, G., Rucklinger, E., & Huber, J. (2005). The impact of age, body mass index and testosterone on erectile dysfunction. *The Journal of Urology, 174*(1), 240–243. doi:10.1097/01.ju.0000162049.95483.51

Kupelian, V., Page, S. T., Araujo, A. B., Travison, T. G., Bremner, W. J., & McKinlay, J. B. (2006). Low sex hormone-binding globulin, total testosterone, and symptomatic androgen deficiency are associated with development of the metabolic syndrome in nonobese men. *The Journal of Clinical Endocrinology & Metabolism, 91*(3), 843. doi:10.1210/jc.2005-1326

Larsen, S. H., Wagner, G., & Heitmann, B. L. (2007). Sexual function and obesity. *International Journal of Obesity, 31*, 1189–1198. doi:10.1038/sj.ijo.0803604

Laumann, E. O., Paik, A., & Rosen, R. C. (1999). Sexual dysfunction in the United States - Prevalence and predictors. *Journal of the American Medical Association*, *281*(6), 537–544. doi:10.1001/jama.281.6.537

Lechleitner, M. (2008). Obesity and the metabolic syndrome in the elderly – a mini-review. *Gerontology*, *54*(5), 253–259. doi:10.1159/000161734

Ledda, A. (2000). Diabetes, hypertension and erectile dysfunction. *Current Medical Research & Opinion*, *16*, S17–S20. doi:10.1185/0300799009117035

Lewis, R. W., Fugl-Meyer, K. S., Bosch, R., Fugl-Meyer, A. R., Laumann, E. O., Lizza, E., & Martin-Morales, A. (2004). Epidemiology/risk factors of sexual dysfunction. *The Journal of Sexual Medicine*, *1*(1), 35–39. doi:10.1111/j.1743-6109.2004.10106.x

McCabe, M., & Connaughton, C. (2014). How the prevalence rates of male sexual dysfunction vary using different criteria. *International Journal of Sexual Health*, *26*(3), 229. doi:10.1080/19317611.2013.873104

Metwally, M., Li, T. C., & Ledger, W. L. (2007). The impact of obesity on female reproductive function. *Obesity Reviews*, *8*(6), 515–523. Oxford, UK. doi:10.1111/j.1467-789X.2007.00406.x

Mikhail, N. (2006). Does testosterone have a role in erectile function? *The American Journal of Medicine*, *119*(5), 373–382. doi:10.1016/j.amjmed.2005.07.042

Miner, M., Esposito, K., Guay, A., Montorsi, P., & Goldstein, I. (2012). Cardiometabolic risk and female sexual health: The Princeton III summary (CME). *The Journal of Sexual Medicine*, *9*(3), 641–651. doi:10.1111/j.1743-6109.2012.02649.x

Moore, R. H., Sarwer, D. B., Lavenberg, J. A., Lane, I. B., Evans, J. L., Volger, S., & Wadden, T. A. (2013). Relationship between sexual function and quality of life in obese persons seeking weight reduction. *Obesity*, *21*(10), 1966–1974. doi:10.1002/oby.20398

Mora, M., Aranda, G. B., de Hollanda, A., Flores, L., Puigdomingo, M., & Vidal, J. (2013). Weight loss is a major contributor to improved sexual function after bariatric surgery. *Surgical Endoscopy*, *27*(9), 3197–3204. doi:10.1007/s00464-013-2890-y

Okeahialam, B., & Obeka, N. (2006). Sexual dysfunction in female hypertensives. *Journal of the National Medical Association*, *98*(4), 638–640.

Ponholzer, A., Temml, C., Marszalek, M., Mock, K., Rauchenwald, M., & Madersbacher, S. (2006). Vascular risk factors and erectile dysfunction in healthy men. *European Urology Supplements*, *5*(2), 101–101. doi:10.1016/S1569-9056(06)60322-9

Power, M. L., & Schulkin, J. (2008). Sex differences in fat storage, fat metabolism, and the health risks from obesity: possible evolutionary origins. *The British Journal of Nutrition*, *99*(5), 931–940. doi:10.1017/S000711450 7853347

Ravnskov, U. (2002). Is atherosclerosis caused by high cholesterol? *QJM: An International Journal of Medicine*, *95*(6), 397–403.

Reis, L. O., Favaro, W. J., Barreiro, G. C., De Oliveira, L. C., Chaim, E. A., Fregonesi, A., & Ferreira, U. (2010). Erectile dysfunction and hormonal imbalance in morbidly obese male is reversed after gastric bypass surgery: A prospective randomized controlled trial. *International Journal of Andrology*, *33*(5), 736–744. doi:10.1111/j.1365-2605.2009.01017.x

Richters, J., Smith, A. M. A., Grulich, A. E., De Visser, R. O., & Rissel, C. E. (2003). Sexual difficulties in a representative sample of adults. *Australian and New Zealand Journal of Public Health*, *27*(2), 164–170. doi:10.1111/j.1467-842X.2003.tb00804.x

Rosen, C., Brown, J., Heiman, S., Leiblum, C., Meston, R., Shabsigh, D., … (2000). The Female Sexual Function Index (FSFI): A multidimensional self-report instrument for the assessment of female sexual function. *Journal of Sex & Marital Therapy*, *26*(2), 191–208. doi:10.1080/009262300278597

Rosen, R. C., Cappelleri, J. C., & Iii, N. G. (2002). The International Index of Erectile Function (IIEF): A state-of-the-science review. *International Journal of Impotence Research*, *14*(4), 226. doi:10.1038/sj.ijir.3900857

Royal Australian College of General Practitioners National Standing Committee. (2006). *Overweight and obesity*. Melbourne: Royal Australian College of General Practitioners.

Rutherford, D., & Collier, A. (2005). Sexual dysfunction in women with diabetes mellitus. *Gynecological Endocrinology*, *21*(4), 189–192. doi:10.1080/09513590400021110

Sayuk, G. S., Gott, B. M., Nix, B. D., & Lustman, P. J. (2011). Improvement in sexual functioning in patients with type 2 diabetes and depression treated with bupropion. *Diabetes Care*, *34*(2), 332. doi:10.2337/dc10-1714

Sowers, K., & Sowers, J. (1999). Obesity, hypertension, and vascular disease. *Current Hypertension Reports*, *1*(2), 140–144. doi:10.1007/s11906-999-0009-6

Stenberg, Å., Heimer, G., Ulmsten, U., & Cnattingius, S. (1996). Prevalence of genitourinary and other climacteric symptoms in 61-year-old women. *Maturitas*, *24*(1), 31–36. doi:10.1016/0378-5122(95)00996-5

Tsai, Y.-J., Wu, M.-P., & Hsu, Y.-W. (2014). Emerging health problems among women: Inactivity, obesity, and metabolic syndrome. *Gynecology & Minimally Invasive Therapy*, *3*(1), 12–14. doi:10.1016/j.gmit.2013.07.005

Vrentzos, B. S. P., Paraskevas, B. S. P., & Mikhailidis, B. S. P. (2007). Dyslipidemia as a Risk Factor for Erectile Dysfunction. *Current Medicinal Chemistry*, *14*(16), 1765–1770. doi:10.2174/092986707781058931

World Health Organisation. (2015). Overweight and obesity. Fact sheets. Retrieved from http://www.who.int/mediacentre/factsheets/fs311/en/

World Health Organisation. (2006). Defining sexual health: Report of a technical consultation on sexual health, 28–31 January 2002. In World Health Organization (Ed.), *Sexual health document series* (pp 1–30). Geneva: WHO.

Yaylali, G. F., Tekekoglu, S., & Akin, F. (2010). Sexual dysfunction in obese and overweight women. *International*

Journal of Impotence Research, *22*(4), 220–226. doi: 10.1038/ijir.2010.7

Yildiz, H., & Bölüktas, R. P. (2015). Evaluation of sexual dysfunction in males with diabetes. *Sexuality & Disability*, *33*(2), 187–205. doi:10.1007/s11195-015-9397-5

Yousef Abdulah Al, T. (2009). Should an inquiry about sexual health, as a reflection of vascular health, be part of routine physicals for young men? Results from an outpatient study. *International Journal of Impotence Research*, *21*(6), 362. doi:10.1038/ijir.2009.36

HEALTH PSYCHOLOGY OPEN

Critical Review

Health Psychology Open
July-September 2018: 1–13

DOI: 10.1177/2055102918786867
journals.sagepub.com/home/hpo
SAGE

Obesity, mental health, and sexual dysfunction: A critical review

Saeideh Botlani Esfahani and Sebely Pal

Abstract

Obesity has profound medical, psychological, and emotional consequences and is associated with sexual difficulties. Little is known regarding the interrelationship between obesity and sexual functioning from a psychological perspective, and less is known regarding treatment options. This review examines these issues and considers various treatments. Literature searches were conducted to locate original research, reviews, systematic reviews, and meta-analyses of obesity, overweight, sexual function, sexual dysfunction, psychological health, mental health, and weight loss. Research demonstrates an association between obesity, mental health, and sexual functioning, but has failed to identify casual pathways between these conditions. Clarifying such pathways is necessary to inform treatment guidelines for clinical practice.

Keywords

obesity, overweight, psychological factors, sexual dysfunction, sexual function

Introduction

Obesity is one of the fastest-growing and most challenging public health problems and at 2014 was estimated to affect 1.9 billion adults globally (World Health Organization (WHO), 2015). The detrimental effects of obesity are well known within the academic literature. Obesity is a risk factor for early mortality, greater morbidity, and chronic diseases such as heart disease, hypertension, stroke, type 2 diabetes, the metabolic syndrome, negatively impacts mental health (Cook et al., 2003; De Wit et al., 2010; Lechleitner, 2008; McLaren et al., 2008; Weiss et al., 2004), and lead to poorer quality of life (Residori et al., 2003; Sturm and Wells, 2001). Furthermore, overweight usually begins the upward trajectory to obesity (Kranjac and Wagmiller, 2016; Williams, 2011), and the severity of these conditions is positively correlated to the degree of obesity (Abilés et al., 2010).

Sexual functioning is an integral component of health; therefore, one could theorize a correlation between sexual functioning and obesity (WHO, 2006). In psychological terms, sexual functioning is broadly defined by the psychological motivators involved (such as attraction and desire), and acknowledges the effect that conditions such as depression, anxiety, stress, and low self-esteem have on sexual functioning (DeLamater and Karraker, 2009). Sexual dysfunction is linked with several psychological problems such as depression, anxiety, poor body image, and low self-esteem. Although obesity has been associated with sexual dysfunction, there is little research investigating the associations between obesity and sexual functioning. However, there is strong evidence to suggest an association between sexual functioning and mental wellbeing (Ace, 2007), as well as body mass index (BMI) and mental wellbeing (McCrea et al., 2012). As mentioned, numerous studies have shown a relationship between sexual dysfunction and common mental health disorders, such as depression and anxiety (Ace, 2007; Angst, 1998; Baldwin, 1996; Kennedy et al., 1999; Laurent and Simons, 2009; Saks, 1999), and yet there are few links between sexual functioning and common mental health disorders noted in the *Diagnostic*

Curtin University, Australia

Corresponding author:
Sebely Pal, School of Public Health, Faculty of Health Sciences, Curtin University, GPO Box U1987, Perth, WA 6845, Australia.
Email: S.Pal@curtin.edu.au

and Statistical Manual of Mental Disorders, 5th Edition (DSM-5) (Cooper, 2014).

The aim of present review is to examine the relationship between sexual functioning and body weight in individuals with overweight or obesity and to determine the effect of psychological health conditions have on sexual dysfunction. To this end, literature searches were conducted to locate original research articles, reviews including systematic reviews and meta-analyses of obesity, overweight, sexual function, sexual dysfunction, psychological health, mental health, and weight loss. The data source was Embase and PubMed, searched from 1980 to 2017. Articles were selected and reviewed based on matches within the title and abstract and/or the full text article.

Definitions

Overweight and obesity

The WHO definition of overweight and obesity is "abnormal or excessive fat accumulation that presents a risk to health" (WHO, 2015). The distribution of body fat is an important indicator of the associated health risk, as central or abdominal obesity is associated with a greater risk to health than a gynoid fat distribution, which is fat that is distributed evenly around the body (WHO, 2015). BMI can be used to classify individuals' weight status according to weight and height (WHO, 2015) and is calculated by dividing the weight in kilograms by the squared height of the individual, in meters (kg/m^2). Overweight is defined as having a BMI between 25 and 29.9 and obesity is defined as having a BMI of 30 or more (WHO, 2015).

Sexual health and sexual function

According to the WHO (2006), sexual health is defined as "a state of physical, mental and social well-being in relation to sexuality; it is not merely the absence of disease, dysfunction or infirmity. Sexual health requires a positive and respectful approach to sexuality and sexual relationships, as well as the possibility of having pleasurable and safe sexual experiences, free of coercion, discrimination and violence. For sexual health to be attained and maintained, the sexual rights of all persons must be respected, protected and fulfilled." Sexual functioning is broader than the frequency of sexual activity alone and includes occurrence of desire, arousal, lubrication, orgasm, pain, satisfaction, and sex hormones (DeLamater and Karraker, 2009; Rosen et al., 2000, 2002).

While there is strong evidence of the relationship between sexual functioning and testosterone in men (DeLamater and Karraker, 2009), the relationship between estrogen and female sexual functioning is not as clear (DeLamater and Karraker, 2009; Diaz-Arjonilla et al., 2008). Examining menopause, a time of hormonal change in women, can help explain the impact of estrogen on sexual functioning (Basson, 2006). Menopause was associated with a significant reduction in estrogen levels; this, in turn, has been associated with vaginal dryness and atrophy, which may lead to dyspareunia (Basson, 2006; DeLamater and Karraker, 2009). In addition, changes to the size of the clitoris and the tissues lining the vagina, which are associated with menopause, may also impact on sexual functioning (DeLamater and Karraker, 2009).

Sexual dysfunction

According to the DSM-5, sexual dysfunction is defined by disorders of desire, arousal, orgasm, and pain (Cooper, 2014); however, there is no universally recognized definition of sexual dysfunction (Boyle et al., 2003; Lewis et al., 2004). As epidemiological research is based on common definitions, prevalence rates have been difficult to ascertain (Lewis et al., 2004). To create a universal definition, and therefore more accurate estimate the prevalence of sexual dysfunction, an International Consultation Committee, consisting of 200 major urology and sexual medicine experts from 60 countries, was assembled (Lewis et al., 2004). As reported by Lewis et al. (2004), the committee defined sexual dysfunction by the following sexual difficulties, faced by women and men:

- Sexual desire dysfunction: diminished sexual interest or desire.
- Persistent sexual arousal dysfunction: genital arousal in the absence of sexual desire that is spontaneous, intrusive, and unwanted.
- Orgasmic dysfunction: the lack, delay, or significantly diminished intensity of orgasmic sensation.
- Sexual aversion: extreme anxiety and/or disgust in response to anticipated or attempted sexual activity.
- Sexual arousal disorder in women: this was defined by the presence of genital sexual arousal dysfunction, subjective sexual arousal dysfunction, or both. Genital sexual arousal dysfunction was defined as absent or impaired genital arousal, and subjective sexual arousal dysfunction was defined as absent or diminished feelings of sexual arousal or pleasure.
- Dyspareunia in women: pain that persists or recurs with attempted or complete vaginal penetration.
- Vaginismus in women: persistent or recurrent difficulty with allowing vaginal penetration, despite the desire to do so.
- Erectile dysfunction in men: this was defined as the inability to attain and/or maintain penile erection sufficient for sexual activity.
- Early ejaculation in men: ejaculation before or shortly after sexual stimulation, which was earlier than desired.

- Delayed ejaculation in men: undesirable delay in attaining orgasm during sexual activity.
- Anejaculation in men: the absence of ejaculation during orgasm evoked by sexual stimulation.

Prevalence of sexual dysfunction

Using the above common definitions, the committee reviewed evidence-based reports to determine global prevalence rates of sexual dysfunction (Lewis et al., 2004). The results of this review, - similar to findings by the WHO (Lewis et al., 2004,), indicate that approximately 40 percent–45 percent of women and 20 percent–30 percent of men had at least one sexual dysfunction (Lewis et al., 2004). In women:

- Prevalence of low sexual desire was 17 percent–55 percent, increasing with age;
- Prevalence of arousal and lubrication disorders was 8 percent–15 percent in non-sexually active, while this increased to 21 percent–28 percent in sexually active;
- Prevalence of orgasmic dysfunction varied with location: western societies had a rate of 25 percent among 18–74-year-old women, while Nordic countries reported an 80 percent prevalence rate in this age cohort;
- While global approximations of vaginismus were difficult to ascertain, the committee reported a rate of 6 percent in Morocco and in Sweden;
- Although an approximate world-wide prevalence rate of dyspareunia was not determined, a prevalence of between 18 percent and 20 percent was found in British and Australian studies.

Research in men primarily focused upon erectile dysfunction; however, the committee critically assessed epidemiological studies on other aspects of sexual dysfunction, based on stringent inclusion criteria (Lewis et al., 2004). In men:

- The prevalence of erectile dysfunction in men under 40 years was 1 percent–9 percent; in men between 40 and 59 years, erectile dysfunction ranged from 2 percent–9 percent to 20 percent–30 percent; for men between 60 and 69 years, the range was 20 percent–40 percent; and in men aged in the 70s and 80s, the range was 50 percent–75 percent.
- The prevalence of early ejaculation globally ranged from 9 percent to 31 percent.
- There was limited epidemiological research investigating orgasmic dysfunction in men, although data for men in the United States and France estimated the prevalence rate to be 7 percent.
- There was a lack of research investigating the prevalence of genital pain in men, and therefore no approximate global rate was determined.

Global prevalence rates indicate that sexual dysfunction is a significant public health issue. Similarly, Australian surveys identified this issue as a notable problem within the population, as 57.8 percent of men (McCabe and Connaughton, 2014) and 41 percent of women reported experiencing sexual dysfunction (Dunn et al., 2000). According to the Australian Study of Health and Relationships, the most common sexual dysfunction in men were lack of sexual desire, early ejaculation, and anxiety about sexual performance, while women more commonly reported lack of sexual desire and orgasmic dysfunction (Richters et al., 2003). To further determine the prevalence of sexual dysfunction in Australia, Boyle et al. (2003) conducted a study with 1793 participants (876 males and 908 females, between 18 and 59 years), selected from the Commonwealth electoral roll. In this sample, sexual dysfunction was reported by 55 percent of men and 60 percent of women (Boyle et al., 2003). Of these, 42 percent of men and 41 percent of women had one to two symptoms of sexual dysfunction, and 13 percent of men and 20 percent of women had three or more symptoms (Boyle et al., 2003). Only 6 percent of participants with sexual dysfunction reported seeking help, and help-seeking behaviors were more common in older respondents (Boyle et al., 2003).

Assessing sexual function

The use of validated scales to assess sexual functioning ensures that sexual dysfunction is accurately classified (Lewis et al., 2004). While there are several indices of sexual functioning in general, instruments that measure sexual functioning by gender would better describe how differs for men and women. The committee identified the International Index of Erectile Function (IIEF) (Rosen et al., 2002) and the Female Sexual Function Index (FSFI) (Rosen et al., 2000) as well-validated indices appropriate for the classification of the severity of sexual dysfunction (Lewis et al., 2004).

IIEF

The IIEF, developed by Rosen et al. (2002), measures the components of male sexual functioning by collecting scores for five domains: *erectile function, orgasmic function, sexual desire, intercourse satisfaction*, and *overall sexual satisfaction*. This self-administered questionnaire relates to experiences of the previous 4 weeks, with several items defining each domain. For example, *erectile function* is determined by such questions as: *When you had erections with sexual stimulation, how often were your erections hard enough for penetration?* and rated on a scale where 0 = no sexual activity, 1 = almost never or never, 2 = a few times (less than half the time), 3 = sometimes (about half the time), 4 = most times (more than half the time), and

5=almost always or always. *Orgasmic function* is determined by such questions as: *When you had sexual stimulation or intercourse, how often did you have the feeling of orgasm or climax (with or without ejaculation)?* and rated on a scale where 1=almost never or never, 2=a few times (less than half the time), 3=sometimes (about half the time), 4=most times (more than half the time), and 5=almost always or always. *Sexual desire* is determined by such questions as: *How would you rate your level of sexual desire?* and rated on a scale where 1=very low or none at all, 2=low, 3=moderate, 4=high, and 5=very high. *Intercourse satisfaction* is determined by such questions as: *When you attempted sexual intercourse, how often was it satisfactory for you?* and rated on a scale where 0=did not attempt intercourse, 1=almost never or never, 2=a few times (less than half the time), 3=sometimes (about half the time), 4=most times (more than half the time), and 5=almost always or always. Finally, *overall sexual satisfaction* is determined by such questions as: *How satisfied have you been with you overall sex life?* and rated on a scale where 1=very dissatisfied, 2=moderately dissatisfied, 3=equally satisfied and dissatisfied, 4=moderately satisfied, and 5=very satisfied. Domain scores are calculated to provide an overall sexual functioning score. Sexual dysfunction is classified by an overall score of 21 or less (Esposito et al., 2004; Rosen et al., 2002). A high degree of internal consistency, test–retest reliability, and discriminant validity was observed for all five domains (Rosen et al., 2002). Furthermore, a high level of sensitivity and specificity was demonstrated using the IIEF to assess sildenafil treatment (otherwise known as Viagra) response in patients with erectile dysfunction (Rosen et al., 2002).

FSFI

Developed by Rosen et al. (2000), the FSFI measures components of female sexual functioning by collecting scores for six domains: *desire, arousal, lubrication, orgasm, satisfaction*, and *pain*. Each item in this self-administered questionnaire is prefaced with the phrase: *Over the past 4 weeks ...*, and has several items for each domain. For example, *desire* is measured with such questions as: "*... how would you rate your level (degree) of sexual desire or interest?*", and rated on a scale where 1=very low or none at all, 2=low, 3=moderate, 4=high, and 5=very high. *Arousal* is measured with such questions as: "*... how would you rate your level of sexual arousal (turn on) during sexual activity or intercourse?*" and rated on a scale where 0=no sexual activity, 1=very low or none at all, 2=low, 3=moderate, 4=high, and 5=very high. *Lubrication* is measured with questions such as: "*... how difficult was it to become lubricated (wet) during sexual activity or intercourse?*", and rated on a scale where 0=no sexual activity, 1=extremely difficult or impossible, 2=very difficult, 3=difficult; 4=slightly difficult, and 5=not difficult. *Orgasm* is measured with such questions as: "*... when you had sexual stimulation or intercourse, how difficult was it for you to reach orgasm (climax)?*", and rated on a scale where 0=no sexual activity, 1=extremely difficult or impossible, 2=very difficult, 3=difficult, 4=slightly difficult, and 5=not difficult. *Satisfaction* is measured with such questions as: "*... how satisfied have you been with your overall sexual life?*", and rated on a scale where 1=very dissatisfied, 2=moderately dissatisfied, 3=about equally satisfied and dissatisfied, 4=moderately satisfied, and 5=very satisfied. Finally, *pain* is measured with such questions as: "*... how often did you experience discomfort or pain following vaginal penetration?*", and rated on a scale where 0=did not attempt intercourse, 1=almost always or always, 2=most times (more than half the time), 3=sometimes (about half the time), 4=a few times (less than half the time), and 5=almost never or never. Again domain scores are calculated to provide an overall sexual functioning score. During development the FSFI, Rosen et al. (2000) was assessed for internal and test–retest reliability, discriminant and divergent validity; a high degree of reliability and validity was detected in each component. An independent study by Wiegel et al. (2005) cross-validated the FSFI, and developed cut-off scores, using the index in clinical- and population-based samples, and found that scores lower than or equal to 26.55 indicated sexual dysfunction.

Association with obesity

Prevalence of sexual dysfunction in individuals with overweight or obesity

Currently, studies of the relationship between body weight and sexual functioning is minimal. (Kolotkin et al., 2006; Larsen et al., 2007) conducted a review investigating the relationship between sexual functioning and obesity and found no evidence to suggest that sexual dysfunction caused obesity, however there was strong evidence to indicate that obesity caused sexual dysfunction (Larsen et al., 2007). Although there are few studies investigating the association between female sexual functioning and obesity, there is strong support from cross-sectional and prospective studies linking erectile dysfunction and obesity. The above review also noted a positive impact of body weight reduction on sexual functioning in women and men with obesity (Larsen et al., 2007). However, the reviewer was unable to conclude whether the improvements in sexual functioning were attributable to body weight reductions or the intervention methods.

Kolotkin et al. (2006) conducted cross-sectional study of 1158 participants with obesity before weight loss treatment to examine the association between sexual quality of life and obesity. Study participants were either patients about to undergo either gastric bypass surgery (n=500; BMI m=41.3 kg/m^2), an intensive weight loss program

($n=500$; BMI $m=47.1\,kg/m^2$), or controls ($n=286$; BMI $m=43.6\,kg/m^2$) (Kolotkin et al., 2006). Results revealed a statistically significant negative correlation between sexual quality of life and BMI ($p<0.001$), with women reporting greater sexual impairment than men (Kolotkin et al., 2006). Of the three groups, gastric bypass patients reported the greatest sexual impairment, while individuals in the weight loss program reported sexual quality of life greater than or equal to the control group, and thus demonstrated a relationship between body weight and sexual quality of life in individuals with obesity (Kolotkin et al., 2006).

Weight loss and sexual functioning

Given an association between obesity and sexual dysfunction exists, the next step would be to investigate whether reductions in body weight improve sexual functioning in individuals with obesity. With this in mind, Kolotkin et al. (2009) conducted a 2-year study of gastric bypass patients ($n=187$) who received regular meetings with a dietitian, personalized diets, an exercise regime, and medication. Data on sexual quality of life and BMI collected every 3 months showed reductions in BMI to be significantly associated with improvements in sexual quality of life ($p<0.0001$) (Kolotkin et al., 2009). Average weight loss over the 2 years was 13.1 percent of baseline body weight; subgroup analysis found that women reported improvements across all items, whereas men reported improvements in their perception of sexual attractiveness only (Kolotkin et al., 2009), and illustrates the benefit of weight loss on sexual functioning (Kolotkin et al., 2009).

These results were supported in other studies specifically investigating the effect of weight loss on the sexual functioning of individuals with obesity by sex. For example, studies using the IIEF to measure post-intervention sexual functioning in men reported improvements in sexual functioning (Hsiao et al., 2012; Khoo, 2010). Further evidence has shown that men with obesity with erectile dysfunction as diagnosed by IIEF had improved sexual functioning following lifestyle changes for weight loss (Esposito et al., 2004). Studies investigating the relationship between weight loss and sexual functioning in obese women are scarce. Kim et al. (2006) conducted an 8-week study of 46 women with overweight or obesity taking weight reduction medication (sibutramine) along with behavioral therapy; sexual functioning data were collected using the FSFI. Weight reduction was significantly associated with improved sexual functioning, specifically in arousal and orgasm scores ($p<0.05$) (Kim et al., 2006). This evidence shows the positive impact that weight loss—achieved by various intervention methods—can have on sexual functioning for men and women. Further research is needed to determine the relationship between sexual functioning and psychological and metabolic conditions associated with obesity, and to investigate the impact weight loss may have on these variables.

Psychological conditions associated with obesity

The relationship between obesity and common mental disorders such as depression, anxiety, and low self-esteem is well-known (Atlantis and Baker, 2008; De Wit et al., 2010; McCrea et al., 2012). The Royal Australian College of General Practitioners Standing Committee highlighted psychological disorders as a considerable health impact associated with overweight and obesity. Both McCrea et al. (2012) and Kubzansky et al. (2012) demonstrated a positive correlation between body weight and common mental illnesses such as depression, anxiety, and stress. Research has also shown that weight reduction can considerably improve the quality of life and reduce the mental health disorders associated with obesity (Carmichael et al., 2001; Järvholm et al., 2012).

Depression, anxiety, stress, and obesity

A range of factors influence the relationship between common mental health disorders and obesity. To investigate this, McCrea et al. (2012) analyzed demographic, physical, and mental health data collected from the UK Adult Psychiatric Morbidity Survey ($n=7043$) and observed a significant relationship ($p<0.05$) between BMI and common mental health disorders, even after controlling for confounding factors. Among young men, mental health disorders were present for those with a lower- or higher-than-normal BMI, whereas a positive correlation between mental health disorders and BMI was observed in young women; this relationship diminished with age for both sexes (McCrea et al., 2012). It is noted however that common mental health disorders, such as depression and anxiety, were combined as a single outcome in this study.

Relationships between BMI and specific common mental health disorders were supported in a study with adolescents ($n=1528$) by Kubzansky et al. (2012) whereby anxiety and depression data were collected every 4 years, along with BMI, demographics, parent education, and stage of pubertal development. The researchers reported that anxiety and depression were significantly associated with higher BMI classifications ($p<0.05$) (Kubzansky et al., 2012). Furthermore, the likelihood of experiencing anxiety or depression was reported to increase with BMI classification; however, BMI trajectories remained stable during the study; therefore, the impact of increasing or decreasing BMI on depression and/or anxiety could not be determined (Kubzansky et al., 2012). The relatively large sample size meant that these results were highly generalizable.

The impact of weight loss on psychological health

With strong evidence of a link between body weight and mental health disorders, it is logical to investigate whether a reduction in body weight improve mental wellbeing. Carmichael et al. (2001) assessed the impact of the Magenstrasse and Mill (M-M; a surgical procedure for weight loss in individuals with obesity) on the quality of life of patients with morbid obesity (MO; $n=82$), compared to participants with MO not undergoing the procedure ($n=35$), and a control group without obesity ($n=20$). The M-M group achieved a higher score on this measure when compared to the MO group ($p<0.01$), but not when compared to the control group (Carmichael et al., 2001). These results suggest that improvements in body weight following the M-M may significantly improve the quality of life in patients with obesity, but also that quality of life may well be restored to that of normal-weight individuals.

Similar findings were reported by Thonney et al. (2010), who investigated this issue in women with MO ($n=43$) following bariatric surgery and found the decrease in weight to be associated with reduced anxiety and depressive symptoms (Thonney et al., 2010). Despite the small sample size and lack of a control group, these findings support the hypothesis that improvements in BMI may be positively associated with improvements in mental health disorders in individuals with obesity. While these findings demonstrate some benefits to weight loss (following bariatric surgery) in women with obesity, further research is needed to determine whether weight loss by means other than surgery produces similar results.

Self-esteem and obesity

Self-esteem is a reflection of self-worth and encompasses beliefs individuals have about themselves, as well as their emotional responses to those beliefs (McClure et al., 2010). Therefore, self-esteem can act as a predictor of life satisfaction, as a reflection of self-worth given the particular circumstances and environments (Biro et al., 2006). To observe the psychological wellbeing of individuals with MO, Abilés et al. (2010) conducted an investigation in 50 bariatric surgery patients before treatment, compared to 25 normal-weight volunteers, and found bariatric surgery patients to report lower self-esteem and quality of life and higher depression, anxiety, and stress, when compared to their normal-weight counterparts (Abilés et al., 2010).

Further evidence demonstrates the link between obesity and low self-esteem, in certain population cohorts. For example, McClure et al. (2010) found a significant negative correlation between obesity and self-esteem in 6522 adolescents recruited through a national study in the United States. In addition, the perception of body weight was shown to be a potent factor for self-esteem in a study by Perrin et al. (2010) who reported that adolescents who perceive themselves as overweight, whether accurate or not, also had lower levels of self-esteem, with a stronger correlation in those who *misperceived* themselves as overweight. It would appear that an inverse relationship exists between obesity and self-esteem, in the obese population in general and certain cohorts in particular.

While this demonstrates the impact of obesity on self-esteem and other components of psychological wellbeing compared to the normal-weight cohort, it does not determine a causal relationship (Abilés et al., 2010). A complex interrelationship exists between obesity and psychological wellbeing such that a causal relationship is difficult to ascertain; therefore, further research is required to identify factors which may influence psychological wellbeing, such as weight loss interventions.

Weight loss and self-esteem

Studies have been conducted to ascertain whether a reduction in body weight would result in improvements in self-esteem in individuals with obesity. Werrij et al. (2008) investigated the influence of two different weight loss diets on self-esteem with 54 with obesity and found self-esteem to significantly increased with a reduction in BMI ($p<0.05$); weight concerns and depressive symptoms were also reduced (Werrij et al., 2008). Interestingly, no significant difference in self-esteem was detected between the individual and group treatment groups (Werrij et al., 2008). It appears that dietary weight loss is positively correlated with improvements in self-esteem.

Improvements in psychological wellbeing attained by individuals with obesity that underwent non-surgical methods of weight loss may be attributed to a range of modifiable lifestyle factors. Assessing the effects of surgical treatment for obesity may better demonstrate the impact of weight loss with a limited number of confounding factors, as minimal behavioral changes are required compared to non-surgical interventions. Dube (2008) examined the impact of bariatric surgery on self-esteem in women with obesity and hypothesized that while self-esteem would improve immediately following surgery, these improvements diminished significantly 12 months post-surgery, regardless of whether weight loss was maintained. This investigator also suggested that individuals with lower self-esteem prior and after weight loss would have a lower likelihood of maintaining weight reductions gained from bariatric surgery; however, these hypotheses were disproved (Dube, 2008). As self-esteem was reported to improve significantly 4 months following bariatric surgery ($p<0.02$), and this improvement was maintained at the 12-month follow-up, these results support the notion of improved self-esteem in individuals with obesity following bariatric surgery (Dube, 2008).

Further research was conducted by Burgmer et al. (2007) assessed the long-term psychological effects of bariatric surgery on depression, self-esteem, and quality of life 1 and 2 years after surgery in 149 patients. The results showed a mean BMI loss of $12.7 \pm 1.6\,kg/m^2$ at 1 year and $13.4 \pm 1\,kg/m^2$ at 2 years following bariatric surgery; self-esteem improved significantly at 1 and 2 years after the surgery compared to the baseline ($p \leq 0.05$), with similar improvements in depression and quality of life (Burgmer et al., 2007). Observing depression in particular, a reduction in depressive symptoms from 40.5 percent at baseline to 17.7 percent was found at the 1-year mark, and to 16.4 percent 2 years following surgery (Burgmer et al., 2007). These results indicate that significant improvements in self-esteem and depression can be achieved with weight loss from bariatric surgery. That such changes can be maintained over the long-term highlights the importance of weight loss as a means of improving psychological wellbeing; however further research in this area is needed. While the impact of improvements in body weight and self-esteem on sexual functioning was not discussed in these studies, the relationships between weight loss, common mental health issues, and sexual function are discussed in greater detail below.

One could argue that improved self-esteem—as a component of self-concept—following weight loss may be the result changes to *perceived* body weight rather than actual BMI. While there are some minor variations depending on gender, in a cross-sectional study with 215 young adults, Connors and Casey (2006) found perceived attractiveness to be positively associated with self-esteem. In newer research, Kamody et al. (2018) found perceived weight status to be inversely associated with both perceived physical health and self-esteem. Although noting similar small variations according to age and gender, a study with 437 adults (mean age 42.3 years) by Davison and McCabe (2005) found body image to be positively associated with both sexual functioning and self-esteem, whereas Kolotkin et al. (2012) reported in a review of the literature that it was *actual* body weight that was negatively associated with sexual dysfunction rather than perceived weight status. This point was supported by the results of a meta-analysis conducted by Blaine et al. (2007), which found weight *loss* to be correlated to higher self-esteem.

Mental health disorders and sexual functioning

The link between sexual functioning and depression is highlighted when considering the issue from the perspective of the DSM-5 (Cooper, 2014) and exists for both women and men, to the extent that both sexual desire and sexual arousal were negatively associated with depression (Laurent and Simons, 2009). Laurent and Simons (2009) identified a negative association between depression and sexual pleasure or satisfaction, as well as a correlation between orgasm, pain, and depression; however, the latter was not investigated extensively. Other studies have demonstrated that depression is significantly associated with orgasm difficulty and pain in women, and delayed and premature ejaculation in men (Frohlich and Meston, 2002; Kennedy et al., 1999). More specifically, the likelihood of premature ejaculation was more than double in men with emotional problems or stress, and sexual pain was twice as likely in women with emotional problems or stress (Laumann et al., 1999). Furthermore, a study with 203 middle-aged Korean men reported a significant positive association between erectile dysfunction and depressive symptoms, which remained strong after adjusting for age, marital status, education, smoking, alcohol, hypertension, physical activity level, cholesterol, and BMI (Jeong et al., 2011).

The relationship between sexual dysfunction and depression among the female population has been well researched. Mezones-Holguin et al. (2011) measured sexual functioning, menopause, and depression in a sample of 335 healthy, middle-aged, sexually active Peruvian women and found depression to be associated with reduced sexual functioning and hormonal status in this cohort (Mezones-Holguin et al., 2011). These results have been supported in women with an existing health condition. Moel et al. (2010) reported an association between poor sexual functioning and increased depression in postpartum women with depression compared to those who had never suffered depression. Despite an improvement in sexual functioning following psychotherapy, sexual functioning remained lower than in those who had never suffered postpartum depression (Moel et al., 2010). In addition, research assessing sexual functioning in women with hypoactive sexual desire disorder reported that lower FSFI scores were associated with greater sexual distress (Connor et al., 2011). These results provide further evidence of the relationship between sexual dysfunction and depression in women.

Anxiety, another common mental health disorder, is also associated with sexual dysfunction, while this relationship is evident in both women and men (Kaya et al., 2006), the research is not extensive. Kaya et al. (2006) reported a positive correlation between sexual dysfunction and anxiety in women with chronic pelvic pain. In addition, increased anxiety is associated with a greater risk of erectile difficulties and reduced sexual enjoyment (Laurent and Simons, 2009). While Seto (1992) reported that the onset of anxiety had no impact on sexual functioning, there appears to be no evidence to establish a causal pathway for the relationship between anxiety and sexual dysfunction in men and women (Laurent and Simons, 2009).

In general, sexual functioning and mental health disorders appear to have a bidirectional associative relationship; that is mental health disorders have been shown to influence sexual activity, and vice versa (Ein-Dor and Hirschberger, 2012; Kashdan et al., 2011; Laurent and

Simons, 2009). Kashdan et al. (2011) examined the effects of anxiety and depression on sexual activity of 150 college students over 3 weeks, and found both social anxiety and depression to be associated with less pleasure and connectedness during sexual activity. Furthermore, the frequency of sexual contact was negatively associated with depressive symptoms (Kashdan et al., 2011), indicating that sexual contact may have a protective effect against depressive symptoms, although this aspect was not investigated in the study.

Physical activity has many health benefits and is important in reducing the risk of serious health conditions and can improve mental health regardless of its impact on weight (Herman et al., 2012). Conversely, physical inactivity is a significant and independent contributor to obesity (Fogelholm, 2010; Fogelholm et al., 2006). Both low exercise and long sedentary activities decrease energy expenditure and impair weight control and prevention of obesity (Fogelholm, 2008). A recent epidemiologic study suggests that both obesity and physical inactivity are associated with sexual dysfunction (Derby et al., 2000). On the other hand, some studies support a relationship between increased physical activity and improved sexual functioning (Bacon et al., 2003; Esposito et al., 2004; Esposito and Giugliano, 2005); specifically, increased physical activity is associated with lower risk of erectile dysfunction (Laumann et al., 1999).

Esposito et al. (2008) evaluated the effect of weight loss and increased physical activity on erectile dysfunction in men with obesity and found that weight loss and physical activity improved sexual function in one-third of the participants after 2 years; however, the authors were unable to determine whether this improvement was due to reduced weight or increased physical activity as causal pathways were not investigated. Dabrowska et al. (2010) assessed self-reported physical activity and sexuality in pre-menopausal Polish women and found that impaired sexual functioning was less frequent among women with moderate and high physical activity. In addition, as physical activity can have a moderating effect on depressive symptoms, increasing physical activity may improve sexual functioning in individuals with depression (Hoffman et al., 2009). There is evidence to suggest a possible physiological pathway between increased physical activity and improved sexual functioning, although the research is more abundant for men than for women. Increased physical activity has been found to improve sexual functioning by improving endothelial function (i.e. blood flow) in men (Gerbild et al., 2018; Leoni et al., 2014), whereas a multidisciplinary approach, which includes diet and physical activity, can improve endothelial function and sexual functioning in women with obesity (Aversa et al., 2013; Esposito et al., 2008). However, weight loss alone does not appear to improve endothelial function in men or women with obesity (Kerr et al., 2011); however, more research is needed to confirm a relationship between all of these factors.

Mental health disorders can reduce the quality of sexual activity; however, conversely sexual activity can alleviate some conditions, such as stress (Ein-Dor and Hirschberger, 2012; Laurent and Simons, 2009). An association exists between stress and the onset of anxiety; therefore, the relationship between stress and sexual activity may be an important factor in the relationship between anxiety sexual functioning (Bale and Vale, 2004). Ein-Dor and Hirschberger (2012) observed the influence of sexual activity on stress in 75 heterosexual Israeli adults, by measuring stress and relationship satisfaction over 18 consecutive weekdays, and found sexual intercourse to relieve stress in participants with satisfying relationships. Furthermore, a stressful day increased the likelihood of sexual activity occurring on a subsequent day, with no significant differences between men and women (Ein-Dor and Hirschberger, 2012).

Self-esteem, body image, and sexual functioning

Some evidence suggests a link between self-esteem and certain health conditions, although the relationships between self-esteem, sexual functioning, and obesity are unclear (Goodson et al., 2006; Shackelford, 2001), as this has not been researched extensively. However, a correlation between self-esteem and the components sexuality has been found (e.g. relationship satisfaction and sexual behaviors) (Park, 1999) and may provide an indication of sexual functioning. Observing a sample of 214 heterosexual married individuals, Shackelford (2001) reported that self-esteem was positively correlated with marital satisfaction. Choi et al. (2011) reported a similar relationship in an elderly married cohort ($n = 156$), after conducting a cross-sectional investigation into self-esteem and sexual behaviors; they found that individuals with a more active sexual life had significantly higher self-esteem than those who were less sexually active ($p < 0.05$) (Choi et al., 2011). Furthermore, satisfaction with their sexual life was positively correlated with levels of self-esteem (Choi et al., 2011).

Adolescence is a period of considerable development in sexuality and self-esteem and therefore provides an opportunity to investigate the relationship between these two factors. Goodson et al. (2006) conducted an extensive review to investigate the relationship between self-esteem and sexual behaviors, attitudes, and intentions in adolescents and found no significant associations, which was contrary to the results from previous research s in older cohorts (Choi et al., 2011; Shackelford, 2001). With the many psychological and physiological challenges stemming from obesity, it is necessary to determine whether this relationship is evident in the obese population in general.

Self-esteem

The relationship between self-esteem, body weight, and sexual functioning is complex, and while there are some similarities, sexual functioning differs between men and women, thereby posing unique factors in the relationship with self-esteem. Erectile dysfunction is known to cause anxiety and lower self-esteem (Ar et al., 1997; Krane et al., 1989; National Institute of Health, 1993). Martinez-Jabaloyas et al. (2010) demonstrated this relationship in a 14-week case-control study (treatment vs placebo) conducted in 119 men with erectile dysfunction and found that erectile function to improve significantly ($p<0.0001$). In addition, the treatment group reported significant improvements in self-esteem compared to the placebo group ($p<0.0001$) (Martinez-Jabaloyas et al., 2010). Furthermore, the authors noted a positive correlation between self-esteem and erectile functioning (Martinez-Jabaloyas et al., 2010).

Strong evidence exists of an association between sexual functioning, body weight, and self-esteem in the women. Woertman and Van den Brink (2012) conducted a review of body image and desire, arousal and lubrication, orgasm, satisfaction, pain, and sexual functioning in general and found that a better body image was associated with greater sexual functioning across all domains. In addition, a positive association between improvements in body image and sexual functioning was associated with weight loss in this group (Woertman and Van den Brink, 2012). Due to a lack of evidence, the reviewers could not comment extensively on the relationship between sexual pain and body image; however, pain was noted as negatively correlated with satisfaction; a domain positively associated with body image (Woertman and Van den Brink, 2012).

Body image

Body image, being the perception of one's own body, is a major component of self-esteem (Akhondi et al., 2011). A positive correlation between body image and sexual functioning has been reported in a range of population cohorts (Lachowsky, 2002; Seal et al., 2009). It follows then that there may be a link between body image and BMI, a hypothesis investigated by Watkins et al. (2008). These investigators analyzed body image scores, together with BMI, collected from 188 male college students, and found BMI to be negatively correlated with body image, noting that satisfaction of body image diminished as BMI increased (Watkins et al., 2008). Body image is influenced by a range of physical factors; therefore, the relationship between body image and physiological conditions can be quite complex. Akhondi et al. (2011) investigated the correlation between body image and sexual functioning in a study of 120 fertile and 120 infertile men and noted that fertile men reported a better body image, compared to their infertile counterparts. This research demonstrates another factor in the multifaceted relationship between body image and BMI.

Seal et al. (2009) examined body-esteem and sexual desire in 85 female college students by measuring arousal, sexual functioning, and body-esteem at baseline and after reading an erotic story. Body-esteem was positively correlated with greater sexual desire and functioning, although there was no significant relationship between body-esteem and mental and physical sexual arousal, or lubrication (Seal et al., 2009).

Evidence of a relationship between sexual functioning and self-esteem also exists for older age cohorts. A discussion paper examining the impact of menopause on self-esteem by Lachowsky (2002) noted that women identified menstruation as a key component of their youth and femininity; therefore, menopause had the potential to represent the end of youth and femininity and may negatively impact sexuality and potentially reduce self-esteem (Reid et al., 2014; Tremayne and Norton, 2017).

Considerable evidence of a relationship between body weight and self-esteem in women has been recorded. The 10-year US National Growth and Health Study ($n=2206$) reported BMI and race as important predictors of self-esteem, with reduced self-esteem potentially leading to increased risk-taking behaviors in adolescent females (Biro et al., 2006). In addition, self-esteem was found to be lower in normal-weight women who were previously obese than in ordinarily normal-weight women, indicating the negative impact of obesity on self-esteem can linger (Mustillo et al., 2012). Rosenberger et al. (2006) investigated the impact of body image in 131 female bariatric candidates with obesity and found depression, self-esteem, and perfectionism to be predictors of body image dissatisfaction, with higher depression and perfectionism, and lower self-esteem, associated with greater body image dissatisfaction. These findings indicate the importance of body weight for self-esteem and psychological wellbeing; however, the impact of weight loss on body image, self-esteem, and sexual functioning in the female population has not yet been investigated.

Weight loss, mental health, and sexual function

Due to the interrelated nature of body weight, mental health, and sexual functioning, possible associations between all of these factors warrant further discussion. Strain et al. (2014) examined changes in BMI along with self-reported health- and impact-of-weight-related quality of life as well as depression in 105 bariatric surgery patients, approximately 2 years after surgery. Participants experienced a reduction in BMI ($p=0.0001$), as well as improved general health, depression, and sexual life scores ($p=0.05$, 0.0001, and 0.04, respectively), among many other variables (Strain et al., 2014). More specifically, Efthymiou et al. (2015) explored changes to BMI, sexual functioning

(IIEF and FSFI), and health-related quality of life at four time points in the first year after bariatric surgery in 80 adults with MO. BMI improved significantly ($p<0.001$), along with all components of sexual functioning, with the exception of male orgasm, as well as all health-related quality of life sub-scales (Efthymiou et al., 2015).

Existing evidence clarifying the sex differences in the relationships between weight loss, mental health, and sexual function is scarce. A review by Glina et al. (2013) investigating modifiable risk factors to treat and prevent erectile dysfunction concluded that weight loss may improve erection functioning, either by increasing testosterone, reducing inflammation, or by improving self-esteem and mood, in men without comorbidities; however, co-existing conditions such as depression, diabetes, and hypertension may require additional treatments. As well as enhancing mental wellbeing, reductions in body weight appear to improve sexual functioning in individuals with obesity (Assimakopoulos et al., 2011; Dymek et al., 2002; Kolotkin et al., 2009; Mamplekou et al., 2005). Assimakopoulos et al. (2011) investigated the impact of bariatric surgery on depressive symptoms and sexual functioning in female patients with obesity ($n=59$). Significant reductions in BMI in all patients were reported ($p<0.001$) and was associated with a reduction in depression, as well as improved sexual functioning (Assimakopoulos et al., 2011). Detailed analysis revealed significant improvements in desire, arousal, lubrication, and satisfaction ($p<0.02$), as well as a significant reduction in the experience of sexual pain ($p<0.02$) (Assimakopoulos et al., 2011); however, a causal relationship between these outcome measures was not established. Strong associations between weight loss, mental health, and sexual function cannot be confirmed based on the current evidence; therefore, further research is need to develop a range of treatment options for overweight and individuals with obesity experiencing sexual dysfunction.

Conclusion

Currently, obesity is at epidemic proportions throughout the world. Many interventions have been implemented in an effort to address this critical issue. Obesity has been shown to be associated with a number of chronic diseases, psychological disorders, as well as sexual dysfunction. The relationship between sexual functioning and obesity is highly complex, and while there is strong evidence to support an association between these two variables, research into sexual functioning and the psychological impacts of obesity (specifically, depression, anxiety, stress, self-esteem, and body image) is limited. Even less research exists for the impact of weight loss on these relationships, therefore research investigating the impact of obesity on sexual functioning, and to illustrate the complex interplay between these two variables, is much needed. Furthermore, while physical activity can improve mental health, it is unclear whether increasing physical activity and therefore mental health will improve sexual functioning in overweight and individuals with obesity suffering from sexual dysfunction.

Implications for future research and clinical practice

While it understood that obesity can negatively impact sexual functioning, the complex interrelationships between excessive body weight, mental health, and sexual functioning are unclear. Many of the studies cited in this review failed to establish causation or identify possible pathways between obesity, mental health, and sexual functioning. Clarifying such pathways is necessary to inform treatment guidelines for clinical practice in individuals with overweight or obesity suffering from poor mental health and/or impaired sexual functioning. For example, future research could focus on pharmaceutical treatments for depression and whether they improve sexual functioning in individuals with overweight or obesity. Investigating physical activity as an alternative treatment to improve mental health and/or sexual functioning in this group is another potential focus for research and treatment. Dietary interventions for weight loss, as an alternative to bariatric surgery, may also need to be examined to assist and treat individuals with overweight or obesity to improve sexual functioning. The findings of this research may have important policy and public health practice implications and place sexual functioning higher on the agenda to help curb obesity.

Acknowledgements

Dr Monica Jane from the School of Public Health at Curtin University (Western Australia) provided assistance with the editing of this article. Both authors contributed to the preparation, writing, and revision of this article.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

References

Abilés V, Rodríguez -Ruiz S, Abilés J, et al. (2010) Psychological characteristics of morbidly obese candidates for bariatric surgery. *The Journal of Metabolic Surgery and Allied Care* 20: 161–167.

Ace KJ (2007) Mental health, mental illness, and sexuality. In: Tepper MS and Owens AF (eds) *Sexual Health Volume 1: Psychological Foundation*. Westport, CT: Praeger Publishers/Greenwood Publishing Group, pp. 301–329.

Akhondi MM, Dadkhah A, Bagherpour A, et al. (2011) Study of body image in fertile and infertile men. *Journal of Reproduction & Infertility* 12: 295–298.

Angst J (1998) Sexual problems in healthy and depressed persons. *International Clinical Psychopharmacology* 13(Suppl. 6): S1–S4.

Ar F-M, Lodnert G, Bränholm IB, et al. (1997) On life satisfaction in male erectile dysfunction. *International Journal of Impotence Research* 9: 141–148.

Assimakopoulos K, Karaivazoglou K, Panayiotopoulos S, et al. (2011) Bariatric surgery is associated with reduced depressive symptoms and better sexual function in obese female patients: A one-year follow-up study. *Obesity Surgery* 21: 362–366.

Atlantis E and Baker M (2008) Obesity effects on depression: Systematic review of epidemiological studies. *Internation Journal of Obesity* 32: 881–891.

Aversa A, Bruzziches R, Francomano D, et al. (2013) Weight loss by multidisciplinary intervention improves endothelial and sexual function in obese fertile women. *The Journal of Sexual Medicine* 10: 1024–1033.

Bacon CG, Mittleman MA, Kawachi I, et al. (2003) Sexual function in men older than 50 years of age: Results from the health professionals follow-up study. *Annals Internal Medicine* 139: 161–168.

Baldwin D (1996) Depression and sexual function. *Journal of Psychopharmacology* 10: 30–34.

Bale T and Vale W (2004) CRF and CRF receptors: Role in stress responsivity and other behaviors. *Annual Review of Pharmacology and Toxicology* 44: 525–557.

Basson R (2006) Sexual desire and arousal disorders in women. *The New England Journal of Medicine* 354: 1497–1506.

Biro F, Striegel-Moore RH, Franko DL, et al. (2006) Self-esteem in adolescent females. *Journal of Adolescent Health* 39: 501–507.

Blaine BE, Rodman J and Newman JM (2007) Weight loss treatment and psychological well-being: A review and meta-analysis. *Journal of Health Psychology* 12: 66–82.

Boyle FM, Cook MD, Purdie DM, et al. (2003) Sexual dysfunction in the Australian population. *Australian Family Physician* 32: 951–954.

Burgmer R, Petersen I, Burgmer M, et al. (2007) Psychological outcome two years after restrictive bariatric surgery. *Obesity Surgery* 17: 785–791.

Carmichael A, Sue-Ling H and Johnston D (2001) Quality of life after the Magenstrasse and Mill procedure for morbid obesity. *Including Laparoscopy and Allied Care* 11: 708–715.

Choi KB, Jang SH, Lee MY, et al. (2011) Sexual life and self-esteem in married elderly. *Archives of Gerontology and Geriatrics* 53: E17–E20.

Connor M, Maserejian NN, Derogatis L, et al. (2011) Sexual desire, distress, and associated factors in premenopausal women: Preliminary findings from the hypoactive sexual desire disorder registry for women. *Journal of Sex & Marital Therapy* 37: 176–189.

Connors J and Casey P (2006) Sex, body-esteem and self-esteem. *Psychological Reports* 98(3): 699–704.

Cook S, Hugli O, Egli M, et al. (2003) Clustering of cardiovascular risk factors mimicking the human metabolic syndrome X in eNOS null mice. *Swiss Medical Weekly* 133: 360–363.

Cooper R (2014) *Diagnosing the Diagnostic and Statistical Manual of Mental Disorders* (5th edn). London: Karnac Books.

Dabrowska J, Drosdzol A, Skrzypulec V, et al. (2010) Physical activity and sexuality in perimenopausal women. *European Journal of Contraception & Reproductive Health Care* 15: 423–432.

Davison TE and McCabe MP (2005) Relationships between men's and women's body image and their psychological, social, and sexual functioning. *Sex Roles* 52(7–8): 463–475.

De Wit L, Luppino F, van Straten A, et al. (2010) Depression and obesity: A meta-analysis of community based studies. *Psychiatry Research* 178: 230–235.

DeLamater J and Karraker A (2009) Sexual functioning in older adults. *Current Psychiatry Reports* 11: 6–11.

Derby CA, Mohr BA, Goldstein I, et al. (2000) Modifiable risk factors and erectile dysfunction: can lifestyle changes modify risk? *Urology* 56: 302–306.

Diaz-Arjonilla M, Schwarcz M, Swerdloff RS, et al. (2008) Obesity, low testosterone levels and erectile dysfunction. *International Journal of Impotence Research* 21: 89.

Dube M (2008) *The obese female and the bariatric weight loss treatment: Potential adverse issues involving patient self-esteem*. Dissertation, Capella University, Minneapolis, MN.

Dunn KM, Croft PR and Hackett GI (2000) Satisfaction in the sex life of a general population sample. *Journal of Sex & Marital Therapy* 26: 141–151.

Dymek MP, Le Grange D, Neven K, et al. (2002) Quality of life after gastric bypass surgery: A cross-sectional study. *Obesity Research* 10: 1135–1142.

Efthymiou V, Hyphantis T, Karaivazoglou K, et al. (2015) The effect of bariatric surgery on patient HRQOL and sexual health during a 1-year postoperative period. *Obesity Surgery* 25: 310–318.

Ein-Dor T and Hirschberger G (2012) Sexual healing: Daily diary evidence that sex relieves stress for men and women in satisfying relationships. *Journal of Social and Personal Relationships* 29: 126–139.

Esposito K and Giugliano D (2005) Obesity, the metabolic syndrome, and sexual dysfunction. *International Journal of Impotence Research* 17: 391–398.

Esposito K, Giugliano F, Ciotola M, et al. (2008) Obesity and sexual dysfunction, male and female. *International Journal of Impotence Research* 20: 358–365.

Esposito K, Giugliano F, Di Palo C, et al. (2004) Effect of lifestyle changes on erectile dysfunction in obese men—A randomized controlled trial. *Journal of the American Medical Assocation* 291: 2978–2984.

Fogelholm M (2008) How physical activity can work? *International Journal of Pediatric Obesity* 3: 10–14.

Fogelholm M (2010) Physical activity, fitness and fatness: Relations to mortality, morbidity and disease risk factors: A systematic review. *Obesity Reviews* 11: 202–221.

Fogelholm M, Stallknecht B and van Baak M (2006) ECSS position statement: Exercise and obesity. *European Journal of Sport Science* 6: 15–24.

Frohlich P and Meston CM (2002) Sexual functioning and self-reported depressive symptoms among college women. *Journal of Sex Research* 39: 321–325.

Gerbild H, Larsen CM, Graugaard C, et al. (2018) Physical activity to improve erectile function: A systematic review of intervention studies. *Sexual Medicine* 6: 75–89.

Glina S, Sharlip ID and Hellstrom WJG (2013) Modifying risk factors to prevent and treat erectile dysfunction. *The Journal of Sexual Medicine* 10: 115–119.

Goodson P, Buhi ER and Dunsmore SC (2006) Self-esteem and adolescent sexual behaviors, attitudes, and intentions: A systematic review. *Journal of Adolescent Health* 38: 310–319.

Herman MK, Hopman MW, Vandenkerkhof GE, et al. (2012) Physical activity, body mass index, and health-related quality of life in Canadian adults. *Medicine and Science in Sports and Exercise* 44: 625–636.

Hoffman BM, Babyak MA, Sherwood A, et al. (2009) Effects of aerobic exercise on sexual functioning in depressed adults. *Mental Health and Physical Activity* 2: 23–28.

Hsiao W, Shrewsberry AB, Moses KA, et al. (2012) Exercise is associated with better erectile function in men under 40 as evaluated by the international index of erectile function. *Journal of Sexual Medicine* 9: 524–530.

Järvholm K, Olbers T, Marcus C, et al. (2012) Short-term psychological outcomes in severely obese adolescents after bariatric surgery. *Obesity* 20: 318–323.

Jeong JY, Lee SK, Kang YW, et al. (2011) Relationship between ED and depression among middle-aged and elderly men in Korea: Hallym aging study. *International Journal of Impotence Research* 23: 227–234.

Kamody RC, Thurston IB, Decker KM, et al. (2018) Relating shape/weight based self-esteem, depression, and anxiety with weight and perceived physical health among young adults. *Body Image* 25: 168–176.

Kashdan T, Adams L, Savostyanova A, et al. (2011) Effects of social anxiety and depressive symptoms on the frequency and quality of sexual activity: A daily process approach. *Behaviour Research and Therapy* 49: 352–360.

Kaya B, Unal S, Ozenli Y, et al. (2006) Anxiety, depression and sexual dysfunction in women with chronic pelvic pain. *Sexual and Relationship Therapy* 21: 187–196.

Kennedy SH, Dickens SE, Eisfeld BS, et al. (1999) Sexual dysfunction before antidepressant therapy in major depression. *Journal of Affective Disorders* 56: 201–208.

Kerr SMP, Livingstone MBE, McCrorie TA, et al. (2011) Endothelial dysfunction associated with obesity and the effect of weight loss interventions. *Proceedings of the Nutrition Society* 70: 418–425.

Khoo J, Piantadosi C and Worthley S (2010) Effects of a low-energy diet on sexual function and lower urinary tract symptoms in obese men. *International Journal of Obesity* 34: 1396–1403.

Kim KK, Kang HC, Kim SS, et al. (2006) Influence of weight reduction by sibutramine on female sexual function. *International Journal of Obesity* 30: 758–763.

Kolotkin R, Binks M, Crosby R, et al. (2006) Obesity and sexual quality of life. *Obesity* 14: 472–479.

Kolotkin RL, Crosby RD, Gress RE, et al. (2009) Two-year changes in health-related quality of life in gastric bypass patients compared with severely obese controls. *Surgery for Obesity and Related Diseases* 5: 250–256.

Kolotkin RL, Zunker C and Østbye T (2012) Sexual functioning and obesity: A review. *Obesity* 20: 2325–2333.

Krane RJ, Goldstein I and Saenz De Tejada I (1989) Impotence. *New England Journal of Medicine* 321: 1648–1659.

Kranjac AW and Wagmiller RL (2016) Decomposing trends in adult body mass index, obesity, and morbid obesity, 1971–2012. *Social Science & Medicine* 167: 37–44.

Kubzansky L, Gilthorpe M and Goodman E (2012) A prospective study of psychological distress and weight status in adolescents/young adults. *Annals of Behavioral Medicine* 43: 219–228.

Lachowsky M (2002) Menopause: Loss of self-esteem? *International Congress Series* 1229: 25–30.

Larsen SH, Wagner G and Heitmann BL (2007) Sexual function and obesity. *International Journal of Obesity* 31: 1189–1198.

Laumann EO, Paik A and Rosen RC (1999) Sexual dysfunction in the United States: Prevalence and predictors. *Journal of the American Medical Association* 281: 537–544.

Laurent SM and Simons AD (2009) Sexual dysfunction in depression and anxiety: Conceptualizing sexual dysfunction as part of an internalizing dimension. *Clinical Psychology Review* 29: 573–585.

Lechleitner M (2008) Obesity and the metabolic syndrome in the elderly—A mini-review. *Gerontology* 54: 253–259.

Leoni LAB, Fukushima AR, Rocha LY, et al. (2014) Physical activity on endothelial and erectile dysfunction: A literature review. *The Aging Male* 17: 125–130.

Lewis RW, Fugl-Meyer KS, Bosch R, et al. (2004) Epidemiology/risk factors of sexual dysfunction. *The Journal of Sexual Medicine* 1: 35–39.

McCabe M and Connaughton C (2014) How the prevalence rates of male sexual dysfunction vary using different criteria. *International Journal of Sexual Health* 26: 229–237.

McClure A, Tanski S, Kingsbury J, et al. (2010) Characteristics associated with low self-esteem among US adolescents. *Academic Pediatrics* 10: 238–244.

McCrea R, Berger Y and King M (2012) Body mass index and common mental disorders: Exploring the shape of the association and its moderation by age, gender and education. *International Journal of Obesity* 36: 414–421.

McLaren L, Beck C, Patten S, et al. (2008) The relationship between body mass index and mental health. *The International Journal for Research in Social and Genetic Epidemiology and Mental Health Services* 43: 63–71.

Mamplekou E, Komesidou V, Bissias C, et al. (2005) Psychological condition and quality of life in patients with morbid obesity before and after surgical weight loss. *Including Laparoscopy and Allied Care* 15: 1177–1184.

Martinez-Jabaloyas JM, Moncada I, Rodriguez-Vela L, et al. (2010) Evaluation of self-esteem in males with erectile dysfunction treated with Viagra: Analysis of a Spanish patients group selected from a multicenter, international study. *Actas Urologicas Españolas* 34: 699–707.

Mezones -Holguin E, Crdova -Marcelo W, Lau-Chu- Fon F, et al. (2011) Association between sexual function and depression in sexually active, mid-aged, Peruvian women. *Climacteric* 14: 654–660.

Moel J, Buttner M, O'Hara M, et al. (2010) Sexual function in the postpartum period: Effects of maternal depression and interpersonal psychotherapy treatment. *Official Journal of*

the Section on Women's Health of the World Psychiatric Association 13: 495–504.

Mustillo SA, Hendrix K and Schafer M (2012) Trajectories of body mass and self-concept in black and white girls: The lingering effects of stigma. *Journal of Health and Social Behavior* 53: 2–16.

National Institute of Health (1993) NIH Consensus development panel on impotence. *Journal of the American Medical Association* 270: 83–90.

Park SA and Kim MA (1999) The sexual life in climacteric women Korean. *Journal of Women's Health and Nursing* 5: 179–192.

Perrin E, Boone-Heinonen J, Field AE, et al. (2010) Perception of overweight and self-esteem during adolescence. *International Journal of Eating Disorders* 43: 447–454.

Reid R, Abramson BL, Blake J, et al. (2014) Managing menopause chapter 8 sexuality and menopause. *Journal of Obstetrics and Gynaecology Canada* 36: S59–S73.

Residori L, García-Lorda P, Flancbaum L, et al. (2003) Prevalence of co-morbidities in obese patients before bariatric surgery: Effect of race. *Including Laparoscopy and Allied Care* 13: 333–340.

Richters J, Smith AMA, Grulich AE, et al. (2003) Sexual difficulties in a representative sample of adults. *Australian and New Zealand Journal of Public Health* 27: 164–170.

Rosen R, Brown C and Heiman J (2000) The female sexual function index (FSFI): A multidimensional self-report instrument for the assessment of female sexual function. *Journal of Sex & Marital Therapy* 26: 191–208.

Rosen RC, Cappelleri JC and Gendrano N (2002) The international index of erectile function (IIEF): A state-of-the-science review. *International Journal of Impotence Research* 14: 226–244.

Rosenberger P, Henderson K and Grilo CM (2006) Correlates of body image dissatisfaction in extremely obese female bariatric surgery candidates. *Obesity Surgery* 16: 1331–1336.

Saks BR (1999) Identifying and discussing sexual dysfunction. *Journal of Clinical Psychiatry Monograph Series* 17: 4–8.

Seal BN, Bradford A and Meston CM (2009) The association between body esteem and sexual desire among college women. *Archives of Sexual Behavior* 38: 866–872.

Seto MC (1992) A review of anxiety and sexual arousal in human sexual dysfunction. *Sexual Abuse: A Journal of Research and Treatment* 5: 33–43.

Shackelford TK (2001) Self-esteem in marriage. *Personality and Individual Differences* 30: 371–390.

Strain GW, Kolotkin RL, Dakin GF, et al. (2014) The effects of weight loss after bariatric surgery on health-related quality of life and depression. *Nutrition & Diabetes*. Epub ahead of print 1 September. DOI: 10.1038/nutd.2014.29.

Sturm R and Wells K (2001) Does obesity contribute as much to morbidity as poverty or smoking? *Public Health* 115: 229–235.

Thonney B, Pataky Z, Badel S, et al. (2010) The relationship between weight loss and psychosocial functioning among bariatric surgery patients. *American Journal of Surgery* 199: 183–188.

Tremayne P and Norton W (2017) Sexuality and the older woman. *British Journal of Nursing* 26: 819–824.

Watkins J, Christie C and Chally P (2008) Relationship between body image and body mass index in college men. *Journal of American College Health* 57: 95–100.

Weiss R, Dziura J, Burgert TS, et al. (2004) Obesity and the metabolic syndrome in children and adolescents. *The New England Journal of Medicine* 350: 2362–2374.

Werrij M, Mulkens S, Bruyn H, et al. (2008) Dietary treatment for obesity reduces BMI and improves eating psychopathology, self-esteem and mood. *Netherlands Journal of Psychology* 64: 8–14.

Wiegel M, Meston C and Rosen R (2005) The female sexual function index (FSFI): Cross-validation and development of clinical cutoff scores. *Journal of Sex & Marital Therapy* 31: 1–20.

Williams PT (2011) Evidence that obesity risk factor potencies are weight dependent, a phenomenon that may explain accelerated weight gain in western societies. *PLoS ONE* 6: e27657.

Woertman L and Van Den Brink F (2012) Body image and female sexual functioning and behavior: A review. *Journal of Sex Research* 49: 184–211.

World Health Organization (WHO) (2006) Defining sexual health: Report of a technical consultation on sexual health. Sexual Health Document Series, World Health Organization, Geneva, 28–31 January 2002. Available at: http://www.who.int/reproductivehealth/publications/sexual_health/defining_sexual_health.pdf

World Health Organization (WHO) (2015) Overweight and obesity. Available at: http://www.who.int/mediacentre/factsheets/fs311/en/

Appendix B

Screening Questions

Dear Sir
Thank you for contacting me to participate in this project. Please answer the following questions before going to the next step.

1 Full Name _____

2 Age _____

3 Mobile phone _____

4 Email _____

5 Do you smoke?

☐ Yes

☐ No

6 Do you use cholesterol lowering medication?

☐ Yes

☐ No

7 Do you use blood pressure lowering medication?

☐ Yes

☐ No

8 Do you use steroidal medication?

☐ Yes

☐ No

9 Do you use warfarin?

☐ Yes

☐ No

10 Do you use viagra?

☐ Yes

☐ No

11 Do you use medication to control diabetes?

☐ Yes

☐ No

12 Do you have hypo or hyperthyroidism?

☐ Yes

☐ No

13 Have you been treated for a psychological condition? (If yes, please provide brief details)

☐ Yes

☐ No

Detail _____

14 Have you had any cardiovascular events within the last six months?

☐ Yes

☐ No

15 Do you have any major systemic diseases?

☐ Yes

☐ No

16 Do you have gastrointestinal problems?

☐ Yes

☐ No

17 Do you have proteinuria?

☐ Yes

☐ No

18 Do you have any liver problems?

☐ Yes

☐ No

19 Do you have any kidney problems?

☐ Yes

☐ No

20 Are you sexually active? (Are you in a sexual relationship)?

☐ Yes

☐ No

21 Are you currently in a homosexual relationship?

☐ Yes

☐ No

22 Have you had any weight fluctuations over the past six months?

☐ Yes

☐ No

23 Have you participated in any other weight loss clinical trials within the last six months?

☐ Yes

☐ No

24 Regarding your physical activity, which one applies to you best in the last 7 days.

☐ 3 or more days of vigorous activity (eg. heavy lifting, aerobics) of at least 20 min/day

☐ 5 or more days of moderate-intensity activity (eg. bicycling) and/or walking of at least 30 min.

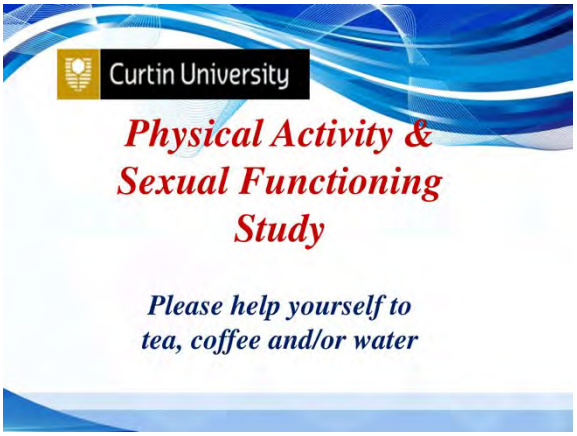
☐ 5 or more days of any combination of walking, moderate-intensity or vigorous-intensity

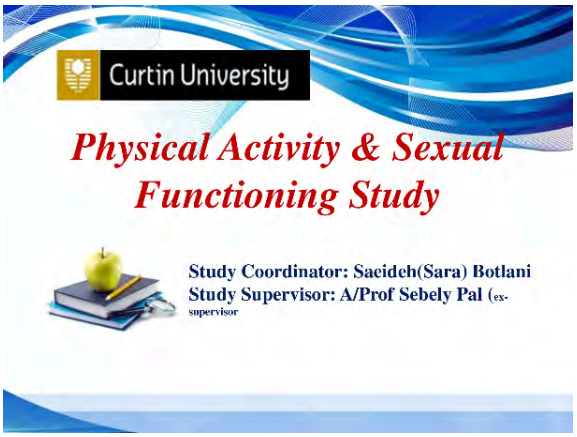
☐ Less than above physical activity

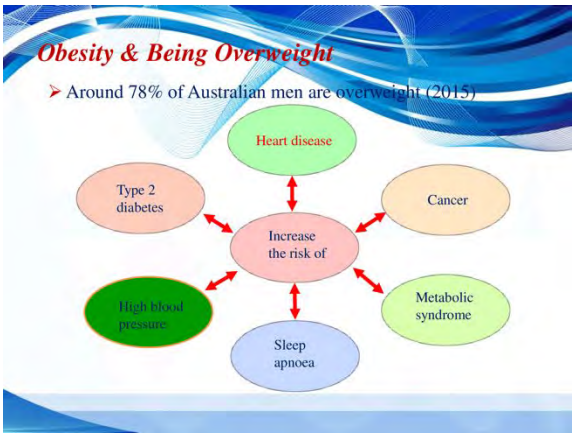
☐ More than above physical activity

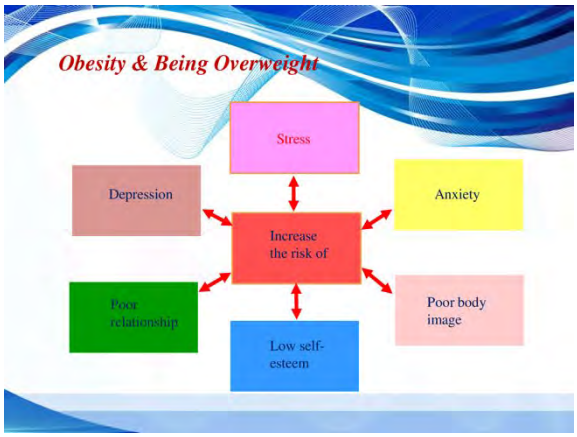
Appendix C

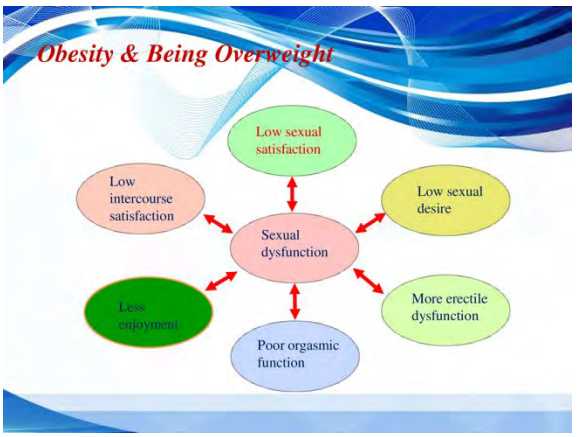
Presentation slides











- 56% Australian adults are either inactive or low levels of physical activity
- These lifestyle factors increase the risk of chronic disease and erectile dysfunction

we can help

Your Participation

- 3 clinic appointments
- Week 0, 6 & 12
- 30 minutes each
- Mornings, fasted
- 3 blood tests

- Refreshments
- Parking permit
- Public transport

Your participation

Please follow:

- Intervention instructions
- Given at first clinic appointment (week 0)

Don't give up, Just do the best you can

Week 0,6 &12 Questionnaires

Provided in a link

- International Index of Erectile Function
- Male Sexual Function Index
- Self-esteem & relationship
- Body Esteem Scale
- Depression, anxiety &stress 21
- Self-esteem
- Sf-36-V2

Participation Information

- Participation Information Sheet
- Map Showing Clinic Room and Parking Area
- Parking Permit
- Appointment Sheet
- Consent Form

Before you begin

Please do not change anything until after your first clinic appointment.

This is to ensure that I collect accurate starting measurements and information for comparison to the later measurements and information. In other words, I need **BEFORE**, **DURING**, and **AFTER** measurements and information.

Before your appointment

Complete
- Questionnaires
- Overnight fast (approx. 10 hours)

Please
- No alcohol
- No strenuous activity
- Don't weigh at home

Your appointments

- Allow time to park / public transport
- Parking permit – temporary
- Map
  - Clinic rooms
  - Parking areas
- Return completed:
  - Questionnaires

Your Appointments

- Weight
- Height
- Waist & hip
- Blood pressure
- Blood test
- Refreshments

- Book next appointment
- Next questionnaires

Potential Benefits…?

- For YOU
  - Improve your health
  - Potential reduction in metabolic syndrome risk factors
  - Copy of clinical results

Your Participation

- Greatly appreciated
- Voluntary
- Withdraw at at any time

Your Information

- Confidential
- Anonymous
- Stored securely

Ethics

- Curtin University Human Research Ethics Committee
- Approval Number: **HRE2016-0367**

Contact Details

- Office of Research and Development
- Study coordinator

Activity checker(Fitbit)

- Your Fitbit is sweat, rain and splash proof but NOT swim or showerproof
- The band may cause irritation due to dirt and sweat so it is important to clean with water (no soap) and dry it regularly.
- Don't wear it too tight. Wear the band loosely enough that it can move back and forth on your wrist.

REMEMBER!

Please do not change anything until after your first clinic appointment.

This is to ensure that I collect accurate starting measurements and information for comparison to the later measurements and information. In other words, I need **BEFORE**, **DURING**, and **AFTER** measurements and information.

Don't forget to book your appointment before you leave

Thank you for your time

Appendix D

Physical Activity Guideline Instruction

According to the WHO, physical activity is defined as any bodily movement produced by skeletal muscles that requires energy expenditure. Physical activity occurs while working, playing, carrying out household chores, travelling, and engaging in recreational activities(World Health Organization, 2015b). Physical inactivity has been identified as the fourth leading risk factor for global mortality causing an estimated 3.2 million deaths worldwide. It is estimated that 56% of Australian adults are either inactive or have low levels of physical activity. A sedentary adult takes less than 5000 steps/day. Walking 10,000 steps/day has been found to be effective in increasing physical activity and improving health outcomes(White et al., 2012). Australia's physical activity guidelines state that 30 minutes of moderate physical activity on at least 5 days of the week is required to achieve health benefits and reduce the risk of chronic disease.

Moving more, sitting less and regular physical activity:

Help prevent heart disease, stroke and high blood pressure;

Reduce the risk of developing type II diabetes and some cancers;

Help build and maintain healthy bones, muscles and joints reducing the risk of injury

Prevent unhealthy weight gain; and

Promote psychological well-being such as depression, anxiety and stress

Physical inactivity is a significant and independent factor contributing to obesity (Fogelholm, 2010; Fogelholm et al., 2006). Both low exercise and long sedentary activities decrease energy expenditure and impair weight control and prevention of obesity (Fogelholm, 2008). Both obesity and physical inactivity are associated with sexual dysfunction while increased physical activity is associated with lower risk of erectile dysfunction This research is investigating the effect of increased physical activity intervention aimed to assist in better sexual functioning.

Steps per day	Category
<2500 steps/day	Sedentary(Basal activity)
2500-4999	Sedentary(limited activity)
5000-7499	Low active
7500-9999	Somewhat active
10,000-12,499	Active
>12,500	Highly active

The average person took 3,500 to 5,000 steps per day, and that if they were to increase their steps to 10,000 steps per day, the result would be healthier, thinner people!

Think of movement as an opportunity, not an inconvenience.

Be active every day in as many ways as you can.

If you can, also enjoy some regular, vigorous activity for extra health and fitness.

Accumulate your 10,000 steps or more throughout the day by combining a few shorter sessions of activity of around 10 to 15 minutes each; or

Do 30 minutes continuously.

Moderate-intensity activity should, however, be carried out for at least 10 minutes at a time without stopping

Example

Walk instead of using the car

Park further away from your destination and walk the rest of the way.

Walk to and from your train station or bus stop, and get on and off at a stop that is further away.

Take the stairs instead of the lift.

Walk rather than rest on escalators or travelators.

Work in the garden.

Play with children in an active way.

Walk or play with pets.

Challenge family, friends and work colleagues to be active with you.

Australian Government

Department of Health

More than half of all Australian adults are not active enough

Make *your* move – Sit less
Be active for life!

AUSTRALIA'S PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOUR GUIDELINES

Adults

What's it all about?

Being physically active and limiting your sedentary behaviour every day is essential for your health and well-being. This brochure presents Australia's Physical Activity and Sedentary Behaviour Guidelines for all adults aged 18 to 64 years, irrespective of cultural background, gender or ability. It also provides you with information about the benefits of being physically active, as well as tips and ideas for ways to move more every day.

More information about healthy living, including references to other Australian Government guidelines concerning healthy weight and healthy eating, can be found at **www.health.gov.au**

What is....

PHYSICAL ACTIVITY? – any activity that gets your body moving, makes your breathing become quicker and your heart beat faster. You can be physically active in many different ways, at any time of day.

SEDENTARY BEHAVIOUR? – sitting or lying down (except for when you are sleeping). It is common to spend large amounts of time being sedentary when at work, when travelling or during leisure time.

Move more, sit less, every day!

More than half of all Australian adults are not active enough. Source: Australian Bureau of Statistics (ABS) 2013. Australian Health Survey: Physical Activity, 2011-12. ABS Cat. No. 4364.0.55.004. Canberra: ABS.

1. Global Health Risks: Mortality and burden of disease attributable to selected major risks. World Health Organization, 2009.

What are the benefits?

Moving more and sitting less will...

- Reduce your risk of, or help manage, cardiovascular disease (CVD).
- Reduce your risk of, or help manage, type 2 diabetes.
- Maintain and/or improve your blood pressure, cholesterol and blood sugar levels.
- Reduce your risk of, and assist with rehabilitation from, some cancers.
- Help prevent unhealthy weight gain and assist with weight loss.
- Build strong muscles and bones.
- Create opportunities for socialising and meeting new people.
- Help you to prevent and manage mental health problems.
- Help you develop and maintain overall physical and mental well-being.

Did you know that higher levels of physical activity can help reduce your risk of some cancers and prevent unhealthy weight gain?

...and the more active I am, the more I will benefit.

Move more...

Doing any physical activity is better than doing none.

If you are not currently doing any physical activity, you will benefit from starting some. You can start slowly and gradually increase the amount you do. Consult your doctor for advice on the best types of physical activity for you.

You can accumulate your activity by being active on most, preferably all, days every week.

Each week:

- 150 minutes (2 ½ hours) of moderate intensity physical activity, **or**
- 75 minutes (1 ¼ hours) of vigorous intensity physical activity,

will help improve blood pressure, cholesterol, heart health, as well as muscle and bone strength.

Each week, increasing to:

- 300 minutes (5 hours) of moderate intensity physical activity, **or**
- 150 minutes (2 ½ hours) of vigorous intensity physical activity,

will provide greater benefits and help to prevent cancer and unhealthy weight gain.

MODERATE INTENSITY ACTIVITIES take some effort, but you are still able to talk while doing them.

E.g. a brisk walk, recreational swimming, dancing, social tennis, golf, household tasks like cleaning windows or raking leaves, or pushing a stroller.

VIGOROUS INTENSITY ACTIVITIES require more effort and make you breathe harder and faster ('huff and puff').

E.g. jogging, aerobics, fast cycling, many organised sports and tasks that involve lifting, carrying or digging.

I could do at least 30 minutes of physical activity on 5 days of the week.

I could enjoy a bike ride or game of tennis with friends.

I could invite some friends to the dance class I've signed up for.

I could go for a 15 minute jog before breakfast every day.

A TIME SAVING TIP

You may choose to do **a combination of moderate and vigorous intensity activities.**

10 minutes of vigorous intensity activity is equal to 20 minutes of moderate intensity activity.

...and sit less!

Even if you do more than the recommended amount of physical activity every week, you will still benefit from minimising time spent sitting each day, and from regularly interrupting periods of sitting.

Break up long periods of sitting as often as possible.

Sedentary behaviour is associated with poorer health outcomes, including an increased risk of type 2 diabetes.

56% of Australian adults are either inactive or have low levels of physical activity - that is more than 9.5 million adults![2]

I could turn off the TV during the day and get out in the garden.

I could visit my colleague to deliver the message in person.

I could set an alarm on my computer to remind me to stand up more often.

Be aware of time spent in front of the screen.

Watching TV and DVDs, playing electronic games, using computers and surfing the internet may all be popular activities, but they usually involve either sitting or lying down for long periods.

There are many opportunities to sit in our daily lives. The key is to find opportunities to move.

What will you do ?

2. Australian Bureau of Statistics (ABS) 2013. Australian Health Survey: Physical Activity, 2011-2012. ABS Cat. No. 4364.0.55.004. Canberra: ABS.

Getting stronger

The Guidelines recommend including muscle strengthening activities on at least 2 days each week.

Did you know, that regular muscle strengthening activities will help to:

- Manage blood pressure, blood sugar and blood cholesterol levels.
- Prevent and control heart disease and type 2 diabetes.
- Improve posture, mobility and balance.
- Reduce the risk of falls and injury.
- Maintain your ability to do everyday tasks.

I could do body weight exercises, like push-ups, squats or lunges, at home.

I could do tasks around the house that involve lifting, carrying or digging.

I could join a gym and do weights or other resistance training.

What will you do ?

Why not try these ideas?

Think about when and where you can be physically active. Making some small changes to your daily routine can make a big difference.

ACTIVE TRAVEL

- For short trips, walk or cycle and leave the car at home.
- For longer trips, walk or cycle part of the way.
- Use the stairs instead of the lift or escalator.
- Get off the bus one stop earlier and walk the rest of the way.
- Park further away from your destination and walk – you may even save on parking fees.

ACTIVE AT WORK

- Park your car an extra 5 or 10 minute walk from work.
- Walk to deliver a message rather than emailing or making a phone call.
- Leave your desk at lunch time and enjoy a short walk outside.
- Organise walking meetings.

ACTIVE AND FUN

- Catch up with friends for a walk, instead of sitting to chat.
- Plan outdoor activities, like bike riding or walking.
- Don't let the weather stop you. Try indoor activities like dancing, indoor swimming, squash or indoor rock climbing.

ACTIVE AND SAFE

- If you are new to physical activity, have a health problem, or are concerned about the safety of being (more) active, speak with your doctor or health professional about the most suitable activities for you.
- Protect yourself from the sun – you should wear sun-protective clothing, including a hat, and apply sunscreen regularly.

Be active every day in as many ways as you can!

Australia's Physical Activity and Sedentary Behaviour Guidelines for Adults (18–64 years)

PHYSICAL ACTIVITY

- Doing any physical activity is better than doing none. If you currently do no physical activity, start by doing some, and gradually build up to the recommended amount.
- Be active on most, preferably all, days every week.
- Accumulate 150 to 300 minutes (2 ½ to 5 hours) of moderate intensity physical activity or 75 to 150 minutes (1 ¼ to 2 ½ hours) of vigorous intensity physical activity, or an equivalent combination of both moderate and vigorous activities, each week.
- Do muscle strengthening activities on at least 2 days each week.

SEDENTARY BEHAVIOUR

- Minimise the amount of time spent in prolonged sitting.
- Break up long periods of sitting as often as possible.

Australia's Physical Activity and Sedentary Behaviour Guidelines

- Move and Play Every Day – National Physical Activity Recommendations for Children 0-5 Years.
- Make *your* move – Sit less – Be active for life!
  - Children (5-12 years)
  - Young People (13-17 years)
  - Adults (18-64 years)
  - Families
- Choose Health: Be Active – A physical activity guide for older Australians.

To order these resources **FREE OF CHARGE**, phone **1800 020 103**

OTHER HEALTHY LIVING RESOURCES:

- Healthy Weight Guide – **www.healthyweight.health.gov.au**
- Eat for Health – **www.eatforhealth.gov.au**
- Clinical Practice Guidelines for the Management of Overweight and Obesity in Adults, Adolescents and Children in Australia – **www.nhmrc.gov.au/guidelines/publications/n57**
- Get Up & Grow – Healthy Eating and Physical Activity for Early Childhood (for centre based care, family day care and pre-schools) – **www.health.gov.au**

To find out more, go to **www.health.gov.au**

1014 | June 2014

Appendix E:

Poster advertising

"Overweight/Obese Male Adults Needed To Help Research"

Do You Want To Have Better Intimate Relationship With Your Partner?
Would You Like To Improve Your Physical Fitness?
Want To Get Free Help?

If you answered yes to the above questions, read on! ☺

I am conducting a 12-week study aimed to help increase your physical activity and see its effect on Sexual Functioning

PERSONAL BENEFITS?

Receive a **FREE STEP MEASURE (FITBIT)** to count your steps during the study. At the end of the 12 week study you can keep the Fitbit

Receive **FREE** assessment of your physical activity and your sexual functioning

Receive **FREE** weigh-in and body measurements

Receive **FREE** blood pressure and blood checks

Requirements?

Looking for men between 18-65 years old who are overweight -but otherwise healthy.

Attend 3 clinic appointments (approximately 15 min) at Curtin University (Bentley) and fill out questionnaires. Flexible appointment times available.

Reliable mobile phone desirable, but not essential.

(Light physical activity only. No sport or gym membership required)

INTERESTED?

Contact Saeideh (Sara) Botlani

Email: Saeideh.botlanie@postgrad.curtin.edu.au
Call or SMS: 0416095613

This study has been approved by the Curtin University Human Research Ethics Committee (Approval Number HRE2016-0367). The Committee is comprised of members of the public, academics, lawyers, doctors and pastoral carers. If needed, verification of approval can be obtained either by writing to the Curtin University Human Research Ethics Committee, c/- Office of Research and Development, Curtin University, GPO Box U1987, Perth, 6845 or by telephoning 9266 2784 or by emailing hrec@curtin.edu.au

Appendix F

Participant's Demographic Information

1. Name: _____
2. Gender: Male ☐ Female ☐
3. Date of Birth: _____ / _____ / _____ Age: _____

4. Address: _____
   Suburb: _____ Postcode: _____

5. Telephone: Home: _____
   Work: _____
   Mobile: _____

6. E-mail Address: _____
7. Where were you born? Country (please specify): _____
   Mother's country of birth: _____
   Father's country of birth: _____
8. What is your ethnic origin? Caucasian ☐
   Asian ☐
   Other (specify): _____

9. What is your highest level of schooling? *(Tick one box)*
   - Never attended school ☐
   - Primary school ☐
   - Some high school ☐
   - Completed high school ☐
   - Technical/Trade certificate ☐
   - University or Tertiary level ☐

10. What is your current employment status? *(Tick one box)*

Don`t work ☐

Full time employment ☐

Part time employment ☐

Home duties (e.g.: gardening) ☐ _____

Other (please specify) ☐ _____

11. What type of work are you currently involved with? *(Tick one box)*

☐ **None**

☐ **Predominately physical** (e.g.: heavy lifting, packing shelves, exercise teacher, heavy gardening, cleaner & heavy housework, maintenance worker, factory worker with heavy physical work, nurse)

☐ **Standing and some walking** (e.g.: office workers, bank workers, light house work, factory work with some walking and some lifting, light gardening, teachers)

☐ **Predominately sitting** (e.g.: desk work, factory but mostly sitting, cashier, student, academic, computer work)

☐ **Other**; Please specify: _____

12. Which one of the following best describes your current living arrangement? *(Tick one box)*

☐ Living alone

☐ Living with adults without children

☐ Living with adults with children

☐ Living in a retirement village / hostel

☐ Other (please specify, e.g. home help, support) _____

Appendix G

Medical History

Please read the questions with Yes/No answers. If you need to add more information, please write it in the details box.

1 Will you be in Perth for the next 6 months? Do you have any holidays or trips planned?

☐Yes

☐No

Details _____

2 Are you able to increase physical activity?

☐Yes

☐No

Details _____

3 Are you able to keep record of physical activity?

☐Yes

☐No

Details _____

4 Are you able to get to Curtin University in Bentley?

☐Yes

☐No

5 Are you able to commit to attending 3 clinic appointments at Curtin University?

☐Yes

☐No

Details _____

6 Have you had your glucose or insulin, cholesterol, TG, measured recently? Can you provide the results?

☐Yes

☐No

Details _____

7 Do you take any nutritional supplements?

☐Yes

☐No

Details _____

8 Have you had any major operations?

☐Yes

☐No

Details _____

9 Have you experienced any fainting or blackouts?

☐Yes

☐No

Details _____

10 Do you have any digestive disorders eg. Irritable bowel syndrome, coeliac disease, diarrhoea?

☐Yes

☐No

Details _____

11 Do you have HIV or any other blood diseases?

☐Yes

☐No

Details _____

12 Do you have any liver diseases or hepatitis?

☐Yes

☐No

Detail _____

13 Do you have heart disease?

☐Yes

☐No

Details _____

14 Do you have any allergies (esp. bee sting)

☐Yes

☐No

Details _____

15 Do you play a sport or exercise regularly?

☐Yes

☐No

Details _____

16 Do you take part in any supervised weight loss programs?

☐Yes

☐No

Details _____

17 Do you regularly have more than 2 alcoholic drinks a day?

☐Yes

☐No

Details _____

18 Do you have any difficulties with blood tests?

☐Yes

☐No

Details _____

19 Most suited appointment time

☐6:45-7:30 am

☐7:30-8;30 am

☐8:30 am Onward

20 Can we keep your contact details for future reference in clinical research?

☐Yes

☐No

21 In the last 6 months has your weight been 5 kg's more/less than your present weight?

☐No

☐Yes, Please explain them _____

22 Have you ever had or has your Doctor ever told you that you have

☐ Parkinson's disease

☐ Asthma

☐ Chronic kidney failure

☐ Hypogonadism (too little)

☐ Hypercortisolism

☐ Heart Disease

☐ Impaired memory

☐ Epilepsy

☐ Neurological/brain damage

☐ Other kidney disease

☐ Liver disease

☐ Osteomalacia/Rickets

☐ Vitamin D abnormality

☐ Spinal surgery

☐ Stroke / hemiplegia

☐ Cancer

☐ Diabetes, Type 2

☐ Gastrectomy

☐ Coeliac disease

☐ Primary hyperparathyroidism

☐ Ulcerative Colitis

☐ Diabetes, Type 1

☐ Cushing’s Syndrome

☐ Hypercholesterolemia

☐ Lactose intolerance

☐ Crohn's Disease

☐ Other: (Please specify) _____

☐ No

23 Have you ever (or currently) taking any of the following medications, (Only tick if appropriate). If yes, please state your age, the length of time you were taking the medication and the dosage (if known)

☐ Androgens/Testosterone

☐ Cortisone-like medication

☐ Corticosteroids

☐ Anabolic steroids (to build bone/muscle)

☐ Vitamin E

☐ Blood pressure medication

☐ Thiazide diuretics If used for hypertension

☐ Non-thiazide diuretics If used for hypertension

☐ Thyroid hormone

☐ Warfarin or Heparin injections

☐ Anti-convulsants

☐ Anti-depressants

☐ Asthma medication

☐ Non-steroidal anti-inflammatory medication

☐ Other medication

☐ No

24 Please indicate your use of non-prescribed medications. How often, on average, do you take the following? (Please tick the appropriate response to each listed medication)

	Never	1-3 times per month	1-3 times per week	4-6 times per week	One or more times per day
Painkillers (Panadol)	O	O	O	O	O
Tranquillisers (eg. Valium)	O	O	O	O	O
Medicine for indigestion (eg., Quickeze, Enos)	O	O	O	O	O
Sleeping Pill	O	O	O	O	O
Salt tablets	O	O	O	O	O
Weight reducing tablets	O	O	O	O	O
Any other medicine not prescribed by a doctor. Please, specify:	O	O	O	O	O

Appendix H

Self-Esteem Scale

Below is a list of statements dealing with your general feelings about yourself.

Please fill in a number for each question that corresponds to your agreement with the statement in the box provided.

1 = Strongly Agree

2 = Agree

3 = Disagree

4 = Strongly Disagree

_____ 1) On the whole, I am satisfied with myself.

_____ 2) At times, I think I am no good.

_____ 3) I feel that I have a number of good qualities.

_____ 4) I am able to do things as well as most other people.

_____ 5) I feel I do not have much to be proud of.

_____ 6) I certainly feel useless at times.

_____ 7) I feel that I'm a person of worth, at least on an equal plane with others.

_____ 8) I wish I could have more respect for myself.

_____ 9) All in all, I am inclined to feel that I am a failure.

_____ 10) I take a positive attitude toward myself.

Appendix I

Depression, Anxiety, Stress Scale (DASS) 2					
Please read each statement and circle a number 0, 1, 2 or 3 which indicates how much the statement applied to you **over the past week**. There are no right or wrong answers. Do not spend too much time on any statement. ***The rating scale is as follows:*** 0 Did not apply to me at all 1 Applied to me to some degree, or some of the time 2 Applied to me to a considerable degree or a good part of time 3 Applied to me very much or most of the time					
1	I found it hard to wind down	0	1	2	3
2	I was aware of dryness of my mouth	0	1	2	3
3	I couldn't seem to experience any positive feeling at all	0	1	2	3
4	I experienced breathing difficulty (e.g. excessively rapid breathing, breathlessness in the absence of physical exertion)	0	1	2	3
5	I found it difficult to work up the initiative to do things	0	1	2	3
6	I tended to over-react to situations	0	1	2	3
7	I experienced trembling (e.g. in the hands)	0	1	2	3
8	I felt that I was using a lot of nervous energy	0	1	2	3
9	I was worried about situations in which I might panic and make a fool of myself	0	1	2	3
10	I felt that I had nothing to look forward to	0	1	2	3
11	I found myself getting agitated	0	1	2	3
12	I found it difficult to relax	0	1	2	3

13	I felt down-hearted and blue	0	1	2	3
14	I was intolerant of anything that kept me from getting on with what I was doing	0	1	2	3
15	I felt I was close to panic	0	1	2	3
16	I was unable to become enthusiastic about anything	0	1	2	3
17	I felt I wasn't worth much as a person	0	1	2	3
18	I felt that I was rather touchy	0	1	2	3
19	I was aware of the action of my heart in the absence of physical exertion (e.g. sense of heart rate increase, heart missing a beat)	0	1	2	3
20	I felt scared without any good reason	0	1	2	3
21	I felt that life was meaningless	0	1	2	3

END!

Thank You for completing this questionnaire

Appendix J

Body Esteem Scale

1. I like what I look like in pictures.
Never☐ rarely☐ sometimes☐ often☐ always☐

2. Other people consider me good looking.
Never☐ rarely☐ sometimes☐ often☐ always☐

3. I'm proud of my body.
Never☐ rarely☐ sometimes☐ often☐ always☐

4. I am preoccupied with trying to change my body weight.
Never☐ rarely☐ sometimes☐ often☐ always☐

5. I think my appearance would help me get a job.
Never☐ rarely☐ sometimes☐ often☐ always☐

6. I like what I see when I look in the mirror.
Never☐ rarely☐ sometimes☐ often☐ always☐

7. There are lots of things I'd change about my looks if I could.
Never☐ rarely☐ sometimes☐ often☐ always☐

8. I am satisfied with my weight.
Never☐ rarely☐ sometimes☐ often☐ always☐

9. I wish I looked better.
Never☐ rarely☐ sometimes☐ often☐ always☐

10. I really like what I weigh.
Never☐ rarely☐ sometimes☐ often☐ always☐

11. I wish I looked like someone else.
Never☐ rarely☐ sometimes☐ often☐ always☐

12. People my own age like my looks.
Never☐ rarely☐ sometimes☐ often☐ always☐

13. My looks upset me.
Never☐ rarely☐ sometimes☐ often☐ always☐

14. I'm as nice looking as most people.
Never☐ rarely☐ sometimes☐ often☐ always☐

15. I'm pretty happy about the way I look.
Never☐ rarely☐ sometimes☐ often☐ always☐

16. I feel I weight the right amount for my height.
Never☐ rarely☐ sometimes☐ often☐ always☐

17. I feel ashamed of how I look.
Never☐ rarely☐ sometimes☐ often☐ always☐

18. Weighing myself depresses me.
Never☐ rarely☐ sometimes☐ often☐ always☐

19. My weight makes me unhappy.
Never☐ rarely☐ sometimes☐ often☐ always☐

20. My looks help me to get dates.
Never☐ rarely☐ sometimes☐ often☐ always☐

21. I worry about the way I look.
Never☐ rarely☐ sometimes☐ often☐ always☐

22. I think I have a good body.
Never☐ rarely☐ sometimes☐ often☐ always☐

23. I look as nice as I'd like to.
Never☐ rarely☐ sometimes☐ often☐ always☐

THANK YOU FOR COMPLETING THESE QUESTIONS

Appendix K

Self-Esteem And Relationship (SEAR) Questionnaire

INSTRUCTIONS: Please think about **the past 4 weeks** when responding to the following statements.

Please check one box for each statement.

1. I felt relaxed about initiating sex with my partner.

1. Almost always/always
2. Most times (much more than half the time)
3. Sometimes (about half the time)
4. A few times (much less than half the time)
5. Almost never/never

2. I felt confident that during sex my erection would last long enough.

1. Almost always/always
2. Most times (much more than half the time)
3. Sometimes (about half the time)
4. A few times (much less than half the time)
5. Almost never/never

3. I was satisfied with my sexual performance.

1. Almost always/always
2. Most times (much more than half the time)
3. Sometimes (about half the time)
4. A few times (much less than half the time)
5. Almost never/never

4. I felt that sex could be spontaneous.

1. Almost always/always
2. Most times (much more than half the time)
3. Sometimes (about half the time)
4. A few times (much less than half the time)
5. Almost never/never

5. I was likely to initiate sex.

1. Almost always/always
2. Most times (much more than half the time)
3. Sometimes (about half the time)
4. A few times (much less than half the time)
5. Almost never/never

6. I felt confident about performing sexually.

1. Almost always/always
2. Most times (much more than half the time)
3. Sometimes (about half the time)
4. A few times (much less than half the time)
5. Almost never/never

7. I was satisfied with our sex life.

1. Almost always/always
2. Most times (much more than half the time)
3. Sometimes (about half the time)
4. A few times (much less than half the time)

8. My partner was unhappy with the quality of our sexual relations.

1. Almost always/always
2. Most times (much more than half the time)
3. Sometimes (about half the time)
4. A few times (much less than half the time)
5. Almost never/never

9. I had good self-esteem.

1. Almost always/always
2. Most times (much more than half the time)
3. Sometimes (about half the time)
4. A few times (much less than half the time)
5. Almost never/never

10. I felt like a whole man.

1. Almost always/always
2. Most times (much more than half the time)
3. Sometimes (about half the time)
4. A few times (much less than half the time)
5. Almost never/never

11. I was inclined to feel that I am a failure.

1. Almost always/always
2. Most times (much more than half the time)
3. Sometimes (about half the time)
4. A few times (much less than half the time)
5. Almost never/never

12. I felt confident.

1. Almost always/always
2. Most times (much more than half the time)
3. Sometimes (about half the time)
4. A few times (much less than half the time)
5. Almost never/never

13. My partner was satisfied with our relationship in general.

1. Almost always/always
2. Most times (much more than half the time)
3. Sometimes (about half the time)
4. A few times (much less than half the time)
5. Almost never/never

14. I was satisfied with our relationship in general.

1. Almost always/always
2. Most times (much more than half the time)
3. Sometimes (about half the time)
4. A few times (much less than half the time)
5. Almost never/never

THANK YOU FOR COMPLETING THESE QUESTIONS

Appendix L

Your Health and Well-Being

Health Status Survey SF-36-V2

This set of questions asks for your views about your health. This information will help keep track of how you feel and how well you are able to do your usual activities. Answer every question by making the answer as indicated. If you are unsure about how to answer a question, please give the best answer you can.

For each of the following questions, please mark an ✕ in the one box that best describes your answer.

1-In general, would you say your health is:

Excellent☐

Very good ☐

Good ☐

Fair☐

Poor☐

2. <u>Compared to one year ago</u>, how would you rate your health in general <u>now</u>?

Much better now than one year ago☐

Somewhat better now than one year ago☐

About the same as one year ago ☐

Somewhat worse now than one year ago☐

Much worse now than one year ago ☐

3. The following questions are about activities you might do during a typical day.

Does <u>your health now limit you</u> in these activities? If so, how much? (Please circle one number on each line).

	<u>Activities</u>	**Yes Limited A Lot**	**Yes Limited A Little**	**Not Limited At All**
3(a)	<u>Vigorous activities</u> , such as running, lifting heavy objects, participating in strenuous sports	1	2	3
3(b)	<u>Moderate activities</u>, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf	1	2	3
3(c)	Lifting or carrying groceries	1	2	3
3(d)	Climbing several flights of stairs.	1	2	3
3(e)	Climbing one flight of stairs	1	2	3
3(f)	Bending, kneeling, or stooping	1	2	3
3(g)	Walking more than a mile	1	2	3
3(h)	Walking several hundred yards (several blocks)	1	2	3
3(i)	Walking one hundred yards (one block)	1	2	3
3(j)	Bathing or dressing yourself	1	2	3

4. During the <u>past 4 weeks</u>, how much of the time have you had any of the following problems with your work or other regular daily activities <u>as a result of your physical health</u>? (Please circle one number on each line).

		All of the time	Most of the time	Some of the time	A little of the time	None of the time
4(a)	Cut down on the amount of time you spent on work or other activities	1	2	3	4	5
4(b)	Accomplished less than you would like	1	2	3	4	5
4(c)	Were limited in the kind of work or other activities	1	2	3	4	5
4(d)	Had difficulty performing the work or other activities (for example, it took extra effort)	1	2	3	4	5

5. During the past 4 weeks, how much of the time have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)? (Please circle one number on each line).

		All of the time	Most of the time	Some of the time	A little of the time	None of the time
5(a)	Cut down on the amount of time you spent on work or other activities	1	2	3	4	5
5(b)	Accomplished less than you would like	1	2	3	4	5
5(c)	Did work or other activities less carefully than usual	1	2	3	4	5

6. During the past 4 weeks, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbours, or groups?

Not at all☐
Slightly ☐
Moderately☐
Quite a bit☐
Extremely☐

7. How much bodily pain have you had during the past 4 weeks?

None☐
Very mild ☐
Mild ☐
Moderate ☐
Severe ☐
Very Severe☐

8. During the past 4 weeks, how much did pain interfere with your normal work (including both work outside the home and housework)?

Not at all ☐
A little bit ☐
Moderately☐
Quite a bit ☐
Extremely☐

9. These questions are about how you feel and how things have been with you <u>during the past 4 weeks</u>. For each question, please give the one answer that comes closest to the way you have been feeling for each item. (Please circle one number on each line.)

		All of the time	Most of the time	Some of the time	A little of the time	None of the time
9(a)	Did you feel full of life?	1	2	3	4	5
9(b)	Have you been very nervous?	1	2	3	4	5
9(c)	Have you felt so down in the dumps that nothing could cheer you up?	1	2	3	4	5
9(d)	Have you felt calm and peaceful?	1	2	3	4	5
9(e)	Did you have a lot of energy?	1	2	3	4	5
9(f)	Have you felt downhearted and depressed?	1	2	3	4	5
9(g)	Did you feel worn out?	1	2	3	4	5
9(h)	Have you been happy?	1	2	3	4	5
9(i)	Did you feel tired?	1	2	3	4	5

10. During the <u>past 4 weeks</u>, how much of the time has your <u>physical health or emotional problems</u> interfered with your social activities (like visiting friends, relatives, etc.)?

All of the time☐
Most of the time☐
Some of the time☐
A little of the time☐
None of the time☐

11. How TRUE or FALSE is <u>each</u> of the following statements for you? (Please circle one number on each line.)

		Definitely True	Mostly True	Don't Know	Mostly False	Definitely False
11(a)	I seem to get sick a little easier than other people	**1**	**2**	**3**	**4**	**5**
11(b)	I am as healthy as anybody I know	**1**	**2**	**3**	**4**	**5**
11(c)	I expect my health to get worse	**1**	**2**	**3**	**4**	**5**
11(d)	My health is excellent	**1**	**2**	**3**	**4**	**5**

Appendix M

International Index of Erectile Function (IIEF)

Instructions: These questions ask about the effects your erection problems have had on your sex life, over the past 4 weeks. Please answer the following questions as honestly and clearly as possible. In answering these questions, the following definitions apply:

-Sexual activity includes intercourse, caressing, foreplay and masturbation
-Sexual intercourse is defined as vaginal penetration of the partner (you entered the partner)
-Sexual stimulation includes situations like foreplay with a partner, looking at erotic pictures, etc.
-Ejaculate is defined as the ejection of semen from the penis (or the feeling of this)
-Orgasm is the fulfilment or climax following sexual stimulation or intercourse

Mark ONLY one circle per question:

Over the past 4 weeks:

1. How often were you able to get an erection during sexual activity?

0. No sexual activity
1. Almost never or never
2. A few times (less than half the time)
3. Sometimes (about half the time)
4. Most times (more than half the time)
5. Almost always or always

2. When you had erections with sexual stimulation, how often were your erections hard enough for penetration?

0. No sexual activity
1. Almost never or never
2. A few times (less than half the time)
3. Sometimes (about half the time)
4. Most times (more than half the time)
5. Almost always or always

3. When you attempted sexual intercourse, how often were you able to penetrate (enter) your partner?

0. Did not attempt intercourse
1. Almost never or never
2. A few times (less than half the time)
3. Sometimes (about half the time)
4. Most times (more than half the time)
5. Almost always or always

4. During sexual intercourse, how often were you able to maintain your erection after you had penetrated (entered) your partner?

0. Did not attempt intercourse
1. Almost never or never
2. A few times (less than half the time)
3. Sometimes (about half the time)
4. Most times (more than half the time)
5. Almost always or always

5. During sexual intercourse, how difficult was it to maintain your erection to completion of intercourse?

0. Did not attempt intercourse
1. Extremely difficult
2. Very difficult
3. Difficult
4. Slightly difficult
5. Not difficult

6. How many times have you attempted sexual intercourse?

0. No attempts
1. 1-2 attempts
2. 3-4 attempts
3. 5-6 attempts
4. 7-10 attempts
5. 11 or more attempts

7. When you attempted sexual intercourse, how often was it satisfactory for you?

0. Did not attempt intercourse
1. Almost never or never
2. A few times (less than half the time)
3. Sometimes (about half the time)
4. Most times (more than half the time)
5. Almost always or always

8. How much have you enjoyed sexual intercourse?

0. No intercourse
1. No enjoyment at all
2. Not very enjoyable
3. Fairly enjoyable
4. Highly enjoyable
5. Very highly enjoyable

9. When you had sexual stimulation <u>or</u> intercourse how often did you ejaculate?

0. No sexual stimulation or intercourse
1. Almost never or never
2. A few times (less than half the time)
3. Sometimes (about half the time)
4. Most times (more than half the time)
5. Almost always or always

10. When you had sexual stimulation <u>or</u> intercourse, how often did you have the feeling of orgasm or climax (with or without ejaculation)?

1. Almost never or never
2. A few times (less than half the time)
3. Sometimes (about half the time)
4. Most times (more than half the time)
5. Almost always or always

11. How often have you felt sexual desire?

1. Almost never or never
2. A few times (less than half the time)
3. Sometimes (about half the time)
4. Most times (more than half the time)
5. Almost always or always

12. How would you rate your level of sexual desire?

1. Very low or none at all
2. Low
3. Moderate
4. High
5. Very high

13. How satisfied have you been with you <u>overall sex life</u>?

1. Very dissatisfied
2. Moderately dissatisfied
3. Equally satisfied & dissatisfied
4. Moderately satisfied
5. Very satisfied

14. How satisfied have you been with your <u>sexual relationship</u> with your partner?

1. Very dissatisfied
2. Moderately dissatisfied
3. Equally satisfied & dissatisfied
4. Moderately satisfied
5. Very satisfied

15. How do you rate your <u>confidence</u> that you can get and keep your erection?

1. Very low
2. Low
3. Moderate
4. High
5. Very high

THANK YOU FOR COMPLETING THESE QUESTIONS

Appendix N

Male Sexual Function Index (MSFI)

1. During the past 30 days, on how many days have you felt sexual drive?

1. No days
2. Few days
3. Some days
4. Most days
5. Every days

2. During the past 30 days, how would you rate your level of sexual drive?

1. None at all
2. Low
3. Medium
4. Medium high
5. High

3. Over the past 30 days, how often have you had partial or full erections when you were sexually stimulated in any way?

1. Not at all
2. A few times
3. Fairly often
4. Usually
5. Always

4. Over the past 30 days, when you had erections how often were they firm enough to have sexual intercourse?

1. Not at all
2. A few times
3. Fairly often
4. Usually
5. Always

5. How much difficulty did you have getting an erection during the past 30 days?

1. Did not get erections at all
2. A lot of difficulty
3. Some difficulty
4. Little difficulty
5. No difficulty

6. In the past 30 days, how much difficulty have you had ejaculating when you have been sexually stimulated?

1. No sexual stimulation in past month
2. A lot of difficulty
3. Some difficulty
4. Little difficulty
5. No difficulty

7. In the past 30 days, how much did you consider the amount of semen you ejaculate to be a problem for you?

1. Did not climax
2. Big problem
3. Medium problem
4. Small problem
5. No problem

8. In the past 30 days, to what extent have you considered a lack of sex drive to be a problem?

1. Big problem
2. Medium problem
3. Small problem
4. Very small problem
5. No problem

9. In the past 30 days, to what extent have you considered your ability to get and keep erections to be a problem?

1. Big problem
2. Medium problem
3. Small problem
4. Very small problem
5. No problem

10. In the past 30 days, to what extent have you considered your ejaculation to be a problem?

1. Big problem
2. Medium problem
3. Small problem
4. Very small problem
5. No problem

11. Overall, during the past 30 days, how satisfied have you been with your sex life?

1. Very dissatisfied
2. Mostly dissatisfied
3. Neutral or mixed
4. Mostly satisfied
5. Very satisfied

THANK YOU FOR COMPLETING THESE QUESTIONS

Appendix O

PHYSICAL ACTIVITY READINESS QUESTIONNAIRE (PAR-Q)

	Questions	Yes	No
1	Has your doctor ever said that you have a heart condition and that you should only perform physical activity recommended by a doctor?		
2	Do you feel pain in your chest when you perform physical activity?		
3	3 In the past month, have you had chest pain when you were not performing any physical activity?		
4	Do you lose your balance because of dizziness or do you ever lose consciousness?		
5	Do you have a bone or joint problem that could be made worse by a change in your physical activity?		
6	Is your doctor currently prescribing any medication for your blood pressure or for a heart condition?		
7	Do you know of any other reason why you should not engage in physical activity?		

Appendix P

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE (IPAQ)

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport. **Think about all the vigorous activities that you did in the last 7 days. Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think *only* about those physical activities that you did for at least 10 minutes at a time.**
1. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, aerobics, or fast bicycling? _____ **days per week** ☐No vigorous physical activities (***Skip to question 3)***
2. How much time did you usually spend doing **vigorous** physical activities on one of those days? _____ **hours per day** _____ **minutes per day** ☐Don't know/Not sure
Think about all the moderate activities that you did in the last 7 days. Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time
3. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking. _____ **days per week** ☐No moderate physical activities (***Skip to question 5)***
4. How much time did you usually spend doing **moderate** physical activities on one of those days? _____ **hours per day** _____ **minutes per day** ☐Don't know/Not sure
Think about the time you spent walking in the last 7 days. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.
5. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time? _____ **days per week** ☐No walking (***Skip to question 7)***

6. How much time did you usually spend **walking** on one of those days?

_____ **hours per day**

_____ **minutes per day**

☐Don't know/Not sure

The last question is about the time you spent sitting on weekdays during the last 7 days. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

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

_____ **hours per day**

_____ **minutes per day**

☐Don't know/Not sure

THANK YOU FOR COMPLETING THESE QUESTIONS

Appendix Q

Ethics Approval

Office of Research and Development

GPO Box U1987

Perth Western Australia 6845

Telephone +61 8 9266 7863

Facsimile +61 8 9266 3793

Web research.curtin.edu.au

11-Oct-2016

Name: Sebely Pal
Department/School:
Epidemiology and Biostatistics
Email:
S.Pal@curtin.edu.
au

Dear Sebely Pal

RE: Ethics approval

Approval number: HRE2016-0367

Thank you for submitting your application to the Human Research Ethics Office for the project **The effect of physical activity on sexual functioning in overweight/obese individuals**.

Your application was reviewed by the Curtin University Human Research Ethics

Committee at their meeting on **04-Oct-2016**. The review outcome is: **Approved**.

Your proposal meets the requirements described in National Health and Medical Research Council's (NHMRC) *National Statement on Ethical Conduct in Human Research (2007).*

Approval is granted for a period of one year from **11-Oct-2016** to **10-Oct-2017**. Continuation of approval will be granted on an annual basis following submission of an annual report.

Personnel authorised to work on this project:

Name	Role
Pal, Sebely	CI
Ho, Suleen	Co-Inv
Botlani Esfahani,Saeideh	Student
Hagger, Martin	Co-Inv
Kane, Robert	Co-Inv
Rooney, Rosanna	Co-Inv
Winter, Stephen	Co-Inv

Standard conditions of approval

1. Research must be conducted according to the approved proposal
2. Report in a timely manner anything that might warrant review of ethical approval of the project including: proposed changes to the approved proposal or conduct of the study
   - unanticipated problems that might affect continued ethical acceptability of the project
   - major deviations from the approved proposal and/or regulatory guidelines
   - serious adverse events
3. Amendments to the proposal must be approved by the Human Research Ethics Office before they are implemented (except where an amendment is undertaken to eliminate an immediate risk to participants)
4. An annual progress report must be submitted to the Human Research Ethics Office on or before the anniversary of approval and a completion report submitted on completion of the project
5. Personnel working on this project must be adequately qualified by education, training and experience for their role, or supervised
6. Personnel must disclose any actual or potential conflicts of interest, including any financial or other interest or affiliation, that bears on this project
7. Changes to personnel working on this project must be reported to the Human Research Ethics Office
8. Data and primary materials must be retained and stored in accordance with the Western Australian University Sector Disposal Authority (WAUSDA) and the Curtin University Research Data and Primary Materials policy
9. Where practicable, results of the research should be made available to the research participants in a timely and clear manner
10. Unless prohibited by contractual obligations, results of the research should be disseminated in a manner that will allow public scrutiny; the Human Research Ethics Office must be informed of any constraints on publication
11. Ethics approval is dependent upon ongoing compliance of the research with the Australian Code for the Responsible Conduct of Research, the National Statement on Ethical Conduct in Human Research, applicable legal requirements, and with Curtin University policies, procedures and governance requirements
12. The Human Research Ethics Office may conduct audits on a portion of approved projects.

Special Conditions of Approval

This letter constitutes ethical approval only. This project may not proceed until you have met all of the Curtin University research governance requirements.

Should you have any queries regarding consideration of your project, please contact the Ethics Support Officer for your faculty or the Ethics Office at hrec@curtin.edu.au or on 9266 2784.

Yours sincerely

Professor Peter O'Leary

Chair, Human Research Ethics Committee

Appendix R

CONSENT FORM

- I have read the participant information sheet and have been given the opportunity to have any questions answered.
- I acknowledge that I understand the purpose of the study.
- I agree to participate in this study, however understand that my participation is voluntary, and that I can have a change of mind and withdraw from the study at any time without any negative consequences.
- I understand that the studies result may be published; however, no personal or confidential information will be used to identify me.
- I agree that I will not participate in any other physical activity and sexual functioning program or intervention while I am participating in this study.
- I approve of engaging in blood samples and understand how my samples will be stored as per the information within the participant information sheet.
- I have read the Physical Activity and Sexual Functioning Study Program Competition Terms and Conditions and provide my consent to be bound by them.
- Note: **I understand I can keep the Fitbit if I complete the study**.

Signed: _____ Date: _____

(Participant)

Signed: _____ Date: _____

(Researcher, Saeideh Botlani)

Appendix S

Participant's Information Sheet

Dear Participant

My name is Saeideh(Sara) Botlani. I am a PhD student in Psychology at Curtin University and conducting this research on physical activity and sexual functioning as part of my PhD thesis.

You have been accepted as a volunteer in this study because you are between 18 and 65 years who are heterosexual/bisexual sedentary overweight/obese male and have an initial body mass index (BMI) of 25 to 47 kg/m². Please read this document carefully before you sign the written consent form. Do not sign the consent form if there is anything in this document that is not completely understood. Please feel free to ask any questions you may have at any time.

BACKGROUND INFORMATION

According to the WHO the obesity epidemic is increasing nationally and worldwide, and by 2014 it was estimated to affect 1.9 billion individuals globally. Obesity and being overweight impose a high risk for a large number of physiological health problems including cardiovascular disease, stroke, type 2 diabetes, hypertension, hyperlipidaemia, musculoskeletal disease and cancer. Obesity has been also associated with a wide range of psychosocial issues such as depression, anxiety, stress, low self-esteem, poor body image and poor relationship.

Physical inactivity has been identified as the fourth leading risk factor for global mortality causing an estimated 3.2 million deaths worldwide. It is estimated that 56% of Australian adults are either inactive or have low levels of physical activity (Fogelholm, 2008). Both obesity and physical inactivity are associated with sexual dysfunction/sexual difficulties while increased physical activity is associated with lower risk of erectile dysfunction. Sexual dysfunction is associated low sexual desire, low sexual satisfaction, low intercourse satisfaction, less enjoyment, poor orgasmic function and more erectile dysfunction and prevents individuals from experiencing satisfaction from sexual activity. This research is investigating the effect of increased physical activity intervention aimed to assist in better sexual functioning.

WHAT PARTICIPATION IN THIS STUDY INVOLVES?

This is a 12-week study. During that time, you will be required to attend three clinic appointments in the morning for weight, height and waist measurements and other testing at Curtin University in Bentley. These appointments will be approximately 30 minutes in length, and will be held at weeks 0, 6 and 12 of the study. As they are fasting appointments, refreshments will be provided afterwards. All of your appointments will be scheduled to occur at roughly the same time, where possible. In addition, you need to comply with your instruction guidelines, complete homework tasks, including completing questionnaires prior to, during, and following the intervention, complete blood sample tests. All participants will receive a free activity checker (Fitbit).

You will be given an instruction sheet at your first appointment at Curtin.

PLEASE NOTE:

Please do not change what you eat or start new activity until after your first clinic appointment.

It is very important that I collect measurements from you first, before you get started, to be able to detect any changes that occur later on due to the intervention guidelines. If you start before your first appointment the data will be ruined. This will be a complete waste of your time and mine.

GUIDELINE AND LIFESTYLE REQUIREMENTS

Please follow the guidelines provided. This may take a little adjustment, especially if the guidelines are different from your usual lifestyle habits. Referring to the guidelines regularly should help with this.

QUESTIONNAIRES

You will be given questionnaires before each appointment. These need to be completed at your appointments at weeks 0, 6 and 12.

BLOOD TESTS

You will be required to undertake blood samples on three occasions (week 0, 6 & 12) by a trained phlebotomist. Tubes containing blood samples will be de-identified with a unique code to protect your privacy. The samples will be stored in a freezer at Curtin University, until the study's completion.

BEFORE YOUR APPOINTMENT

- You will be required to complete your questionnaires before you attend each clinic appointment
- Please do not consume any alcoholic beverages in the day/night before your appointment
- Please do not weigh yourself at home
- Please do not do any strenuous activity before your appointment

CLINIC APPOINTMENTS

- Arrive at the clinical room on time and relaxed. Allow enough time to get to Curtin and to find parking.
- Try to complete your questionnaires.
- Don`t forget to display your parking permit on the dashboard of your car (Don't worry about this as it is saved on the system).
- Your weight, height, waist and hip will be measured.
- Your blood pressure will then be taken.
- You will be provided with tea or coffee and a light snack after your appointment.
- Your next appointment will be scheduled.
- You will then be given your questionnaires to be completed before your next appointment.
- You will also be provided with a parking permit for your next appointment

BENEFITS TO VOLUNTEERS

The results of this study may lead to the development of new strategies to help sedentary overweight/obese people increase their physical activity and improve overall health and wellbeing. Your time and commitment as a volunteer in this study is very valuable and greatly appreciated.

Therefore, as a participant in this study, you have the potential to increase your physical activity and reduction in metabolic syndrome risk factors, depending on how closely you follow the physical activity program provided.

In addition, the results of all of your clinical measurements will be available after the study has finished, and provided to you upon request.

YOUR PARTICIPATION IS VOLUNTARY

This is an important study and your compliance is essential to its success. However, participation in this study is entirely voluntary, and you have the right to withdraw to participate at any time and no reason is needed for this decision. If you decide to withdraw from the study, all data and blood samples will be destroyed in a confidential manner.

POTENTIAL RISKS

This program is aimed to lead to better sexual functioning. A potential risk is that no improvement in sexual functioning is experienced, and no guarantee can be given that you will benefit from the intervention. However, following the study's completion, you will be provided with the opportunity to receive further information about the study results regarding increased physical activity and better sexual functioning.

CONFIDENTIALITY

All of the data collected including your personal information will remain anonymous and confidential. Access to your information will only be viewed by the researcher and research supervisor. The information provided will only be used for the purpose of this study. Copies of questionnaires and other written material will be stored in a locked cabinet in the School of Psychology for five years, and then destroyed. If the results of this study are published, you will not be identified.

ETHICS APPROVAL

This study has been approved by the Curtin University Human Research Ethics Committee (Approval Number: HRE2016-0367). The Committee is comprised of members of the public, academics, lawyers, doctors and pastoral carers. If needed, verification of approval can be obtained either by writing to the Curtin University Human Research Ethics Committee, c/- Office of Research and Development, Curtin University, GPO Box U1987, Perth, 6845 or by telephoning 9266 2784 or by emailing hrec@curtin.edu.au

PARKING INFORMATION

A parking permit has been provided that allows you to park in parking bays B6 & B7 free of charge. Please see the attached map for parking bay location information.

PUBLIC TRANSPORT INFORMATION

Trains and buses make it easy to get to and from Curtin University. For more information, please contact the Transperth InfoLine on 13 62 13 or go to www.transperth.wa.gov.au

STUDY COORDINATOR CONTACT DETAILS:

For any questions or concerns regarding your participation in this study at any time, please call Saeideh (Sara) on 0416095613 or email: saeideh.botlanie@postgrad.curtin.edu.au. These details are also on your Appointment Sheet, to be kept in your folder for future reference.