The effect of a three month, low- resistance- high- repetitions group-based exercise program on aerobic fitness and body composition in inactive women

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Abstract

Various factors contribute to the high obesity rates observed worldwide including physical inactivity, sedentary lifestyle and impaired sleep quality. The current PhD project consisted by two studies: a cross sectional study and an interventional study.

The aim of the cross-sectional study was to examine the association among physical fitness, body composition, depression, fatigue and sleep quality among a sample of adult women (36.1 ± 11.7 yrs) with different obesity status. One hundred and ninety one volunteer adult healthy women participated in this cross-sectional study and were divided as follows: normal body weight (BMI 18.5-24.5kg / m²), overweight (BMI 25-30 kg/m²) and obese (BMI ≥ 30).

Obese women were observed to experience significantly worse score in depression ($p<0.05$). Similarly, the obese and overweight women were found to exhibit lower levels of aerobic fitness compared to women with normal BMI ($p<0.05$). Body composition parameters were shown to be inversely associated with low score on both physical fitness tests as well as with poor sleep, depression and fatigue levels ($p<0.05$). Depressive symptoms and performance on various physical fitness tests were found to be significantly impaired in obese and overweight adult women indicating the negative impact of increased body weight in overall health and wellbeing.

The aim of the intervention study was to examine the effects of a three month, low resistance, high repetition (LRHR) group fitness program on aerobic fitness and compare results obtained, with a Pilate's program.

Twenty six adult women were assigned in the LRHR program, whereas sixteen women in the Pilates. Aerobic fitness, as well as lower extremities explosive power and body composition

parameters were significantly improved in women of the LRHR group compared to the Pilates group ($p<0.05$).

On the other hand, the Pilates group, as expected, showed a significant increase in scores related to flexibility ($p<0.05$). In summary, LRHR group fitness programs can be well tolerated by unfit women of the general population and could be used as an alternative method to the traditional cardiorespiratory exercise training in terms of improving physical fitness and body composition.

Taking all into account, the current PhD thesis highlights the negative impact of obesity in aspects related to physical and mental health and wellbeing in adult women, whilst participation in a low resistance and high repetition exercise regimes for 3 months could result in significant improvements in fitness and health related parameters.

Keywords: body composition, depression, physical fitness, BMI, low resistance program, high repetition exercise

CHAPTER 1

GENERAL INTRODUCTION

Premature mortality, as well as various chronic diseases are known to be associated, among others, with excessive body weight and body fat and thus obesity. In addition, increased body weight and obesity are well-known contributing factors for developing cardiovascular diseases (De Schutter et al., 2014) (further information in Section 1.1, in Chapter 1). Many intervention and cross sectional studies have examined the connection between unhealthy lifestyle, i.e. physical inactivity, unhealthy eating patterns, alcohol consumption etc., and its connection with CVD (Biswas et al., 2015), diabetes mellitus(Rahati et al., 2014) and arterial stiffness(Lessiani et al., 2016).

In addition, hypertennsion (Rahmouni, 2014) and Non Insulin Dependant Diabetes Mellitus (Komaroff, 2017) are other health related negative impacts of obesity. Both of these diseases and their relation with obesity are analysed in Section 1.2 and 1.3, respecrivily.

These factors are likely to cause stroke and end-stage organ damage. Studies show that obese persons have higher health care expenditure than non-obese persons (Anderson et al., 2005, Bell et al., 2011).

Obesity also has a negative impact on sleep quality and quantity .Poor sleep quality, often associated with insomnia, may cause imbalance of hormonal status, decreased glucose tolerance, decreased insulin sensitivity and increased evening concentrations of cortisol, as well as increased levels of ghrelin. All of these alterations are analysed in Section 1.4, of Chapter 1).

Obesity has a wide range of negative influences on human health. These influences are increased in women due to female reproductive system. (Obesity and the effects of female hormones are analysed in Section 1.5 of chapter 1.)

On the other hand, increased obesity has a negative impact on mental state and has shown to increase susceptibility towards depression and anxiety. In addition, it has shown to negatively influence Health-related quality of life (HRQOL). An Instrumental Variable Analysis of the Hunt Study reveals the positive correlation between increased BMI and depression (Bjorngaard et al., 2015). A systematic review analysing the results of Short-Form 36 (SF-36) and Impact of Weight on Quality of Life–Lite (IWQOL-Lite) instruments, showed the negative impact of excessive weight and obesity on quality of life and wellbeing (Kroes et al., 2016). As obesity is worldwide studied due to its high prevalence, its negative impact on Health-related quality of life (HRQOL) and patient functioning is considered a very important secondary end-point (Kolotkin et al., 2017). The vast majority of published studies conclude that obesity leads to decrements in HRQOL. The US Preventive Services Task Force examined the relationship between obesity and HRQL, from 2000 Medical Expenditure Panel Survey. The findings revealed that persons with severe obesity were found to have scores in physical and mental components (PCS-12 and MCS-12), which were similar to scores found in diabetic and hypertensive patients. Respondents with moderate obesity or were overweight, were found to have low HRQL scores, particularly on the PCS-12 (Jia and Lubetkin, 2005). Obesity and decreased HRQL is analysed in Section 1.6 of chapter 1.

It is well known that obesity could also result in impaired physical function and reduced exercise capacity and physical performance. For instance, as shown by Tai-Fen Song et al, obesity is associated with low cardiovascular fitness (Song et al., 2016). Subjects that participated in the Korean Physical Activity and Obesity (K-POP) study, reveal the strong association among physical fitness, obesity and metabolic syndrome, along with obesity-related diseases (Kim et al., 2014).

Apart from the negative influence of obesity on cardiovascular and cardiorespiratory fitness, other physical-related parameters such as flexibility, strength and balance levels are shown to be impaired in obese subjects also (Benetti et al., 2016; Abidin and Adam, 2013). Many studies (Mora et al., 2006; AlAbdulwahab and Kachanathu, 2016) emphasize how elevation of BMI negatively affects physical fitness levels (additional information can be found in in Section 1.8, Chapter 1).

Obesity also has been found to cause low back pain (Nilsen et al., 2011, Grossschadl et al., 2014) and decreased flexibility levels (Lau et al., 2015, Sarsan et al., 2006). These factors, as analysed in Section 1.8 can negatively influence HRQOL and daily functioning

These studies culminate that increased body fat leads to multiple health problems (both mentally and physically). Taking this into account, we studied an exercise trend, seen in many health clubs these days, in order to examine its impact on fitness and health related parameters of adult women.

Throughout the 1970s and early 1980s exercise classes performed in gyms and sporting centres consisted mostly from high impact aerobic (cardiorespiratory) exercise. Later low impact aerobics gained popularity. Step aerobics was introduced at a later stage and then the word 'aerobics steadily was replaced by the word' group exercise', mostly due to the fact that it incorporates a variety of body conditioning exercises. These group fitness classes were attendant by a large proportion of female participants. By getting to know the history, one can understand why group fitness classes involve, in higher percentage, women and fewer men. Programs like low-resistance-high-repetitions (LRHR) were developed in order to navigate men in group fitness classes.

Women seem to prefer exercising and moving with the rhythm of the song, whereas high number of men mostly prefers to simply exercise, with background music. Resistance or weight training was used to be considered a men's workout, but today many studies show the beneficial effect of resistance training in women (LeCheminant et al., 2014; Winters-Stone et al., 2013; Li et al., 2017).

Group fitness programs have longer term adherence rates compared to individual ones, probably due to program suitability, professionalism of the program, class encouragement (both from staff and other participants) and program atmosphere (Canuto et al., 2013). Sport centres and gyms have a variety of group based exercise programs which, among others, aid in socialization and allow participants to experience physical, emotional and social-related benefits. It is well known that by getting involved in group fitness programs, participants gain health related benefits (Oliveira et al., 2017). Exercising in groups gives the opportunity for participants to communicate with other participants, get to know new people and increase their social environment. Participating in physical activities and having an active lifestyle is not considered easy these days. Although health benefits of physical activities are well known, many people remain inactive. Available data show that globally, one third of adults do not reach public health guidelines on recommended levels of physical activity and that the prevalence of inactivity, in most industrialized countries, is higher in women than in men (Laeremans et al., 2017).

People participate in group fitness classes due to a need of 'belonging' (Maher et al., 2015), feeling of pleasure and felling of pressure to pursue health and weight aims in a stigmatizing environment (Bombak, 2015). Additionally they participate due to social cohesion (Izumi et al., 2015). A study by McDonnell et al., names that exercising in a group, at least once per week, reduces depression and stress rates in people following stroke than those who didn't participate (McDonnell et al., 2014).

A number of exercise training programs exist today with reported health and other physical benefits.A number of these exercise workouts is analyzed in Section 1.8, of Chapter 1. Among the other programs, low resistance, high repetition group exercise program has shown to have positive muscular and body composition effects (Mikkola et al., 2015). Do these programs, especially those involving dumbbells and free weight, improve aerobic fitness?

The aim of the current PhD thesis was to evaluate depression, sleep quality, physical fitness and fatigue among adult women of different obesity status, as well as to examine the impact of a three month, low-resistance-high-repetitions group-based exercise program on aerobic fitness and body composition in inactive women.

LITERATURE REVIEW

Obesity contributes to a large number of chronic diseases, pathological conditions and public health problems. World Health Organization (WHO) reported that 2.8 billion adults die each year due to overweight/obesity (Blumel et al., 2015).Reasons responsible for the obesity epidemic are referred to previously.

Obesity and cardiorespiratory fitness (CRF) are independent predictors of cardiovascular (CV) diseases and all-cause mortality (Ekblom-Bak et al., 2009). Increased body fat was found to be one of be the main factors increasing the susceptibility towards various chronic diseases. The main deleterious effects of adiposity on human health are discussed below.

1.1 Obesity and Cardiovascular Diseases (CVD)

Cardiovascular diseases such as coronary heart disease (CHD) and ischemic stroke are found to be proportionate to body mass index (BMI) (the most commonly used index of obesity). In the heart itself, alterations occur as a result of increased adiposity (Bastien et al., 2014). Increased adiposity causes adaptations of the cardiovascular system (CV) as it tries to maintain whole body homeostasis. Increased cardiac output and decreased peripheral resistance are of importance in this adaptive state (Bastien et al., 2014). An increase in blood volume , due to above alterations, causes enlargement of the cardiac cavities and increased wall tension which may eventually lead to left ventricular (LV) hypertrophy (LVH).). In addition, numbers of other mechanisms are thought to mediate the relationship between CRF, CV and obesity. Those include, reduced endothelial function seen in visceral adiposity (Brook et al., 2001) which is likely to lead to inflammation, adhesion and thrombosis, all of which are predictors for CV diseases (Vallance and Chan, 2001). Obesity and low CRF leads to an increase in arterial stiffness (Veijalainen et al., 2016), which in turn is a contributing factor of decreased CRF and increased risk for development of CVD.

Obesity is a risk factor associated with a cluster of conditions, which either directly or indirectly contributes to CHD (Todd Miller et al., 2008). Romero-Corral et al, analysed 40 studies, for a period of 3.8 years, involving obese and severe obese (≥35) subjects (Romero-Corral et al., 2006). What was revealed was that the highest risk for cardiovascular mortality (1.88 [1.05 -3.34]) was observed only among severe obese patients (BMI ≥ 35).

Similar results were seen in a cross sectional study carried out in 3562 individuals living in Iran. Anthropometric and clinical examinations: blood pressure (BP), 2- hour post-load plasma glucose level, fasting plasma glucose, along with serum total cholesterol (TC) and triglycerides (TG) were measured. High-density lipoprotein cholesterol (HDL-C) and low density lipoprotein cholesterol (LDL-C) were also assessed. The prevalence of HDL-C increased with BMI in women and prevalence of metabolic syndrome and high BP increased significantly with BMI in both sexes. A significant increase in CVD risk factors was seen with obesity, and particular abdominal obesity. Specifically, blood test values were changed, when women with waist to hip ratio (WHR) < 80 where compared with women whose WHR > 80. Blood test values were as follows: TC ≥ 240 mg/dL: 5.5% with 30.7%, TG ≥ 200 mg/dL: 4.5 % with 32.2%, LDL-C ≥ 160 mg/dL: 5.5% with 22.8%, HDL-C < 40 mg/dL: 19.1 with 22.0%, Metabolic syndrome: 2.7% with 44.4%, respectively (Kelishadi R.et al, 2008).

Subjects enrolled in the Cooper Center Longitudinal Study (CCLS)(Gupta et al., 2011) between 1970 and 2006, were studied in order to classify the association between CRF and risk of cardiovascular disease mortality. Clinical examinations included fasting blood glucose and total cholesterol. Fitness was assessed by a maximal exercise test, with the use of Balke protocol. Treadmill speed was set at 80m/min.First grade was set at 0%, the second time it was increased at 2% and it continued a 1% increase every minute, until the end. This protocol exercise time correlated with maximal equivalent uptake (METs). Quantile 1 was classified as the lowest fitness level, whereas Quantile 2 and 3 as intermediate and high fitness levels accordingly. What was observed was that participants in quantile 2 and 3 were associated with decreased risk of CVD, in comparison with subjects of quantile 1 (Gupta et al., 2011), showing that low fitness levels increase risk for development CVD.

Similar findings showed that an increase in CRF can have favourable effects on arterial stiffness in healthy (Moreau et al., 2003, Tanaka et al., 2000) or cardiac disease patients (Parnell et al., 2002). For instance, regular aerobic exercise participation for 3 months, was found to be associated with augmented carotid arterial compliance in healthy postmenopausal women (Moreau et al., 2003). Another mechanism that might contribute to decreased aortic stiffness as a result of CRF is the decrease in resting heart rate induced by aerobic exercise. Obesity, especially central obesity in women, can lead to aortic stiffness, increasing the risk of CVD disease (Augustine et al., 2016) and leading to a decrease in CRF. This is even more important in females, as a decrease in oestrogen levels during menopause, leads to an increase in heart diseases risks. Women with higher levels of CRF are less likely to increase body weight and BMI in the future (Brien et al., 2007. The association between female reproductive hormones and cardiovascular system is described in Section 1.5, Chapter 1.

Increases in body fat levels have shown to impair anaerobic capacity, strength and explosiveness of lower body (Abidin and Adam, 2013), as oppose to the reduction of body fat levels, which has shown to cause improvements in leg power, in both male and female athletes (Abidin and Adam, 2013).

1.2 Obesity and Hypertension

Droyvold et al. conducted a large cross sectional study in order to investigate the association between body mass index (BMI) and changes in diastolic blood pressure. They examined 29 817 men and women, without high blood pressure or any other metabolic or cardiovascular disease. Various health-related parameters were examined such as body weight, height, BMI as well as systolic blood pressure (SBP) and diastolic blood pressure (DBP). The monitoring of these parameters lasted 11 years. They found that an increase or decrease in BMI was significantly associated with increased and decreased SBP and DBP respectively (Droyvold et al., 2005), revealing that an elevation in BMI levels, increases the risk for hypertension.

Moreover, several human and animal studies have documented that excess body weight is possible to cause an increase in blood pressure (De Ciuceis et al., 2011, Weisbrod et al., 2013) and obstructive sleep apnea (OSA). The role of the sympathetic nervous system is believed to be a major contributor of hypertension in obesity(Rahmoun,2014).Renal alterations induced by the increased body fat are also believed to lead to increased blood pressure **(**Lambert, et al, 2010).

1.3 Obesity and Non-Insulin Depended Diabetes Mellitus (NIDDM)

Type 2 diabetes mellitus (T2DM) (also called non-insulin dependent diabetes mellitus-NIDDM) and obesity are both growing epidemics, whilst there association is well documented (Al-Goblan et al., 2014). The International Diabetes Federation estimates that 382 million people worldwide will have diabetes in 2035 (Jeon et al., 2015). Among other factors, obesity and lack of activity are well established factors that contribute to the developments of NIDDM (Jeon et al., 2015). Current available data suggests that NIDDM is associated with unhealthy lifestyle which results to impaired insulin secretion from beta cells of the pancreas (Szoke and Gerich, 2005).

Mechanisms by which FFA cause insulin resistance in obese subjects are not completely understood. Guenther Boden emphasizes the importance of finding ways that can lead to a decrease in the rise in obesity, either through decrease in caloric intake or via increase in caloric expenditure (Boden, 2011). One possible mechanism for insulin resistance occurrence may is the increase of insulin production from b-cells of the pancreas. This leads to over production of insulin and initially leading to higher levels of insulin circulation. The b-cells are no longer able to meet the higher demands of insulin production. As a result insufficient hepatic and peripheral glucose will be in circulation. This will eventually lead to the development of T2D-NIDDM. The exact mechanisms as to why obesity and abdominal obesity in particular, lead to metabolic complications are not fully understood. Insulin resistance and T2D-NIDDM are among these complications. Evidence from studies show that a number of these complications are caused by elevation of FFAs (Jensen, 2008). Additionally, in abdominal obesity, adipocytes expand in order to store more fat, become more mature and start accumulating in visceral adipose tissue. Once adipose tissue expansion limit is reached, adipose tissue ceases to store energy efficiently and lipids begin to accumulate in other tissues (Virtue and Vidal-Puig, 2010). All individuals have a maximum capacity for adipose expansion which is determined by both genetic and environmental factors (Virtue and Vidal-Puig, 2010).A prospective cohort study among Korean subjects aimed to examine the relationship between BMI and NIDDM. Subjects who had received medical examination from 1990 to 1991 and who were available for the detection of NIDDM until September 1999 were included. Review of medical history, physical examination, anthropometric measurements and health risk appraisal questionnaire were evaluated at baseline. In order to examine insulin resistance and diabetes, all participants were examined after an overnight fast. Follow-up of this cohort revealed 117 cases with diabetes with an incident of 7.8 per 1,000 person-years. After a mean follow-up period of 5.95 yr, there were 117 new cases of NIDDM among the 2,531 subjects. Women with BMI ≥ 27.0 had 14.5 relative risk for NIDDM, as opposed to men who had a relative risk for NIDDM 3.38 when BMI was over and equal to 27.0(Sung et al., 2001)

1.4 Obesity, Fatigue and Sleep Quality and Quantity

1.4.1 Fatigue and Obesity

Fatigue, is often described by patients as a lack of energy, mental or physical tiredness and diminished endurance. The exact mechanism regarding fatigue is not well understood. Due to the physiological and neuromuscular changes that accompany obesity, it may alter the fatigue development mechanism and exacerbate injury risk. Obesity has been linked with fatigue by a variety of population studies. Some researchers name that the cause of fatigue is the fact that obese and overweight individuals carry more weight than normal weight people carry.

This may also be the reason that obese individuals experience impaired physical fitness status (Grieve et al., 2000).

Additionally, studies show that the transition from a seated to a standing work posture every 30 min across the workday, relative to seated work, may lead to a significant reduction in fatigue levels (Thorp et al., 2014). This explains that there are also emotional causes of fatigue both in the obese and non-obese population. Habitual exercise causes increase of neuromuscular characteristics of muscles fibers and increase in mitochondrial density. Inactivity, either due to injury or sedentary lifestyle, causes decrease in oxidative capacity and capillarization, as well as decreased phosphocreatine resynthesizes. All of these factors are able to result in the increase of feeling fatigued (Bogdanis, 2012).

Interestingly, women are more prone to the feeling of fatigue than men, since the skeletal muscles of men are larger, stronger and have greater proportional area of metabolically and functionally faster muscle fibres (Type II) than that of women (Staron et al., 2000, Porter et al., 2002). Sex differences are seen in different muscle groups and type of muscle contraction and the explanation for these differences involves a combination of muscular mechanisms, which include contractile properties, fibre type proportion and perfusion (Hunter, 2014). Women typically exhibit greater physiological responses to stress-inducing events than men (Kajantie and Phillips, 2006), thus being more sensitive to fatigability.

A large cross sectional study that examined the association of fatigue between self-reported fatigue with measured BMI and waist circumference and self-reported physical activity found that higher level of self-reported fatigue was associated with higher BMI, higher waist circumference, and less likelihood of getting sufficient physical activity (Resnick et al., 2006). Obese individuals were found to experience longer arm movement time to complete rapid tasks (Berrigan et al., 2006), due to abdominal circumference (Gilleard and Smith, 2007).

On the other hand, fatigue may also be attributed to insomnia and poor sleep (Palm et al., 2015). It may also be due the presence and severity of OSA (Hamilton and Joosten, 2017) which is found in number of obese individuals. Both physiological and emotional reasons can cause fatigue and OSA.

Fatigue can also be attributed, among others, to mitochondrial dysfunction (Filler et al., 2014), as mitochondrial and metabolic dysfunction is observed in individuals with increased body fat levels (Rector et al., 2010; Ritov et al., 2005; Bournat and Brown, 2010). Mitochondria have an essential role in energy production through oxidative phosphorylation, where nutrients are converted into adenosine triphosphate (ATP) which, in turn, supplies the human body with energy. Therefore, dysfunction of the mitochondria leads to extensive consequences (Duchen, 2004).Myopathy (Vincent et al., 2016), as well as loss of muscle coordination (Holvoet et al., 2017) are among these negative consequences.

1.4.2 Sleep Quality and Quantity in the obese population

Moreover, numerous studies reveal the negative effect of adiposity, particularly of central adiposity, on sleep quality and quantity (Moreno-Vecino et al., 2017, Aparicio et al., 2014, Truthmann et al., 2017) and therefore on quality of life. Obesity is considered a significant factor which influences sleep quality and quantity in a negative way (Mesarwi et al., 2013). This in turn, leads to impaired HRQOL and increased fatigue during daytime (Lou et al., 2015).

Interestingly, some studies showed that women may have a higher incidence of insomnia and disturbed sleep compared to men, due to menstrual circle influences (de Zambotti et al., 2017; Cuadros et al., 2012)but also due to increased levels of daily stress (White et al., 2016; Winzeler et al., 2014; Kashani et al., 2012;Hertig et al., 2007). So, gender differences do exist when it comes to analysing sleep patterns. This raises the necessity for finding different ways to decrease the continuous rising increase of obesity.

Normal sleep is characterized by decreased glucose turnover by the brain and has a reparative role, marked by increased glycogen stores and peptide synthesis. Consequently, although changes in glucose tolerance appear in normal sleep individuals, lipid metabolism during sleep is still on investigation (Mesarwi et al., 2013).As the level of glycogen stores (Kong et al., 2002), ATP changes (Dworak et al., 2010) and hormone changes release and metabolism (Leproult and Van Cauter, 2010) are dependent on sleep quantity and quality, it is easily seen how sleep deprivation inversely affects body fat. Growth hormones, together with leptin and ghrelin, both hormones which play a major role in appetite regulation, are somewhat dependant on sleep architecture (Leproult and Van Cauter, 2010). Leptin is dependent on meal intake, thus is decreased during morning hours and increased during daytime culminating in a nocturnal maximum. On the other hand, ghrelin levels decrease rapidly after meal ingestion and then increase in anticipation of the following meal. Both of these hormones are shown to be higher during nocturnal sleep (Leproult and Van Cauter, 2010). Despite prolonged fasting during sleep, glucose levels remain stable. This does not occur during fasting in an awaken state, allowing us to suggest that operative mechanisms during sleep must take part in order to prevent glucose levels from falling during the overnight fast (Leproult and Van Cauter, 2010). Reductions in sleep duration are known to be among the reasons responsible for obesity increase (Keith et al., 2006). Numerous epidemiological studies reveal than 6-7 hrs of sleep per night may cause an increase in body fat levels and increase in BMI (Dashti et al., 2015; Vgontzas et al., 2014).

Laboratory studies have shown that disorganization of sleep architecture can interfere with the secretion of prolactin (Spiegel et al., 2003), catecholamine (Penev et al., 2005) and growth hormones (Spiegel et al., 2000). Gender differences are regularly found in some sleep disorders. For instance insomnia is more prevalent in women (Bayon et al., 2014), probably due to emotional and daily stress (Winzeler et al., 2014). Sex differences and chromosomes generally contribute to sleep differences between men and women, with women gasping more weight barrel (Mallampalli and Carter, 2014). A study on excessive sleep duration and quality of life reports than women (age: < 55 years) report less sleep than men (Ohayon et al., 2013), and that older women report 20 minutes less sleep than men.

Apart from the fact that woman are at 40% increased risk for developing insomnia, compared to men (Zhang and Wing, 2006), they also have twice the risk for developing Restless Leg Syndrome (RLS) (Berger et al., 2004). Women also complain for sleep disturbances such as cramps, bloating, and headaches during pre -menopausal week or during menses. The prevalence of insomnia is increased by 33%–36% in premenopausal women and to 44%–61% in postmenopausal women (Krishnan and Collop, 2006). All of these factors contribute to defective sleep architecture, which as stated above, is a contributing factor for body weight increase.

It is estimated that 50% to 60% of people who are obese also experience symptoms of metabolic syndrome and Obstructive Sleep Apnea (OSA) (Resta et al., 2001). OSA is a common disorder of the upper airway collapse during sleep, which leads to oxygen desaturation and disrupted sleep. Obesity could increase the likelihood of airway collapse by directly affecting the anatomy of upper airway as fat is deposited in surrounding structures.

1.5. Obesity and the effects on female hormones

1.5.1 Women and CVD

Women, during menopause, due to decrease of production of female reproduction hormones (mainly oestrogen) are considered more sensitive to cardiovascular problems.

The role of oestrogen on cardiovascular system is widely understood, as oestrogen, aids in regulation of vascular function, blood pressure, endothelial relaxation, and the development of hypertrophy and cardio protection (Menazza and Murphy, 2016). The prevalence of left ventricular diastolic dysfunction sharply increases in women after menopause and may lead to heart failure.

It is thus seen that estrogen has direct cardiovascular effects (He et al., 2016, Johannes and Bairey Merz, 2011, Mercuro et al., 2001). Menopause, on the other hand, directly affects estrogen balance. If this balance is affected there is a direct negative impact in women of postmenopausal age. This raises the need to find different ways, apart from traditional, in order to improve CRF in women.

1.5.2 Female Reproductive System and Obesity

Numerous studies reveal that women, when in menopause transition, are prone to body composition changes due to reproductive hormones. Oestrogen levels can affect food intake and satiety (Lizcano and Guzman, 2014). As oestrogens enhance epinephrine production, fat burning process is also enhanced. When oestrogen balance is disrupted, due to menopause, the process of fat burning is decreased and women of this age group (menstrual circle has ended) are more prone to obesity.

In women, oestrogen levels appear to have additional effect on muscle size and power. Sex hormones have the ability to change hormone relaxin and collagen structure and metabolism (Dehghan et al., 2014b).Circulating oestrogen is a basic regulator of relaxin secretion (Dehghan et al., 2014a). This is of highly importance as women in menopause age have lower oestrogen levels and thus a higher susceptibility of body fat increase and lower muscle power. Increased muscular pain (Nilsen et al., 2011; Grossschadl et al., 2014) due to obesity (probably due to the increased load of joints and muscles as a result of excessive body weight) and elevated BMI are known to decrease flexibility of muscles. Flexibility and lumbar spine segments in obese and non-obese subjects are indifference (Rodriguez-Martinez et al., 2016).

In addition, obesity has been associated to disc degeneration (Samartzis et al., 2012) and osteoarthritis (Lementowski and Zelicof, 2008), both of which contribute to a decline in muscle flexibility and low quality of life levels. During axial rotation and compression of the lumbar spine segments, differences were seen in flexibility and compression test of the lumbar spines between obese and non-obese individuals (Rodriguez-Martinez et al., 2016), with coinciding sex differences. This again may be due to oestrogen levels been decreased with increasing age, leading to decline in relaxin and collagen metabolism in women. These hormonal changes seen in women of menopause also cause increase in central obesity.

1.5.3 Female Reproductive System and Depression

In addition, hormonal changes across the menstrual cycle are reported to modify symptoms of a number of mental disorders such as anxiety, bipolar, and psychotic and eating disorders (Pinkerton et al., 2010). All these mental abnormalities seen in obese individuals, lead to decreased levels of Health Related Quality of Life (HRQL).

A cross sectional study by Blumel et al. (Blumel et al., 2015), examined 6079 women, 40-59 years of 11 Latin American countries. Participants completed the Goldberg Anxiety and Depression Scale, the Menopause Rating Scale, the Athens Insomnia Scale, the Pittsburgh Sleep Quality Index and a general questionnaire containing personal socio-demographic data, anthropometric measures and lifestyle information. The results revealed that 63% of the women reported inactivity, 18.5% of them were obese and 12.2% had severe menopausal symptoms with a proportion of 13.2% using hormone therapy for the menopause. Depressive symptoms in the obese were higher than the non-obese group (54.3% and 44.7% respectively). Anxiety was also found to be increased in the obese group. Apart from obesity status (obese and non-obese) age is also considered an important parameter to take into consideration.

Obesity was seen to negatively influence HRQL in overweight and obese premenopausal women in higher extent than polycystic ovary syndrome (PCOS) (Thomson et al., 2010). 100

Mediterranean women with PCOS (group A), 50 with a body mass index (BMI) >25 kg/m^2 (group A_1) and 50 with BMI <25 kg/m^2 (group A_2), were recruited. They were evaluated with a combination of questionnaires: the Symptom Checklist-90 Revised, the 36-Item Short-Form Health Survey, and the Polycystic Ovary Syndrome Questionnaire. Results of this study showed that women of group A_1 (BMI > 25 kg/m^2) had decreased HRQOL (Panico et al., 2017).

Obese women are at an increased risk of obesity, as oppose to men, probably due to female reproductive hormones (Palmer and Clegg, 2015), because they are consistently shown to be less active in their leisure-time than men (Trost et al., 2002), and have a stronger association with time spent watching TV (Dunstan et al., 2010). Additional, the female reproductive system and hormonal fluctuations due to menstrual cycle, maternity, breastfeed and menopause lead to alternations of eating habits.

1.6. Effects of obesity on Health Related Quality of Life (HRQL)

In order to examine the relationship between self-reported body mass index (BMI) and health-related quality of life, of adult population in United States, data was gathered via a cross-sectional telephone health surveillance survey. Body weight and body height were collected and subjects were grouped according to six BMI-defined categories (<18.5 kg/m^2, underweight; 18.5 to 24.9 kg/m^2, desirable weight; 25 to 29.9 kg/m^2, overweight; 30 to 34.9 kg/m^2, obesity class I; 35 to 39.9 kg/m^2, obesity class II; and ≥40 kg/m^2, obesity class III). Data indicated that an increase in BMI values lead to impaired HRQL and the influence of joint pain and obesity related commodities impaired the negative influence of BMI on HRQL even more (Ford et al., 2001). The same study also examined the number of unhealthy days and self-reported BMI by gender, physical activity status and age. The mean overall number of unhealthy days was nonlinearly (J- or U-shaped) related to self-reported BMI, whereas mean number of unhealthy days increased with increasing age. BMI >20 kg/m² in women led to the experience of more unhealthy days, in relation to men with the same self-reported BMIs. The lowest mean number of unhealthy days occurred at a self-reported BMI of ~23 kg/m^2 among women and at 25 kg/m^2 among men. Men reported a decrease in both in mental and physical unhealthy days when BMI decreased bellow 25 kg/m². Unhealthy mental days, in women, increased as self-reported BMI decreased to <23 kg/m².Participants who were moderately or vigorously active reported fewer unhealthy days than did those respondents who reported no or light activity (Ford et al., 2001).

Jia and Lubetkin also showed the inverse relationship between obesity and HRQL (Jia and Lubetkin, 2005). After calculation of BMI of participants, via self-reported height and weight, they were allocated into BMI groups according to the World Health Organization guidelines and classification. Physical (PCS) and mental (MCS) component summaries was analysed with the use of SF-36 questionnaire, along with the self-classifier and a visual analogue scale, EuroQol EQ-5D. Overall averages for PCS was 49.12 and for MCS, EQ-5D index and EQ VAS scores were 51.2, 0.823 and 979.2 respectively. Participants who were overweight (BMI 25-29.9kg/m2) had poor score in HRQL and scores on both measures decreased with increasing level of obesity.

Physical and mental components were found to be improved (8% and 5% respectively) after 16 week participation, of both diabetic and obese participants, in aerobic plus strength training workout (Sukala et al., 2013).In this study, the Short-Form 36 was administered to the participants. Aim of the questionnaire was to evaluate 8 domains, as well as physical and mental component scales (PCS and MCS) of Quality of Life (QoL). Mental components between week 0 and week 16 had only 5% change, whilst there was a 22% and 12% change in physical functioning and bodily pain improvement respectively from exercise in week 0 to week 16. In addition, vitality and social functioning was improved by 22% and 18% respectively, whereas emotional scores were improved by 22%. Apart from the beneficial metabolic influence of exercise in these patients, emotional scores were beneficially influenced by exercise.

1.6.1 Obesity, Anxiety and Depression

Recent data reveal a possible association between obesity and depression. In this study, body mass index and depression were found to be positively associated, with an increased association between BMI and suicide mortality. Data from 32,457 mother offspring and 27,753 father-offspring pairs from the Norwegian HUNT-study were examined. Anxiety and depression were assessed using the Hospital Anxiety and Depression Scale and suicide death from national registers. Associations between offspring and own body mass index with symptoms of anxiety and depression and suicide mortality were estimated using logistic and Cox regression. What was found was that both own and offspring body mass index was found to be increasing in combination with depression levels. Surprisingly depression was low and suicide mortality was increased as BMI increased (Bjorngaard et al., 2015).

Elevated visceral fat could increase a person’s susceptibility towards depression, whilst visceral fat could be associated with increased inflammation (Murabito et al., 2013) and endocrine abnormalities (Hryhorczuk et al., 2013), which both could contribute to depressive-like behaviour. Some individuals are prone to increase food intake in response to stressful experiences (Dallman, 2010). Studies showed that female gender is consistently associated with an increased risk of depression among obese individuals (Ma and Xiao, 2010). In agreement to the previous findings, Ma and Xiao found that the probability of moderate/severe depressive symptoms and major depression, assessed with the use of the nine-item Patient Health Questionnaire (PHQ-9) increased progressively, beginning at BMI of 30(Ma and Xiao, 2010) .

Moreover, a growing amount of published studies suggest that metabolic abnormalities caused by central obesity lead to metabolic diseases and may be responsible for the increased incidence of depression seen in obesity. This may be the reason as to why obese individuals have a 55% increased risk for development of depression (Luppino et al., 2010). Studies conducted by Dong, C.et al (Dong et al., 2004) and Hamer et al. (Hamer et al., 2012) revealed that central obesity has been implicated in the development of depressed mood.

Results of the Strain et al., study (Strain et al., 2014) showed a small but positive effect of exercise on depression. Similarly, depressive patients who had undertook bariatric procedures, thus had decrease in obesity levels, and were not found to be negatively influenced by exercise. Patients, who were to receive laparoscopic surgical procedures in order to assist weight losses, completed the Short-Form-36 Health Survey (SF-36), Impact of Weight on Quality of Life-Lite (IWQOL-Lite) and the Beck Depression Inventory (BDI), in order to analyse QoL and depression levels. The procedure by which weight loss was assisted, differed among patients [(laparoscopic (GB) vs. adjustable gastric banding

(LAGB)]. Patients appeared for follow-up at least 1 year after surgery and forms were completed at differed periods, depending on the procedure for weight loss that was used. Although there was statistical difference in SF-36 between the different groups (surgical vs. laparoscopic), the correlation of the SF-36 change with EWL was limited to R=0.11 with a P=0.36.Increased BMI and obesity levels, lead to hazardous effects on HRQOL and mental health related parameters such as anxiety (Bjorngaard et al., 2015).

1.6.2 Obesity, cardiorespiratory fitness and physical performance

As mentioned in the introduction, elevated body fat levels are associated with impaired physical health related outcomes (Pataky et al., 2014, Sternfeld et al., 2002).

In the study of Farrrell et al, 2002, 9925 female patients completed a comprehensive medical examination (fasting blood chemistry, personal and family health history, anthropometry, resting blood pressure and electrocardiogram). Cardiorespiratory fitness (CRF) was measured on a treadmill using the modified Balke protocol. On the basis of the National Institute of Health, three categories were used for BMI: normal, overweight and obese. At the end of the study, highly fit individuals were found to have lower relative risk (RR) of all-cause mortality by BMI category. Obese women though (BMI ≥ 30kg/m2) had RR =1.58, which was lower when compared with normal and overweight individuals (RR =1.0 and RR=0.92 respectively). In addition, regarding CRF, moderate and highly fit women had a significantly lower risk of mortality (p = 0.002). Among the low fit group 75 number of deaths occurred during the time of study, as opposed to 57 deaths among the highly fit group. It is thus recognised that fit overweight and obese people may have significantly lower rates of all-cause mortality than normal-weight persons who are unfit (Farrell et al., 2002).

Pataky et al., showed that obese participants have slower fast gait speeds ($P < 0.05$), poorer sit-to-stand performance and low aerobic endurance (assessed by a gait test) ($P < 0.05$) (Pataky et al, 2014). In this particular observational study, thirty-six women with a BMI ≥ 30 kg/m^2 and 10 women with normal body weight (BMI between 18 kg/m^2 and 25 kg/m^2) were enrolled. Examinations criteria consisted of being able to walk 10m without a walking aid, complete a functional endurance test, examination in gait, balance and flexibility. People in the normal weight group had a mean, self-selected gait speed of 1.53 ± 0.22 ms^{-1} and as body weight increased, people decreased their gait speed. People with a BMI between 30 and 35 kg/m^2 walked at a self-selected speed that was similar to the speed of the normal body weight group (1.34 ± 0.20 ms^{-1}; $P \geq 0.05$). Regarding the sit and reach test the main difference could be observed between people with a normal BMI (8.28 ± 1.42 s) and the obesity category (11.29 ± 3.14 s) ($P = 0.026$). Endurance levels were significantly lower in the obesity groups. People with a BMI of less than 25 kg/m^2 walked 613.4 ± 45.9 m in 6 min. People in the obese category walked 532.3 ± 62.7 m, people in the severely obese category walked 487.3 ± 61.2m, and people in the morbidly obesity category only walked 462.8 ± 68.2 m.

Cardiorespiratory fitness (CRF) or aerobic fitness is well known to be improved via aerobic exercise training (Chin et al., 2015). Colcombe et al. found that 6 months of aerobic training improved cardiorespiratory fitness (Colcombe et al., 2004). In addition, Chapman et al. proved that even a short term of aerobic exercise can produce beneficial effects on cardiorespiratory fitness (Chapman et al., 2013). Regarding resistance training Fernandez-Lezau et al, found that 3 months of resistance training (RT) may lead to improvements in

CRF initially, but probably higher training frequencies may be required for further increase (Fernandez-Lezaun et al., 2017).

Corbnelissen et al examined the effects of RT on BP and CRF, by analysing 28 randomized controlled trials, of 1012 participants. Subjects were divided into normotensive, pre-hypertensive and hypertensive patients. Four weeks of RT caused significant blood pressure reduction in 28 normotensive or pre-hypertensive study groups. The hypertensive group showed no significant reductions. As for CRF, after dynamic resistance training , VO_2 max increased by 10.6%, (Cornelissen et al., 2011).The Health Benefits of Aerobic and Resistance Training examined in individuals With Type 2 Diabetes (HART-D study).Participants were randomly assigned to an aerobics training group (AT), resistance training (RT), and aerobic with resistance training group (ATRT). Intensity of all three groups was accustomed so all three groups equally agreed, regarding the level of exercise. The AT and ATRT groups participated in treadmill walking 3–5 days per week at a moderate to vigorous intensity , whereas the RT group completed 3 days of strength training exercises per week. The aerobic exercise dose in the ATRT group was lowered in order to accommodate the RT component and ensure equal time commitment across all exercise groups (Johannsen et al., 2013). Primary outcome of the study of Joannsen et al, was that AT alone or in combination with RT, can have a beneficial effect on CRF in sedentary individuals, diagnosed with diabetes mellitus (Johannsen et al., 2013).

A cross sectional study conducted by Gilleard and Smith (Gilleard and Smith, 2007) examined the effect of obesity on flexion motion in sitting and standing, and postural adaptations whilst a hip joint moment for a standing work task was examined. Ten obese and ten normal weight females were included in the study. Subjects were asked to perform anatomical trunk forward flexion, reach down on the floor in front of their feet, as far as possible with feet being flat and still and then bring their straight arms above their head looking upwards. After this, subjects performed three trials of a simulated static work task while standing at a 90 cm bench. Seated flexion was also calculated. The obese group had decreased thoracic segment angular displacement (*P*=0.005) and thoracolumbar spine range of motion (*P*=0.002), whereas there was no effect of obesity on pelvic segment (p=0.326), on hip range of motion (p=0.880) and base of support mediolateral width (p=0.364). The fact that thoracic segment angular displacement and thoracolumbar spine range of motion were influence by weight shows that an increase in BMI causes decrease in range of motion. Additionally, the hip joint net moment was significantly larger in the obese group, showing the negative influence of increased BMI.

In the same study, forward flexion of the trunk in standing position was also examined. Flexion demonstrated a significantly smaller thoracic segment angular displacement (*P*=0.005) and thoracolumbar spine range of motion (*P*=0.002). A significant low positive relationship was seen for pelvic segment angular displacement (rho=0.48, *P*<0.001) and the base of support mediolateral width (r=0.39, *P*=0.002), indicating that as BMI increased the base of support width and pelvic segment angular displacement increased. For the standing work task the obese group showed a significantly more flexed posture for the thoracic (*P*=0.002) and pelvic (*P*=0.010) segments and the hip joint (*P*=0.023) and thoracolumbar spines (*P*=0.028). During the initial quiet standing posture, the obese group stood further back from the bench with the hip-to-bench distance significantly larger (*P*=0.001) compared to normal weight subjects. BMI showed a high positive significant correlation with the posture of the thoracic segment (rho=0.78, *P*=<0.001), hip joint moment (rho=0.83, *P*=<0.001) and hip-to-bench distance (rho=0.73, *P*=<0.001). BMI also showed a moderate positive significant correlation with the posture of the pelvic segment (rho=0.54, *P*=<0.001), hip joint (rho=0.57, *P*=<0.001) and thoracolumbar spine (rho=0.64, *P*=<0.001). Specifically, obesity caused restriction, both in standing and sitting, of the trunk forward flexion and an increase in hip joint moment. Obesity also caused individuals to stand or sit further from the work area.

Additionally, studies show that transitioning from a seated to a standing work posture every 30 min across the workday, relative to seated work, may lead to a significant reduction in fatigue levels (Thorp et al., 2014), explaining that there are also emotional causes of fatigue both in the obese and non-obese population. Although habitual exercise causes increase of neuromuscular characteristics of muscles fibers and increase in mitochondrial density, inactivity, either due to injury or sedentary lifestyle, causes decrease in oxidative capacity and capillarization, as well as decreased phosphocreatine resynthesizes, resulting in the increase of feeling fatigued (Bogdanis, 2012). Women are more prone to the feeling of fatigue than men, since the skeletal muscles of men are larger and have greater proportional area of metabolically and functionally faster muscle fibres (Type II) than that of women (Staron et al., 2000, Porter et al., 2002). Sex differences are seen in different muscle groups and type of muscle contraction. The explanation for these differences involves a combination of muscular mechanisms, which include contractile properties, fibre type proportion and perfusion (Hunter, 2014). Women typically exhibit greater physiological responses to stress-inducing events than men (Kajantie and Phillips, 2006), thus being more sensitive to fatigability.

There is persuasive evidence that physical activity, in any form, has shown to counteract the increase in obesity and overweight, as well as to promote health benefits (Reiner et al., 2013, Lavie et al., 2015).Hu et al showed that, overweight, women with hypertension that attenuated physical activity, experience lower risks of health problems that accompany hypertension and increased body fat levels, in relation to normal weight women who were physically inactive (Hu et al., 2004). In addition, previous studies had found a joint association of physical activity with diabetes (Fogelholm, 2010), cardiovascular diseases (Jakovljevic et al., 2015) and obesity (Donnelly et al., 2009).

1.7 Effect of different exercise programs on physical parameters

Pyramid Resistance Training Programs have been shown to produce same benefits as traditional resistance exercise programs (Ribeiro et al., 2017). Pyramid training is a stepped approach to sets and repetitions. A pyramid means big at the bottom and narrow at the top. In weight training one starts heavy and gradually decreases the weights or repetitions. One might also start with light intensity and gradually increase the weight or repetitions.

Studies regarding High vs. Low intensity resistance training showed that high training is superior when it comes to strength adaptation (Schoenfeld et al., 2015).

On the other hand, High Intensity Interval Training (HIIT), has shown to produce large improvements in physical fitness parameters including significant improvement in $V0^2$max (Milanovic et al., 2015)

Strength training exercise, as apart from increasing muscular strength, it can increase muscle activation through isometric (Kim et al., 2015) and dynamic exercises (Hamlyn et al., 2007) and also increase bone mineral density (BMD)(Vincent and Braith, 2002).

1.7.1 Low Resistance, High Repetition training programs (LRHR)

Low Resistance, High Repetition training programs (LRHR) have been used in a variety of fitness centers within the last years within European countries and United States. As seen from studies focusing on women and LRHR (Rustaden et al., 2017) (Rustaden et al., 2017, Berthiaume et al., 2015), an increasing amount of women are including resistance training into their exercise schedule, these days, either to increase their performance or to improve body composition. Many health clubs are now having weight training within a group setting, with music. This approach makes it more enjoyable and fun as exercising with weights is done in a pleasant environment-within the aerobic room. LRHR group fitness classes are pre-choreographed, thus providing uniformity between health centers and providean easily reproducible resistance training programme (Nicholson et al., 2015).

There is limited research regarding the influence of LRHR on aerobic fitness. A study of O'Connor (O'Connor and Lamb, 2003) showed that Bodymax, an exercise program utilizing low weight and high repetitions, was found to decrease body fat levels and improve muscle strength in women who were exercising with this form of workout (O'Connor and Lamb, 2003).The particular LRHR exercise program caused a decrease on body fat levels, measured via skinfold fitness levels. However, the effect of such programs on aerobic fitness is still controversial.

Campos et al. (Campos et al., 2002), analysed muscular adaptations in response to three different resistance training programs. 3-5 maximal repetitions (RM), with four sets of each lower body exercise, were done by a Low repetition group, with 3 min rest in-between sets and exercises. 9-11 RM, for 3 sets was done by an Intermediate group, with 2 min rest. Additionally, a High repetition group performed 2 sets of exercises at 20-28RM, with 1 min rest. The first 4 weeks participants exercised for 2 days / week and the on the final 4 weeks participants exercised 3 days/ week. Maximal strength, local muscular endurance and a number of cardiorespiratory parameters were assessed at the beginning and the end of the intervention. Maximal strength was shown to be significantly improved by the end of the 8th week, mostly in the Low Rep group. Maximal number of repetitions at 60% of 1 RM was improved in the High Rep group. The High Rep group also had increased aerobic power and time to exhaustion and was shown to be better adapted for prolonged contractions. What the study of Campos et al demonstrated, was that physiological adaptations that are seen after an exercise program, are directly linked with the intensity and the number of repetition performed.

Ebben, et al (Ebben et al., 2004) showed that rowers who performed high repetition training demonstrated greater improvements in their sport performance and endurance. The study was to compare the effects of high-load (H-load) periodized resistance training and high-repetition reverse step loading periodized resistance training on endurance performance. Among the High load group were 5 novice and 8 varsity , whereas the High Rep consisted of 7 novice and 6 varsity. A rowing ergometer test was used for evaluation of the rowers, pre and post-test. VO2 peak, time to test completion, total power, average power per stroke, total number of strokes rate and body mass were improved by the end of week 8, in participants from the High Load training .On the other hand, novice rowers who performed H-rep training demonstrated greater improvements, in the above parameters, compared with those who performed H-load training. This leads to the conclusion that experienced and advance athletes have more to gain when exercising with High load training. Opposed to this, for immature athletes, who are not considered highly trained, High Rep training has shown to be more effective.

Cardiorespiratory fitness is an important predictor of all-cause mortality (Farrell et al., 2002). Research by Lin, X. showed that exercise raises cardiorespiratory fitness, improves lipid profile, lowers fasting insulin and increases high density lipoprotein (HDL), thus improving cardiac health of exercise participants (Lin et al., 2015). Even diabetic patients, with improved CRF, were found to have better metabolic control and better HRQOL (Lukacs et al., 2013). Women with a high CRF were found to have increased attention spam, working memory and problem solving advantages (Scott et al., 2016).

1.8 Group Fitness Exercise Programs

Exercising in groups is a very popular form of exercise. It is considered as a pleasant method in order to gain all the beneficial effects of exercise on human health. Additionally, it is also considered an effective way to accomplish body composition improvements as well as improvements in fitness components (Tarakci et al., 2013). Group exercise offers a variety of benefits. The social group dynamic of the group fitness programme leads to participants expressing with a sense of togetherness and belonging, which serves as a conduit to adherence (Bethancourt et al., 2014). Participation in group fitness classes leads to the feeling of ‘’ being part’’ of a team which in turns could lead to several psychological and social benefits.

Maher et al., 2015, evaluated participants attending group fitness classes. It seemed that emotional and intrinsic satisfaction was increased after class participation, in participants where the instructor was encouraging and increased motivation within group fitness class.

Greater adherence in a class can be produced by an inspirational instructor, who has the knowledge to help participants fulfil the goals. On the other hand, it has been shown that too intense group fitness classes result in unpleasant feelings (Maher et al., 2015). Feeling of negativity towards high intense group fitness classes can be understood, as participants try to accomplish fitness routines but get a feeling of loss of achievement (Maher et al, 2015).

Participants love to engage in group-based fitness classes where the atmosphere is fun. When a pleasant felling is been created, participants forget they are exercising (Cugusi et al., 2016).This approach to exercise enables long-lasting interest and continuous exercising.

Exercising in groups has been associated with a parallel increase in socialization (Oliveira et al., 2017). It is reasonable to say that physically challenging participants will choose and feel better working out with a high intense group fitness class. This is a reason as to why there is a variety of group fitness classes in the majority of health clubs today and participants are able to choose according to their needs and suggestions of their fitness trainer. Increased adherence is noticeable among participants of group fitness classes because adaptations in muscular movements and intensity allow participants to participate fully and complete all activities within each exercise class. As a result, feelings of accomplishment can be produced. The experience of being in a group setting and the enthusiasm as well as the motivation given by the trainer-leader, are other parameters that increase the positive psychological benefits of exercising within a group(Luettgen et al., 2012).

Group-based exercise is a popular form of exercise both in the general healthy and clinical populations. A very popular form of group exercise is circuit training (CRT). Ferreira et al. (Ferreira et al., 2017) showed that CTR could result to significant cardiovascular and skeletal muscle improvements with a parallel decrease in body fat levels can be seen in women with normal weight obesity category. Normal Weight Obesity (NWO) is observed when BMI is normal but body fat (BF) levels are increased (BF ≥ 30kg/m2). Twenty-three women performed CRT for 10 weeks and both at baseline and after the intervention period body composition measurements were done, along with dual-energy X-ray absorptiometry, echocardiography, blood tests, arterial pressure, exercise testing, and total-overload-by-training-session. After the training period, participants of NWO group reduced BF by 8kg, reduced 3kg in trunk fat mass, showed smaller fasting glucose than the control group, increased load at VO2peak (from 122.55 to 1 37.5 W), reduced double product/load at VO2peak ratio (from 277.4 to 237.7 mmHg) and increased left ventricular mass/body surface area ratio (from 84.29 to 90.29g/m2) (Ferreira et al., 2017).

Ninety-nine patients with multiple sclerosis (MS) participated in three exercise sessions per week for 12 weeks. Participants taking part in this intervention study were supervised to perform flexibility and range of motion exercises, core and balance exercises as well as coordination and functional activities. Primary outcome was to examine balance and functional status, whereas examination of difference in spasticity, fatigue and quality of life were the secondary outcome measurements. Balance was improved after the 12 weeks intervention (pre post: 37.68 ±9.91, post 42.01 ±9.32), as well as 10-metre walk test (pre: 17.97 ±2.89, post: 15.24 ±2.51). Flexibility levels were also increased, both in right (R) and in left (L) hip flexors (pre: 1.35 ±1.33, post: 0.68 ±0.83 and pre: 1.35 ±1.18 and 0.70 ±0.75 respectively), as well as R and L hamstrings (pre: 1.01 ±1.15, post: 0.54 ±0.70 and pre: 0.86 ±0.87, post: 0.68 ±0.73, respectively). The specific study showed that supervised group exercise can improve balance and functional time test scores, as opposed to the control group which had decreased levels in balance, increase in 10-metre walking test and elevation of Fatigue Severity Scale scores (Tarakcil et al, 2013).

One form of group fitness program, which is commonly used in gyms and sporting centres is the Low-Resistance -High-Repetition workout. The specific group based program is pre-choreographed and lasts for one hour. Exercises are done with the use of barbell plates with light to moderate amount of weight. The amount of weight that is used in each track is provided as a guideline by the fitness instructor. Plates come in three sizes: 1.25kg, 2.50 kg and 5 kg. During the group fitness workout a variety of exercises are done: squats, lunges, curls, overhead presses, kickbacks and others. Each group fitness program is made up to ten tracks. The workout starts with a warm up and finishes with a cool down. Each track works out a muscle group (both as a compound and as an isolation exercise), for a specific amount of time: Track 1: Warm up (4:57), Track 2: Legs (5:15) , Track3 : Chest (3:47), Track 4: Back and legs (5:17), Track 5: Triceps (4:02), Track 6: Biceps (3:50), Track 7: More legs (5:25), Track 8: Shoulders (4:17), Track 9: Core (4:56), Track 10: Cool Down (4:31). Whenever there is a change in a track, and thus muscle been exercised, a small break of max 30 sec occurs, assuring the explanation of the exercise that follows and the change in the amount of weights been used. Every exercise has a specific number of repetitions and sets to be performed. Usually, in order to ensure the optimal technique of exercises been used and the number of repetitions and sets, the fitness instructor is been tested both technically but also in writing, in order to assure the structure of the workout.

Nicholson and colleagues(Nicholson et al., 2015) examined the effects of a low-load high-repetition resistance training group exercise program (BodyPump™) on maximal strength, gait speed, balance and self-reported health status in healthy, in sixty-eight active middle-aged adults, after 26 weeks of training. Participants were allocated to either the intervention (PUMP) or control group (CON). Subjects in the PUMP group undertook two or three group fitness classes per week and weights lifted for each exercise were self-selected, whereas CON participants did not undergo any training and were told to maintain their current level of physical activity for the duration of the study. Assessments were conducted from baseline and post- intervention. One-repetition maximum (1RM) strength was assessed during a single session, while gait and balance performance was assessed during a second session, with each session having difference from the other 3-5 days. During session one, lower limb maximal strength was assessed on an incline leg-press and upper body strength was assessed on a Smith-machine bench press. Balance and mobility measures were assessed with participants unshod, whereas the SF-36v2® Health Survey was used to assess the self-reported health status of each participant.

At the end of the intervention the PUMP group showed an increase from baseline to post-intervention. Improvements were also seen in gait and maximal strength. Between week one and sixteen there was a significant increase in the Pump group for squats (in terms of % of 1RM), (week one: 4.4±2.5, week 26: 11.8 ±5.1%). Increased in chest press weight was also seen from week one (12.8 ± 6.6%) to 13 (27.0 ± 12.1%).By week 26, the elevation of chest press weight increased even more (29.0 ± 10.9).). An increase of 0.31m/s in the PUMP group for gait speed was notable.

In the same study, there were significant time effects and time-by-baseline score effects for the role-physical domain ($p = 0.033$). The CON group did not show any improvement's, from baseline to the end of intervention at any parameter examined: [(1RM leg press (kg) pre: 146.2 ± 49.5, post: 149.8 ± 49.5), 1RM bench press (kg) pre: 29.1 ± 13.5, post: 30.6 ±13.8). No improvements were seen in Fast gait speed in the CON group (pre: 2.03±024, post: 2.10±0.22).].

The effect of a LRHR program was also examined by Greco al. (Greco et al., 2011). The participants in this specific program experienced increase in muscular strength and decrease in muscular fatigability. Nine participants were examined in muscular strength, body composition and cardiorespiratory fitness after 12 weeks of BodyPump™ group-based exercise program.

Examinations at the end of the intervention study showed improvements in 1RM in squats by 33.1% ($p < 0.001$) and maximal isometric voluntary contraction (MVC) by 13.6% ($p < 0.05$). A 30%, ($p < 0.01$) decrease in knee extensor electromyographic activity during the MVC, during the squats (15%, $p < 0.05$) was observed. Blood test and heart rate analysis following a stimulated training of the specific workout showed a decrease by 33 and 7% ($p < 0.05$), respectively. On the other hand, body mass, body fat, and the running velocity at the onset of blood lactate accumulation, did not change significantly in response to this training program.

Significant reductions in body fat levels were also observed in the study contacted by O'Connor and Lamb, were a light intensity, high-repetition resistance-training program showed decreases on skinfold thickness and increase in muscular strength in women who participated (O'Connor and Lamb, 2003). In this particular study 39 physically-active women were randomly allocated into a resistance-training group (RT: n = 20) or a control group (CG:

n = 19). The LRHR (known as Bodymax™) consisted of exercises with light, variable free weights and high repetitions in a group setting. After the analysis of body fat levels with the use of skinfold thickness at four anatomical sites, a significant decrease was observed in triceps (mm) (pre: 22.8 ± 4.0 , post : 19.8 ± 3.9), suprailiac (mm) (pre: 17.5 ± 8.8 and post: 12.5 ± 6.5), abdominal (mm) (pre: 24.2 ± 10.0 and post: 19.7 ± 9.1 and thigh (mm) (pre : 34.8 ± 7.7 and 30.5 ± 7.8) skinfolds respectively. In summary, a 99.4 ± 27.8 and 82.4 ± 25.3 decrease was observed in the resistance group as opposed to the control were no significant reductions were found following the intervention period (105.8 ± 25.1 and 105.1 ± 24.6, pre and post intervention, respectively).

Participants of Bodymax™ showed an increases in leg extension strength (kg) (pre: 45.3±11.3, post: 69.4±11.4), leg curl (pre: 65.3 ± 13.4, post: 80.6 ± 12.4), lat pull downs (pre: 33.8 ± 8.9 and post: 38.3 ± 4.1), chest press (pre: 30.8 ± 7.9 and post :33.8 ± 8.9). Additionally increases were observed in pecdec (pre: 27.8 ± 4.4 and post: 34.5 ± 5.1) and shoulder press (pre: 25.5 ± 5.1 and post: 30.0 ± 6.9).

In the study of Campos et al. (2002) thirty-two untrained men were divided in four groups: a low repetition group performing 3-5 repetitions maximum, with 3 min rest between sets and exercises, an intermediate repetition group performing 9-11RM for three sets with 2 min rest, a high repetition group performing 20-28 RM for two sets with 1 min rest, and a non-exercising control group. Trainees performed three leg exercises (leg press, squats and leg extension), 2 days per week for a period of 4 weeks. For the final 4 weeks, exercises were done 3 days/week. Maximal strength was examined, as well as local muscular endurance, maximum oxygen consumption, pulmonary ventilation, maximal aerobic power and time to exhaustion. These parameters were examined at the begging at the end of the intervention study. Fibre-type composition, cross-sectional area, myosin heavy chain (MHC) content, and capillarization were analysed with muscle biopsy. At the end of the intervention period, body fat in the Low and Intermediate repetition group increased respectively (pre: 13.9 to post: 14.3% and 14.7% to 16.0%).On the other hand, participants of the High Repetition group maintained their body fat (pre: 11.2 to post: 11.4%). High Rep Group also obtained an increase in body mass (pre: 70.2 kg to post: 71.5kg). For aerobic capacities, Vo2 max tests and VE, time to exhaustion and aerobic power were examined at the beginning and end of the study. The low repetition group had a small decrease in VO^2max (50.3 ml/kg/min pre band 48.5 ml/kg/min post).The intermediate group had a small decrease as well(48.1 ml/kg/min pre and 45.7 ml/kg/min post), whereas the high repetition group showed also an increase in VO_2max (51.0 ml/kg/min pre and 52.5 ml/kg/min post).Regarding V E time to exhaustion both low and intermediate group had decreases in values (140.1 I/min pre with 132.1 I/min post and 149.8 I/min with 137.8 I/min post, respectively). The high repetition group, on the other hand, showed an increase in VE (I/min) time to exhaustion (140.3 I/min pre with 153.7 I/min post).The high repetition group was the only group to show significant increase in time to exhaustion [from 7.6 t (min) to 9.1 t (min) and maximal aerobic power 266 (W) to 309 (W)] in the endurance test done. Both the low and the intermediate group did experience significant increases (297(W) pre with 307(W) post and 290(W) with 293(W) respectively.

Average training heart rates for week 2 were 87%, 86% and 93% and for week 7 were 88%, 87% and 93% for the low, intermediate and high repetition group respectively. As noticed, a decrease was seen in average training heart rates of the high repetition group from week 2 to week 7.

AIMS-OBJECTIVES

Overall:

The aim of the first study was to examine the association between physical fitness, depression, sleep quality and fatigue among inactive women with different obesity status. Afterwards, a 3 –month intervention consisted from two popular –based programs was applied, aiming to improve physical fitness and health in inactive women. The second study could be considered as a proof of concept study in order to be tested in the future in obese women or even in patients with chronic diseases.

Study 1:

The aim of this cross-sectional study was to examine the association among objectively assessed physical fitness, body composition, fatigue, sleep quality and depression score among a sample of adult women with different obesity status.

Study 2:

The aim of this interventional study was to investigate the effect of a 3 months, low-resistance, high repetition group based fitness exercise program on physical fitness related parameters (including aerobic fitness) and body composition of inactive adult women.

HYPOTHESES

1. Overweight and obese women will have decreased fitness related parameters (aerobic fitness, flexibility, lower body power, lower handgrip strength)

2. Overweight and obese women will have disturbed body composition favouring high adipose tissue levels (body weight, body fat, visceral fat and waist circumference)

3. Women with increased levels of body fat will have higher depression and anxiety levels, compared to women with normal BMI levels, as well as impaired sleep quality.

4. Fatigue levels will be increased in women with elevated BMI and body fat levels.

5. Women completing the LRHR Program will have better body composition values (decrease in body fat and body weight) after 3 months of training as opposed to women exercising with Pilates.

6. LRHR will have a positive impact on aerobic fitness whereas Pilates will only have a positive influence in flexibility levels.

Null hypotheses:

1. Overweight and obese women will not have impaired fitness related parameters.

2. Body composition levels will not be elevated in women who are overweight and obese.

3. Depression and anxiety rates will not increase proportionately as body fat increases.

4. Overweight and obese women will not experience fatigue symptoms.

5. Quality of Health (both physically and mentally) will not decrease as body composition values increase.

6. LRHR will not improve aerobic fitness and will not be able to decrease body fat levels.

7. Pilates will not be able to increase flexibility level.

CHAPTER 2

General Methods

1.8.1 **Participants and Study Approval**:

Participants- cross sectional study: One hundred and ninety one volunteer adult healthy women (36.1 ± 11.7 yrs) participated in this cross-sectional study. Based on body mass index (BMI) the participants were allocated into 3 groups: normal (n=134 BMI 18.5-25), overweight (n=32, BMI 25-30) and obese (n =25, BMI>30).

Participants- intervention study: Forty-two (n=42) inactive but otherwise healthy adult women volunteered to participate in the current study. Prior to the initiation of the study, the participants were examined by a physician for confirming their health status .Participants were randomly allocated in two groups: the LRHR group (n=26; 39.8±9.1y) and the Pilates group (n=16; 39.1± 12.2y). All assessments were blinded to the intervention group of the participants.

All volunteers were given a full explanation of the purpose and the procedures of the study and gave their written consent. The study was approved by the National Bioethical Committee (No: EEBK/ΕΠ/2015/34). Data was analysed in blind fashion without the researchers knowing the characteristics of the participants.

2.1.2 Questionnaires

All questionnaire data acquired using the interview method.

The participants' depressive symptoms were assessed by using the **Beck Depression Inventory (BDI)** (Beck AT et al, 1997). This questionnaire measures key symptoms of depression, including mood, sense of failure, self-dissatisfaction, self-dislike, self-accusation, social withdrawal, indecisiveness, guilt, punishment, crying, irritability, loss a appetite, loss of libido and others.It consists of 21 multiple choice self-rated questions. Each set of question includes four alternative statements ranging from zero to three.When the test is scored, a value of 0 to 3 is assigned for each answer and then the total score is compared to a key to determine the depression's severity.Conventional cut offs were 0–9 for normal range, 10–18 for mild to moderate depression, 19–29 for moderate to severe depression, and 30–63 for severe depression.

Subjective sleep quality was assessed by using **the Pittsburg sleep quality index (PSQI**) (Buysse DJ, et al, 1989).The questonnaire consists of 19 items and seven clinically relevant domains of sleep difficulties: subjective sleep quality, sleep latency, sleep duration, sleeps efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. A global score of overall sleep quality can be calculated by adding up the single scores of these dimensions, producing scores ranging from 0 to 21. Global scores >5 are generally used to indicate poor sleep.

Fatigue levels were assessed by using the **Fatigue Severity Scale (FSS)**(Krupp LB, et al, 1989).FSS is a is a self-report instrument assessing the physical aspects of fatigue and their impact on the patient's daily function in a variety of medical and neurologic disorders. The FSS consists of 9 statements for evaluating the impact of fatigue .Subjects were asked to rate the severity of fatigue symptoms using a numeric scale ranging from 1 (strong disagreement with the statement) to 7 (strong agreement with the statement). The total score was calculated by averaging the scores of each item.

SF 36 Health Syrvey Questionnaire was used in order to measure helath realted status of women of different BMI. SF 36 gives the ability to evaluate 8 sections of health: vitality, physical functioning, bodily pain, general health perceptions, physical role functioning, emotional role functioning, social role functioning and mental health.The SF-36 has eight scaled scores; the scores are weighted sums of the questions in each section. Scores range from 0 – 100. Lower scores = more disability, higher scores = less disability.

2.1.3 Physical Parameters and Body Composition assessment

Aerobic fitness assessment

Aerobic fitness was assessed using the 20 meter multi stage shuttle run test (Leger, Mercier, Gadoury, & Lambert, 1988). Participants started running a distance of 20m at an initial speed of 8.5 km/h $km \cdot h^{-1}$, and speed increased by 0.5 $km \cdot h^{-1}$ every minute. The pace was given by a sound signal from an audio tape. Each stage of the test was made up from several shuttle runs. Participants were instructed to keep pace with the signals for as long as they could and were informed that they would be withdrawn from the test if they were more than two strides away from the turning point on two consecutive shuttles. For each participant, the number of shuttles completed was recorded and was used as an index of their aerobic fitness levels. The 20m shuttle run (20MSR) is considered to be an appropriate and practical aerobic fitness test for the general population. Due to the number of participants, as well as due to financial restrains, we did not access aerobic fitness in the lab using gas analysis system. On the other hand, the use of other tests (i.e. step test) was considered inappropriate due to the increased number of women being overweight (n = 26.7±2.1) and obese (n= 35.1 ±5.5).This would have caused increased pressure on the lower body, especially ligaments of the knee. Increasing the rhythm of running was considered a safer option as the characteristic movement is known by all.

Flexibility assessment

The sit and reach test was used to measure flexibility levels of hamstrings muscles and lower back, using a sit-and-reach box. The participants were asked to remove their shoes, assume the sitting position facing the box and place their feet against the side of the box. Feet were shoulder width apart and both knees held straight. The palms of the participant's hands were facing down. The participant were asked to reach as far forward as they could, and hold for 2 s. The distance on the box was recorded in cm.

Lower limb power assessment

Lower limb power was assessed by using the squat jump (SJ) and the countermovement jump (CMJ) tests. Each participant performed three squats with 1 min rest between jumps. All participants had been taught the correct technique and became familiar with the SJ and CMJ at least one week prior to the tests. Jumps were measured in cm by the Optojump electronic device (Microgate, Bolzano-Bozen, Italy), which measured flight time. For the SJ, participants got into a squat position and jumped as high as they could and returned back to start position. No movement or swing was allowed before take-off. For the CMJ test, participants started from an upright standing position, making a downward move by flexing the knees and hips and then immediately extending the knees and hips to jump vertically off the ground. In both jumps the participants were advised to keep their hands on their hips throughout the jump, in order to avoid external force and interference with jump height.

20meters sprint time assessment

Twenty meter sprint performance was measured with an electronic photocell timing system (Microgate Timing Systems, Microgate, Bolzano-Bozen, Italy). The participants were told to run for 20 m as fast as they could. Women participating started from an upright position, behind the starting line. A photocell camera was used to calculate and record speed time in seconds. Due to the fact that we wanted to test as many variables we could regarding physical fitness, in order to see the influence of obesity status on these variables, conducting the speed test gave us the opportunity to test anaerobic power as well.

Isometric handgrip strength assessment

Handgrip strength (in kg) was measured using a digital dynamometer (T.K.K. 5401 Grip-D; Takey, Tokyo, Japan). Both arms were relaxed, in the neutral position by the side of the body. For each arm, participants were asked to hold and squeeze it for about 3 seconds. No other body movement was allowed. The measurement was done both on right and left arm.

Total body and trunk fat assessment

Total body fat percentage was used using bioelectrical impedance analysis (BIA) (Tanita body composition analyser, TBF-300).Participants were asked to remove their shoes and socks and to stand on the platform with bare feet .Because activity and food tend to interfere with the impedance participants were asked to avoid any fitness activity or eating for 3 hours before to the test. Trunk fat along with abdominal girth were measured with the use of a different portable BIA system (Tanita, Viscan AB 140) specialized for central adiposity measurement in healthy adults (Browning et al., 2010).

CHAPTER 3

Depression, sleep quality, physical fitness and fatigue among adult women with different obesity status

Submitted of publication in "Sport Sciences for Health" journal (under review)

Abstract

Purpose: The aim of the current study was to examine the association among depressive symptoms, sleep quality, objectively assessed physical fitness and fatigue, among a sample of adult women with different obesity status.

Methods : One hundred ninety one volunteer adult women (36.1 ± 11.1yrs) participated in the study. Based on body mass index (BMI), participants were allocated into 3 groups: normal weight (n=134), overweight (n=32) and obese (n =25). Physical fitness related parameters were assessed by a battery of field tests. Total body fat and trunk fat levels were assessed using bioelectrical impedance analysis system. Depressive symptoms, sleep quality and fatigue were assessed by using various validated questionnaires.

Results: Obese women were found with significantly worse total score in depressive symptoms ($p<0.05$). Similarly, the obese and overweight women were found to exhibit lower levels of aerobic fitness compared to women with normal BMI ($p<0.05$). All body composition variables examined were shown to inversely associated with low score on both physical fitness tests as well as with poor sleep, depressive symptoms and fatigue levels ($p<0.05$).

Conclusions: Depressive symptoms and performance on various physical fitness tests were found to be significantly impaired in obese and overweight adult women indicating the negative impact of increased body weight and body fat in health and wellbeing.

Keywords*:* cardiorespiratory fitness; total body fat; trunk fat; sleep quality

Introduction

Obesity and overweight are increasing worldwide (NCD-RisC, 2016). High body weight and fat levels increase the risk for a variety of diseases, including cardiovascular diseases, diabetes type II, cancer and hypertension(Baumgartner, Heymsfield, & Roche, 1995).Therefore, it is not surprising that obesity has been associated with all-cause mortality (Britton et al., 2013; Masters et al., 2013).

Various factors have been blamed for the high obesity rates observed worldwide. Physical inactivity (Lee, Djousse, Sesso, Wang, & Buring, 2010), sedentary lifestyle (Blumel et al., 2015) impaired sleep quality (Mesarwi, Polak, Jun, & Polotsky, 2013)and unhealthy eating habits(Qi et al., 2014) are among these factors. Interestingly, it seems that the prevalence of obesity is higher in women compared to men (Collaboration, 2016). In women, elevated body fat and body weight levels are highly related with a sedentary life- style (Blumel et al., 2015) , impaired physical(Pataky, Armand, Muller-Pinget, Golay, & Allet, 2014) and mental health related parameters such as anxiety (Bjorngaard et al., 2015) and depression(Martin-Rodriguez, Guillen-Grima, Auba, Marti, & Brugos-Larumbe, 2016), all of which are known to be significant contributors to low quality of life levels (Jia & Lubetkin, 2005).

Obesity has been reported to have a negative impact on physical fitness related parameters such as cardiovascular fitness (Ortega et al., 2007) and strength (Tomlinson, Erskine, Morse, Winwood, & Onambele-Pearson, 2016). The reduced physical fitness levels may explain the fact that obese individuals experience impaired functional capacity and difficulty performing daily activities (Backholer, Wong, Freak-Poli, Walls, & Peeters, 2012). On the other hand, low physical fitness levels have been reported to be inversely associated with depression

(Suija et al., 2013), and anxiety on obese women (Mollaoglu et al., 2012), indicating the negative effects of physical inactivity on mental health. Moreover, recent evidence reveals that obesity should be considered as a risk factor for depression (Olvera, Williamson, Fisher-Hoch, Vatcheva, & McCormick, 2015).

The aim of the current study was to examine the relationship between depression score, sleep quality, objectively measured physical fitness and fatigue among a sample of adult women of different obesity status.

3.1 Materials and methods

Participants

One hundred and ninety one volunteer adult healthy women (36.1 ± 11.7 yrs) participated in this cross-sectional study. Based on body mass index (BMI), participants were allocated into 3 groups: normal (n=134, BMI 18.5-25), overweight (n=32, BMI 25-30) and obese (n =25, BMI>30). Fitness measurements were taken during the morning hours (9-11am) at an accredited fitness center. Exclusion criteria were inability to perform the fitness testing as well as inability to fill in the questionnaires due to cognitive impairment or mental disorder. All participants refrained from food and fluid consumption for a 3-hour period prior to body composition measurements. All volunteers were given a full explanation of the purpose and the procedures of the study and gave their written consent. The study was approved by the National Bioethical Committee (No: ΕΕΒΚ/ΕΠ/2015/34). Data was analysed in blind fashion without the researchers knowing the characteristics of the participants.

3.2 Questionnaires

The interview method was used in order to complete all questionnaires. The participants' depressive symptoms were assessed by using the Beck Depression Inventory (BDI) (de Oliveira et al., 2014). Zung Self-Rating Depression Scale (SDS) was used in order to asses anxiety levels (for details please refer to page 54 in the General Methods section). Quality of life was assessed using the SF36 Health questionnaire (for details please refer to page 55 in the General Methods section). Subjective sleep quality was assessed by using the Pittsburg sleep quality index (PSQI)(Moghaddam F. et al,2011), (for details please refer to page 54 in the General Methods section).Finally, fatigue levels were assessed by using the fatigue severity scale (FSS) (Tarakci, Yeldan, Huseyinsinoglu, Zenginler, & Eraksoy, 2013)(for details please refer to page 55 in the General Methods section).

3.3 Physical Parameters and Body Composition assessment

Aerobic assessment

Aerobic fitness was assessed using the 20 meter multi stage shuttle run test (Leger, Mercier, Gadoury, & Lambert, 1988) (for details please refer to page 55in the General Methods section).

Flexibility assessment

The sit and reach test was used to measure flexibility levels of hamstrings muscles and lower back, using a sit-and-reach box(for details please refer to page 56 in the General Methods section).

Lower limp power assessment

Lower limb power was assessed by using the squat jump (SJ) and the countermovement jump (CMJ) tests (for details please refer to page 56 in the General Methods section).

20meters sprint time assessment

Twenty meter sprint performance was measured with an electronic photocell timing system (Microgate Timing Systems, Microgate, Bolzano-Bozen, Italy) (for details please refer to page 57 in the General Methods section).

Isometric handgrip strength assessment

Handgrip strength (in kg) was measured using a digital dynamometer (T.K.K. 5401 Grip-D; Takey, Tokyo, Japan) (for details please refer to page 57 in the General Methods section).

Total body and trunk fat assessment

Total body fat percentage was used using bioelectrical impedance analysis (BIA) (Tanita body composition analyser, TBF-300) (for details please refer to page 57 in the General Methods section).

3.4 Statistical Methods

One way analysis of variance (ANOVA) was used to compare differences in the independent variable among groups. The Pearson correlation test was used to assess the relationship between the examined variables. All data are presented as mean ±SD and the level of statistical significance was set at $p<0.05$. All analyses were carried out using the SPSS Statistical Package version 19.

3.5 **Results**

In this cross sectional study, 16.5% of the women were overweight (32 out of 194), 13% were obese (25 out of 194), and 69% had normal BMI (134 out of 194). The group with the normal BMI was categorized as ‘Healthy weight’.

Body composition analysis showed significant differences in abdominal girth and visceral fat

Table 1: Anthropometry, and body composition data presented as pool data and divided into three groups according to obesity status

Variable	**Pooled data**	**Healthy Weight**	**Overweight**	**Obese**
Age	36.1± 11.1	35.3±10.8	39.1±10.7	39.1±12.2
Weight (kg)	62.3±15.1	56.9±6.5*	68.9±6.5*	90.5±16.3*
Height (cm)	161.6±6.1	162.0±6.4	160.5±5.7	160.3±4.6
Total fat (%)	29.2±9.4	25.1±5.6*****	33.9±7.2	43.9±4.3**‡**
Abdominal Girth (cm)	84.6±14.4	80.5±8.6	89.3±12.0**†**	103.0±26.3**¥‡**
Visceral fat (%)	29.2±9.9	25.4±6.6	35.5±6.4**†**	43.7±11.4**¥‡**
Body Mass Index	23.8±5.7	21.6±1.8	26.7±2.1**†**	35.1±5.5**¥‡**

All data are mean values ±SD

***** Significant differences between all groups of the subjects

¥ Significant differences between the women of the healthy weight group and the obese group

† Significant differences between the women of the healthy weight group and the overweight group

‡ Significant differences between the women of the obese group and the overweight group

Depressive symptoms score was found to be significantly worse in the obese group compared to the healthy weight group ($p < 0.05$) (Table 2).

Table 2: Sleep quality, depression score and fatigue levels data presented as pool data and divided into three groups according to obesity status

Variable	**Pooled Data**	**Healthy Weight**	**Overweight**	**Obese**
PSQI	5.3±3.4	5.1±3.1	5.7±3.8	6.5±4.5
BDI	16.7±7.2	15.9±6.7	17.4±7.8	21.4±7.6¥
FSS	3.2±1.3	3.2±1.2	3.4±1.4	3.6±1.7

Abbreviations: PSQI, Pittsburgh sleep quality index; BDI, Beck Depression Inventory FSS, Fatigue Severity Scale

All data are mean values ±SD

¥ Significant differences between the women of the healthy weight group and the obese group

In addition, both the performance in the two jump tests and in the 20 m shuttle run test was significantly worse in the obese and overweight group compared with the healthy weight group ($p < 0.05$). No significant differences were observed between the groups in regards to handgrip strength ($p > 0.05$) (Table 3).

Physical fitness data presented as pool data and divided into three groups according to obesity status

Variable	**Pooled Data**	**Healthy Weight**	**Overweight**	**Obese**
Flexibility (cm)	17.7± 8.8	18.9±8.6	17.1±7.3	13.7±8.9
Handgrip R (kg)	24.1± 6.0	24.0±5.7	23.8±5.2	24.5±7.2
Handgrip L (kg)	23.5±5.3	23.3±5.1	23.5±3.8	24.5±7.3
SJ (cm)	15.1±5.0	16.0±4.7	14.1±4.9†	11.2±5.5¥
CMJ (cm)	17.4±5.8	18.7±5.7	15.6±4.2†	12.7±6.0¥
20m Sprint (sec)	3.4±2.3	3.4±2.0	3.7±1.8	3.9±2.0
20m shuttle run test (completed shuttles)	22.4± 10.1	25.2±9.9	16.6±6.2†	14.3±6.1¥

Abbreviations:SJ, squat jump; CMJ, counter movement jump

All data are mean values ±SD

¥ Significant differences between the women of the healthy weight group and the obese group

† Significant differences between the women of the healthy weight group and the overweight group

Performance in squat jump (r = -0.216, p= 0.006), CMJ (r = -0.282, p = 0.000) and 20-m shuttle run (r = -0.363, p= 0.000)were inversely correlated with total body fat levels. Visceral fat inversely correlated with the 20m-shuttle run test (r = -0.490, p= 0.000), squat jump (r = -0.374, p= 0.000) and countermovement jump (r = -0.366, p = 0.000).

BMI was inversely correlated with performance in the 20-m shuttle run test (r= -0.460, p= 0.000), positively correlated with FSS (r= 0.233, p= 0.001), positively correlated with BDI score (r= 0.281, p= 0.000) and FSS (r= 0.233, p= 0.001), whereas it was inversely correlated with flexibility score (r= -0.174, p= 0.024).

Positive correlation among FSS was found with total body fat (r = 0.179, p= 0.013), visceral fat (r = 0.206, p= 0.007) and PSQI score (r= 0.233, p= 0.001).

BDI score was positively correlated with body fat (r = 0.214, p = 0.003), BMI (r= 0.281, p= 0.000), visceral fat (r = 0.236, p= 0.002) and PSQI score (r = 0.474, p = 0.000). A positive connection with PSQI score was also seen between total body fat (r = 0.157, p= 0.029) and BMI (r = 0.248, p= 0.001).

Age positively correlated with BMI (r= 0.198, p= 0.006) and total body fat (r = 0.295, p= 0.000), whereas age inversely correlated with SJ (r = -0.275, p= 0.000) and the 20-m shuttle run test (r = -0.212, p= 0.015).

3.6 Discussion

Prevalence of overweight and obesity is increasing worldwide (NCD-RisC, 2016).A number of reasons are responsible for the increase of obesity, with physical inactivity and therefore, low physical fitness been one of the most evident (Lee et al., 2010). The findings of the present study confirm that the high rate. Most importantly however, the current study adds to our knowledge that obesity seems to be related to impair sleep quality and mental state (i.e. depressive symptoms), which in turn affect quality of life and wellbeing.

Despite the physical fitness impairments, the outcomes of the current study reveal also an association between body composition parameters and depressive symptoms score, confirming previous studies (Bjorngaard et al., 2015; Hryhorczuk, Sharma, & Fulton, 2015; Martin-Rodriguez et al., 2016). Research has indicated that elevated BMI is associated with anxiety, and particularly appearance-based social anxiety (Titchener & Wong, 2014). Moreover, an increase in visceral fat is objective to increase a person's susceptibility towards depression (Murabito, Massaro, Clifford, Hoffmann, & Fox, 2013). This can be explained by the fact that visceral fat is associated with increased inflammation (Murabito et al., 2013) and endocrine abnormalities, (Hryhorczuk, Sharma, & Fulton, 2013) which could contribute to brain chemistry changes and depressive-like behaviour. Interestingly, both obesity and depression may share common pathogenesis. A dysregulation of the hypothalamic-pituitary-adrenocortical system has been reported in both depressed and obese patients supporting the hypothesis of the interconnection between depression and obesity (Stunkard, Faith, & Allison, 2003). On the other hand, lliterature exists regarding the positive effects of exercise training in terms of reducing depression symptoms (Silveira et al., 2013), whilst other studies showed a significant amelioration of depressive symptoms following surgically-induced weight loss (Dixon, Dixon, & O'Brien, 2003).Interestingly, low aerobic fitness levels (seen also in the current study in the obese group) have been reported to be associated with depression in both men and women (Sui et al., 2009). Obese women should be encouraged to participate in systematic exercise and physical activity interventions in order to lose weight and reduce potential depressive symptoms and mental health.

The results of the current study reveal that overweight and obesity may indeed cause significant impairments on aerobic fitness levels, confirming existing literature (De Schutter, Lavie, & Milani, 2-14; T. N. Kim et al., 2014). Aerobic fitness has been reported to be inversely related to cardiovascular risk factors such as aortic stiffness in adult women with high visceral fat levels (Augustine, Yoon, Choo, Heffernan, & Jae, 2016), as well as with insulin resistance and impaired blood lipid profile in adult overweight women (Hunter et al., 2010). In the study of Kim and colleagues (S. Kim et al., 2014) both visceral fat and cardiorespiratory fitness were found to be associated with metabolic syndrome in overweight and obese adults. Interestingly, the results of the previous study showed that adults with normal visceral fat and low cardiorespiratory fitness exhibit significantly greater risk for metabolic syndrome compared with adults with high visceral fat but with high levels of cardiorespiratory fitness.

Obese individuals may be subject of significant impairments in muscle and skeletal system physiology and functionality (Tomlinson et al., 2016). An inverse relationship between BMI and squat jump as well as countermovement jump was found in this cross sectional study, confirming previous findings (Abidin & Adam, 2013). Moreover, it is well known that muscle mass, strength and power decrease with advancing age, lead to significant impairments in daily living and quality of life (Trombetti et al., 2016). In the current study, an inverse relationship was found between age and performance in lower extremities power (assessed by the jump tests).In the present study, BMI was inversely correlated with flexibility, as measured using the sit and reach test. Obesity is considered one of many reasons that lead to low back pain (Grossschadl et al., 2014) which in turns could impair flexibility levels. According to the literature, both muscle strength and flexibility should be improved through specific exercise training programs in obese women (Lau, Yu, & Woo, 2015; Sarsan, Ardic, Ozgen, Topuz, & Sermez, 2006).

Fatigue is also a common complaint in overweight and obese people (Impellizzeri, Agosti, De Col, & Sartorio, 2013) and is associated with impaired quality of life (Lasselin et al., 2012). Alam and Rahman reported that in obesity, mitochondrial dysfunction occurs (Alam & Rahman, 2014), which causes increased fatigue and muscle weakness (Filler et al., 2014). Moreover, overweight individuals carry an increased amount of body weight, experience low physical fitness levels and sleep disturbances, all significant contributors of fatigue (Mesarwi et al., 2013). Indeed, significant correlations between BMI, visceral fat and sleep quality were also observed in the current study.

The outcomes of the current study reveal a positive correlation between increased BMI/body fat and impaired sleep quality, confirming previous studies also reporting a link between obesity and impaired sleep quality (Drager, Togeiro, Polotsky, & Lorenzi-Filho, 2013; Mesarwi et al., 2013). In addition, a number of studies emphasize that increased BMI and high body fat cause sleep disturbances, probably due to stress-induced hormone reactivity(Prather, Puterman, Epel, & Dhabhar, 2015), sleep problems such as sleep apnea symptoms (Kritikou et al., 2012) and generally obstruction of the upper airway causing respiratory problems (Drager et al., 2013).

A positive correlation between age and body composition indices such as BMI and body fat was also seen in the current study. Based on the literature, increase in age is associated with considerable changes in body composition (Xu et al., 2016), whilst concentration of oestrogens are also related to adiposity (Mauvais-Jarvis, Clegg, & Hevener, 2013). In addition, food intake in women is associated with the phases of the menstrual cycle (Hirschberg, 2012), which can explain the positive correlation of age and BMI, as well as body fat. Low levels of serotonin in the brain during pre-menopause lead to binge-eating (Cao et al., 2014), thus increased caloric intake. Duval et al. after a 5 year study, revealed that there is an appetite-related interaction during the menopausal transition and this transition is characterised by an increase in appetite(Duval et al., 2013).

In conclusion, overweight and obese adult women were found to experience significant impairments on physical fitness and increased depressive symptoms compared with women with normal BMI. Moreover, high body-fat levels were associated with significant impairments in various physical fitness parameters, as well as sleep and depression. Measures, such as increase physical activity should be taken for combating obesity in order to improve health and quality of life of adult women.

CHAPTER 4

The effect of a three month, low- resistance - high- repetitions group-based exercise program on aerobic fitness and body composition in inactive women

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Abstract

Low-resistance-high-repetitions (LRHR) programs constitute a popular group-based form of exercise for the general population, accompanied by various health benefits for the participants involved. The aim of the current study was to examine the effects of a 3-month LRHR group exercise program on aerobic fitness, body composition and overall health on previously inactive adult women. Twenty six women (39.8±9.1y) were assigned to a LRHR pre-choreographed group program, and sixteen women (39.1± 12.2y) were assigned to a Pilate's group program. Both programs were performed 3 times per week. Aerobic fitness, flexibility, handgrip strength and lower extremities explosiveness were assessed by a battery of field testing, prior and after the 3-monthintervention period. Total body fat and trunk fat levels were assessed by bioelectrical impedance analysis. Heart rate response during the two exercise programs was recorded once every month by using a telemetry system. Aerobic fitness, lower extremities explosive power, left arm handgrip strength and body composition significantly improved in the LRHR group; while flexibility significantly improved only in the Pilates group, following the intervention period ($p<0.05$). LRHR was superior to the Pilates program in improving aerobic fitness and body composition; whilst Pilates was superior in improving flexibility ($p<0.05$). In conclusion, LRHR group-based exercise programs may significantly improve various aspects of physical fitness, including aerobic fitness, in inactive adult women. This form of exercise is generally well tolerated by unfit women and might be used as an alternative method to the traditional aerobic exercise training.

Keywords: aerobic fitness; body composition; health; women

INTRODUCTION

Group-based exercise is a popular form of exercise training, which is available for the general population in several gyms and sport centres. Apart from an increase in socialization participants in such programs experience health physical, emotional and social-related benefits (Malcolm et al., 2016). Consequently, group-based programs can be considered as an effective tool for health promotion with high levels of adherence. Among the forms of several group training programs that exist today, low-resistance-high-repetitions (LRHR) training is a popular form of group-exercise which is known to affect many aspects of physical health (Nicholson, McKean, & Burkett, 2015). LRHR refers to a specific form of resistance exercise which utilises low resistance and very high repetitions (Nicholson et al., 2015).

High repetitions group fitness programs have been shown to cause favorable changes in body composition and improvements in muscular strength (O'Connor & Lamb, 2003), as well as decreased muscle fatigability induced by high intensity exercise training (Greco et al., 2011). However, the effect of such programs on aerobic fitness is still controversial. For instance, a group based LRHR program of 12 week duration failed to improve aerobic fitness in young adult women (Greco et al., 2011).

On the other hand, cardio-protective properties of systematic exercise are well established, and resistance training, either on its own or in combination with aerobic exercise training, has proven to be particularly effective for both cardiorespiratory and endothelial function in adults with hypertension, chronic heart failure, or type II diabetes (Roberts & Barnard, 2005). Cardiorespiratory benefits of other "resistance training" related forms of exercise such as circuit training is a popular issue nowadays. A study by Ferreira and colleagues showed that circuit resistance training produced cardio-metabolic, cardiovascular, and skeletal muscle benefits (Ferreira et al., 2016) decreasing susceptibility to cardiovascular diseases. Moreover, a recent study showed that a low-load, high repetition training program can increase maximal strength and gait speed in unfit men (Nicholson et al., 2015). The current recommendations for such training regimes are of 12-40 repetitions for improving muscular endurance (Ebben et al., 2004). Given the fact that obesity and sedentary life style are related to low fitness levels, the implementation of the LRHR could be an alternative approach to help unfit participants get fit and adhere to a regular and systematic exercise regime.

The aim therefore of the current study was to investigate the effect of a 3-month, low-resistance - high repetition group based fitness exercise program on physical fitness related parameters (including aerobic fitness) and body composition on inactive adult women.

METHODS

4.1 Participants

Forty-two (n=42) inactive healthy adult women volunteered to participate in the current study. Prior to the initiation of the study, the participants were examined by a physician for confirming their health status. According to the updated criteria, “inactive” is an individual who is performing insufficient amounts of moderate-to-vigorous physical activity (Network, 2012). Participants were randomly allocated in two groups: the LRHR group (n=26; 39.8±9.1y) and the Pilates group (n=16; 39.1± 12.2y). All assessments were blinded to the intervention group of the participants. Exclusion criteria were inability to perform the exercise training program due to musculoskeletal injury, medication that could affect cardio-metabolic function, including anti-hypertensive, diabetic or anti-obesity drugs and inability to systematically participate in the proposed training programs according to the schedule.

No participant withdrew from any of the two programs. All women were given a full explanation of the purpose and procedures of the study and gave their written consent. Ethical approval was obtained by the national ethical committee.

4.2 Intervention Protocols

Both exercise programs are very popular group –based programs in gyms and health .They were performed in group settings, done for three months, performed 3 times per week and lasted for 60 minutes. The two programs were not matched regarding energy expenditure and intensity. Intensity of both programs was steadily increased. This is explained later the chapter, in the explanation of each program. We seek to investigate the effects of those programs when performed in the real-world and without any modification in intensity etc.

Low-resistance- high- repetitions exercise protocol

Participants in the LRHR training participated in a three-months, group based pre-choreography exercise programme, of the same duration, consisting of three LRHR training sessions per week (in non-consecutive days). All participants were familiar with the exercises that were used in this intervention. Each LRHR fitness program, included a workout of a variety of muscle groups with the use of concentration and multifunction exercises (i.e. squats, lunges, chest press and chest extension, rowing, triceps extension and bicep curls), along with the use of barbells, dumbbells or body weight. Each session lasted 60 min (including 5 min warm up and 5 min cool down).Exercise intensity increased progressively once a month by adding weights to the barbells and dumbbells.

Pilates exercise protocol

Participants in the Pilates program were trained with the same exercise schedule for the 3-month period. Their 60 min session, consisted of warm up and cool down (5 minutes each), along with standing or lying Pilates poses and exercises. Pilate's exercises focused on breathing, concentration, control and precision. Exercise intensity progression in the Pilates program was performed every one month by increasing the demanding of the exercises.

All training sessions of both the LRHR and Pilates programs were supervised by a qualified sports scientist (different sport scientists were responsible for each of those programs) for securing training standardization. Participants in both programs were advised to avoid taking part in any other exercise session during the intervention period.

4.3 *Physical Parameters and Body Composition assessments*

Aerobic fitness assessment

The 20m shuttle run was used in order to assess aerobic fitness levels (Mayorga-Vega, Aguilar-Soto, & Viciana, 2015) (for details please refer to page 55 in the General Methods section).

Flexibility assessment

The sit-and-reach test was used in order to measure flexibility levels of hamstrings and lower back (for details please refer to page 56 in the General Methods section).

Lower limb power assessment

Lower limb power assessment was assessed using Squat jump (SJ) and countermovement jump (CMJ) tests (for details please refer to page 56 in the General Methods section).

Isometric handgrip strength assessment

Handgrip strength (in kg) of both arms was measured using a digital dynamometer (T.K.K. 5401 Grip-D**;** Takey, Tokyo, Japan)(for details please refer to page 57 in the General Methods section).

Anthropometry, body fat and trunk fat assessment

Body mass was calculated to the nearest 0.1kg with an electronic scale, and height was measured to the nearest 0.1cm with a stadiometer (Tanita, VB 3000). Body fat percentage was measured using bioelectrical impedance analysis (BIA) (Tanita body composition analyser, TBF-300). Participants were asked to remove shoes and socks and stand on the platform with bare foot. They were also asked to avoid any fitness activity, caffeine consumption or eating for 3 hours previous to the test. In addition, trunk fat along with abdominal girth were measured with the use of a portable BIA system (Tanita, Viscan AB 140) (for details please refer to page 57 in the General Methods section).

Heart rate assessment

Hosand G.T heart rate (HR) telemetry system (Hossand, Verbania, Italy), was used for recording minimum, maximum, and average HR response of the participants,during the two exercise programs in the first session and once every month for monitoring their HR response during the intervention period.

4.4 Statistical Analysis

Baseline characteristics of the two exercise groups were compared using unpaired t-tests. Two-way (time X group) analysis of variance (ANOVA) with repeated measurements on both factors was used to examine the effect of both training programs on the examined parameters. The absolute changes (delta change) between the two exercise groups from baseline to the end of the three months intervention were evaluated via unpaired t-tests. All statistical analyses were performed by using the statistical package for social sciences (SPSS for windows version 19). All data are reported as mean ± standard deviation and the level for significance was set at $p \leq 0.050$. A p-value less than 0.090 was considered as trend.

4.5 RESULTS

At baseline there were no significant differences in all examined body composition and physical fitness parameters between the two groups (p>0.05). A main effect of time appeared following the intervention period for total body fat (p=0.010), abdominal girth (p=0. 001) (Table 1), aerobic fitness (p=0.000 and p= 0.001), left arm handgrip strength (p=0.040), SJ (p=0.072), CMJ (p=0.006), body weight (p= 0.000), BMI (p= 0.000) and flexibility (p=0.025) (Table 2).

Table1. Basic characteristics and body composition data divided in two groups according to the assigned intervention.

Variables	LRHR Group (N= 26)	Pilates Group (N= 16)	Main Effects and Interactions (*p* value)		
			Time	Time X Group	Group
Age (years)	39.8±9.1	39.1 ± 12.2	-	-	-
Height (cm)	161.3±6.0	160.6±11.02	-	-	-
Total Body weight (kg)					
Baseline	62.3±7.6	57.4±10.8			
3-m post	59.8±7.1***P= 0.000**	56.8±10.8	**0.000**	**0.000**	0.121
Δ Change	-2.4±1.7**#P=0.000**	-0.5±0.4			
Body mass index					
Baseline	24.7±3.6	22.4±3.8			
3-m post	23.2±3.3 ***P= 0.000**	22.2±3.8	**0.000**	**0.000**	0.146
Δ Change	-1.5±1.1**#P=0.000**	-0.2±0.2			
Total Body Fat (%)					
Baseline	30.1±6.9	28.52±7.90			
3-m post	28.2±6.6 ***P= 0.001**	28.49±7.74	**0.010**	**0.012**	0.760
Δ Change	-1.9±2.7# **P= 0.012**	-0.2±1.3			
Abdominal Girth (cm)					
Baseline	84.16±9.86	82.93±11.68			
3-m post	79.26 ±10.05***P=0.000**	83.44±12.38	**0.001**	**0.000**	0.664
Δ Change	-4.8 ±4.8**#P=0.000**	0.5±1.15			
Trunk Fat (%)					
Baseline	29.01±9.10	26.45±11.68			
3-m post	26.52±8.93***P=0.002**	27.54± 10.23	0.261	**0.006**	0.802
Δ Change	-3.66± 5.08	-0.97±4.42			

All data are mean ± SD. Abbreviations: LRHR, low- resistance-high-repetitions

Significantly different than Pilates group.

*****Significantly different from the respective baseline value

Table 2. Physical fitness data divided in two groups according to the assigned intervention.

Variables	LRHR Group (N= 26)	Pilates Group (N= 16)	Main Effects and Interactions (*p* value)		
			Time	Time X Group	Group
Hand Grip Right Arm (kg)					
Baseline	24.27±5.97	23.24±6.50	0.158	0.142	0.267
3-m post	26.36±4.56***P=0.024**	23.65±7.00			
Δ Change	2.08±6.54	0.41±2.88			
Hand Grip Left Arm (kg)					
Baseline	23.06±5.44	23.00±5.94	**0.040**	0.190	0.527
3-m post	25.47±4.07	23.55±6.38			
Δ Change	2.41±5.11	0.55±2.81			
20 meter shuttle run test (ml/kg/min)					
Baseline	31.4 ± 3.5	29.7± 3.1	**0.001**	**0.004**	**0.023**
3-m post	33.2 ± 3.5 ***P= 0.000**	29.9 ±3.6			
Δ Change	1.8 ± 1.9 **# P=0.004**	0.2 ± 1.3			
20 meter shuttle run test (completed shuttles)					
Baseline	24.53±9.85	18.18±9.55	**0.000**	**0.011**	**0.017**
3-m post	29.15±10.50***P=0.000**	19.87±10.0***P=0.031**			
Δ Change	4.61.0±3.76**#P=0.011**	1.68±2.84			
Squat Jump (cm)					
Baseline	15.39±6.13	15.26±5.72	**0.072**	0.187	0.917
3-m post	17.67±4.49***P=0.041**	16.87±4.67			
Δ Change	2.28±5.4	1.60±4.04			
Counter Movement Jump (cm)					
Baseline	18.35±5.0	18.44±6.29	**0.006**	0.157	0.620
3-m post	21.04±4.41***P=0.001**	19.35±6.51			
Δ Change	2.68±3.81	0.90±4.01			
Flexibility (cm)					
Baseline	23.19±8.35	19.18±9.13	**0.025**	**0.030**	0.331
3-m post	23.26±7.90	22.31±7.57***P=0.000**			
Δ Change	0.71±5.06	3.12±2.70 **#P=0.032**			

All data are mean ± SD. Abbreviations: LRHR, low- resistance -high-repetitions

Significantly different than Pilate's group.

* Significantly different from the respective baseline value

The results of the ANOVA analysis showed a significant time X group interaction for total body fat ($p=0.012$), abdominal girth ($p=0.000$), trunk fat ($p=0.006$), body weight ($p= 0.000$) and BMI ($p= 0.000$) (Table 1), as well as in aerobic fitness ($p= 0.004$ and $p=0.011$) and flexibility ($p=0.030$) (Table 2). A significant group effect was detected in aerobic fitness ($p=0.017$) (Table 2). A significant group effect was also seen between the two groups on VO^2max ($p=0.023$) (Table2).

Between group changes analysis (Δ-change comparison) revealed significantly greater reductions in both total body fat ($p=0.012$), trunk fat ($p=0.000$), abdominal girth ($p=0.002$), total body weight ($p= 0.000$) and BMI ($p= 0.000$) in the LRHR group compared with the Pilates group (Table 1).The changes in aerobic fitness at post-intervention period were significantly greater in the LRHR group compared with the Pilates group ($p<0.011$) in regards to the number of shuttles and 0.004 in regards to ml/kg/min) (Table 2). Changes in flexibility levels were significantly greater in the Pilates program compared to the LRHR program ($p<0.032$) (Table 2).

At the beginning of each month, both maximal and average heart rates achieved during the exercise programs were significantly higher in the LRHR group compared with the Pilates group ($p < 0.05$) (Table 3).

Table 3: Heart rate response in the two groups during the intervention

	Maximum HR	Average HR	HR % max
LRHR Group			
Month 1	160#	125#	75.3
Month 2	170#	142#	79.5
Month 3	171#	145#	81.5
Pilates Group			
Month 1	128	95	45.7
Month 2	125	102	52.8
Month 3	142	111	66.3

Abbreviations: LRHR, low-resistance, high-repetitions group; maximum HR, maximum heart rate achieved during the exercise program; average HR, average heart rate achieved during the exercise program; HR% max, percentage of maximum heart rate achieved according to age (220-age). Heart rates during warm-up and cool-down periods were excluded from analysis.

Significantly different than Pilate’s group.

4.6 DISCUSSION

The purpose of this study was to examine the effects of a 3-month, low-resistance-high repetitions (LRHR) group-based exercise program on physical fitness and body composition in previously inactive adult women. Interestingly, a LRHR group-based resistance exercise training program was well tolerated and show evidence of aerobic improvement. In parallel, LRHR training resulted in favourable adaptations in body composition and abdominal obesity indices.

The findings of the current study showed that a LRHR program can increase aerobic fitness, confirming previous findings related to similar exercise programs (Campos et al., 2002). Campos et al., examining four different groups, found that the high repetitions group had increased aerobic fitness (expressed by the maximal aerobic power and time to exhaustion) following an 8-week intervention training programme. Similarly, Ebben et al. showed that rowers who performed high repetition training demonstrated greater improvements in their sport performance and endurance capacity (Ebben et al., 2004). Studies investigating cardiorespiratory adaptations to circuit weight training with intensities of 40-60% of 1 repetition maximum reported significant improvements in cardiorespiratory fitness levels in post-menopausal women (Brentano et al., 2008).The increase in aerobic fitness might be due to improvements in mitochondrial function (Russell, Foletta, Snow, & Wadley, 2013). The longer time under load, which occurs in LRHR, may favour mitochondrial synthesis and improve fatigue resistance, thus causing an increase in cardiorespiratory fitness (Schoenfeld, Peterson, Ogborn, Contreras, & Sonmez, 2015).

Another potential explanation for the increased in aerobic fitness observed in LRHR group, may be that performing high repetitions resulted in increasing in HR. Indeed, the average HR measured in the LRHR program during the intervention (excluding warm-up and cool-down periods) was approximately 78% of maximal HR (according to the participant's age), compared with a HR of 55%HRmax in the Pilates group. However, we acknowledge the fact that the level of improvement found in the LRHR group could also be attributed to the low initial level of aerobic fitness of the participants. Finally, we should note that other studies did not confirm the beneficial effect of LRHR programs on aerobic fitness levels (Greco et al., 2011).

The participants in the LRHR group increased their lower body muscle power as expressed by the performance in the two jump tests. Exercises included in the LRHR required a number of plyometric jumps, which are known to improve power of the lower body (Ramirez-Campillo et al., 2014). Marx and colleagues showed that a high repetition program may increase lower body power levels (Marx et al., 2001). This can be explained by the increased number of repetitions completed while performing squats and lunges during the LRHR program, thus increasing lower's body strength, power and muscular explosiveness. In contrast, only slight non-significant improvements in the two jump tests occurred in the Pilates group.

The prevalence of obesity is higher in women compared to men (NCD-RisC, 2016). In women, elevated body fat and body weight levels are highly related with a sedentary lifestyle (Blumel et al., 2015), impaired physical (Pataky, Armand, Muller-Pinget, Golay, & Allet, 2014) and mental health-related parameters such as anxiety (Bjorngaard et al., 2015) and depression (Soriano-Maldonado et al., 2016). Therefore, a reduction in body fat in this population is very crucial. Confirming the findings of the current study, a low-load-high repetitions program for 12 weeks resulted to a significant reduction in skinfold thickness (O'Connor & Lamb, 2003). In addition, in the current study, both abdominal girth and trunk fat levels appeared significantly reduced in the LRHR group following the intervention period, in contrast to the Pilates group (Table 1).

Abdominal fat accumulation is a risk factor for cardiovascular mortality and morbidity (Mottillo et al., 2010). The decrease in total and abdominal fat indices observed in the current LRHR group may be contributed to increased post–exercise oxygen consumption (Russell et al., 2013) or decreased level of cortisol concentration which occurs after the intervention period (Marx et al., 2001). Other potential reasons of the influence of LRHR workout in reducing body composition variables is the increase in both basal metabolic rate (Ibanez et al., 2005) as a result of resistance training, and in lean body mass (Kraemer, Ratamess, & French, 2002). Multi-joint exercises involved in the particular exercise routine (squats, bench press, power lift, dead row) have been regarded as exercises which cause the greatest acute metabolic responses having direct implications in the reduction of body fat (Kraemer & Ratamess, 2004). Finally, resistance exercise is well known to contribute in increasing epinephrine, testosterone and growth hormones, which all may induce lipolysis (Kraemer & Ratamess, 2005).

In contrast, the results of the current study reveal that body composition is unaffected by three months of Pilates exercise training. Previous relevant Pilates studies, reported a decrease in body weight and body fat levels (Fourie et al., 2014; Rogers & Gibson, 2009). However, several other studies did not show any beneficial effect of Pilate’s programs on body composition parameters (Aladro-Gonzalvo, Machado-Diaz, Moncada-Jimenez, Hernandez-Elizondo, & Araya-Vargas, 2012).

Individuals with adequate levels of flexibility have the ability to live more independently, having therefore a better quality of life as reported in intervention studies which examined the long-term effects of Pilates exercise (Vieira, Faria, Wittmann, Teixeira, & Nogueira, 2013). In addition, systematic participation in Pilates training has been associated with less muscular and ligament pain, as well as increased physical function (Wells, Kolt, Marshall, Hill, & Bialocerkowski, 2013). Several studies showed that Pilates exercise improves flexibility (Engers, Rombaldi, Portella, & da Silva, 2016; Geremia, Iskiewicz, Marschner, Lehnen, & Lehnen, 2015; Pata, Lord, & Lamb, 2014). In the current study, an increase in sit-and-reach flexibility levels was observed in participants of the Pilates group, confirming previous findings showing that 1 hour of Pilates per week for two months could increase finger-tip-to-floor distance by 3.4cm (Segal, Hein, & Basford, 2004).

On the other hand, the current study the LRHR group failed to show significant improvements in flexibility. Joints range of motion was significantly found to be enhanced but only when resistance exercise was combined with stretching exercise (Swank, Funk, Durham, & Roberts, 2003). However, other studies did not show any beneficial effect of resistance exercise on flexibility (Morton, Whitehead, Brinkert, & Caine, 2011; Nobrega, Paula, & Carvalho, 2005). It is possible that the LRHR program failed to show increases in flexibility as no stretching exercise were included, except of a limited number of exercises during the cool down period.

LRHR significantly improved left arm handgrip strength levels, whilst a non-significant increase was found in the right hand. In contrast, the Pilates program failed to induce significant improvements in handgrip strength levels. It is noted that between groups analysis revealed no significant differences between the two groups in regards to handgrip strength levels. In order to maximise strength gains, higher loads may be needed (Kraemer & Ratamess, 2004). In addition, Schoenfeld, et al. (2015) found that a high load training is required for increasing muscle strength, as after comparing the effects of a low- and high-load resistance training, the latter training group had superior muscle strength adaptations (Schoenfeld et al., 2015).

The international guidelines for exercise and physical activity in adults suggest both cardiorespiratory and strength training in order to promote health and wellbeing and to reduce the risk of chronic diseases (WHO, 2010). In particular, for improving cardiovascular health, at least 30 minutes of moderate intensity physical activity is required (or 150 minutes per week in total) or at least 25 minutes of high intensity physical activity at least 3 days per week (or 75 minutes in total) or combination between moderate and high intensity physical activity. In addition, for achieving muscle and skeletal system health benefits, at least two strength training sessions are required for an adult. It is noteworthy that many adults do not meet the above recommendations, with lack of time being the most common barrier to exercise reported in adults (Commission, 2014). Interestingly, the LRHR program applied in the current study consisted by 3 X 60 minutes group sessions per week, and resulted in improvements of aerobic fitness, body composition and lower extremities explosive power. It is noted that no participant dropped out from the program nor any injuries or complaints were reported. Consequently, these suggests that LRHR programs could be considered as effective and safe methods for improving fitness and health related parameters in adult women.

It is acknowledged that the current study has some limitations which have to be pointed out. Aerobic fitness was examined using the 20-m shuttle run test and not by an incremental exercise test to exhaustion using a pulmonary gas analysis system for obtaining the maximal oxygen uptake (VO_2max), which is considered to be the gold standard index for cardiorespiratory fitness levels assessment. Moreover, we did not assess muscle mass, therefore we lost the opportunity to examine whether the two forms of exercise could affect muscles.

In conclusion, a three-month group-based LRHR was found to improve aerobic fitness and body composition in inactive adult women, although more research is needed to further elucidate the mechanism behind such favourable changes. As obesity and sedentary lifestyle are hazardously increasing, there is a need for sport professionals to find different forms of physical activity, apart from the traditional “cardio” exercise method for increasing aerobic fitness and minimizing the tendency towards obesity.

CHAPTER 5

GENERAL CONCLUSIONS

In the current PhD project it has been shown that depressive score and performance on various physical fitness tests were found to be significantly associated with obesity levels in sedentary adult women, indicating the negative impact of increased body weight in health and wellbeing. Additionally, this thesis has shown that LRHR exercise programs can be well tolerated with excellent adherence rate by inactive, adult women who wish to improve their overall health improving their body composition and reducing central adiposity.

The fact that obese and overweight women exhibit lower levels of physical fitness components and mental-related parameters compared to women with normal weight is well documented in our study. In particular, aerobic fitness, flexibility, isometric handgrip muscular strength and sprint levels were found to be impaired in women with elevated BMI. These physical fitness impairments are showing the detrimental effect of excess body weight and body fat in physical fitness of adult women.

A significant interaction was found between BMI and depression score. Women categorized as overweight or obese were shown to have higher scores implying more severe depressive symptoms while women with a normal BMI, were appeared to have very low depression score. As women's Body's Mass Index increased, negative emotions, sense of failure, self-dissatisfaction, self-dislike, social withdrawal, indecisiveness, guilt, punishment, crying and irritability were observed after analyzation of BDI. This does make sense, since having increased amount of body weight makes daily tasks difficult. Just to name a few, overweight or obese mothers have difficulty playing with their toddlers, whereas household shores are tiresome. Being overweight does lead to discrimination and this may easily lead to depression. So much importance is given these days on appearance and ''necessity'' to be thin in order to be accepted, that overweight and obese people may often feel inadequate or insecure in social occasions. This is even more troublesome in the female population in school. The feeling of rejection, as well as strenuous daily routine, easily causes increased irritability. Women with increased amount of body fat were most likely to report negative emotions in the questionnaire, as well as no optimistic feelings regarding their future. Unlike participants with normal body fat levels, women with increased BMI were not satisfied with anything and usually felt quality and self -hatred.

Been overweight was also associated with an increased feeling of fatigue and tiredness. On the other hand, women with normal BMI had an increased interest for other people and life in general, showed increased pessimism, increased social interactions and rarely cried.

Results from the Zung Self –Rating Depression Scale revealed that overweight and obese participants had higher total scores. Mild or moderate depression was seen in women with lower body fat levels, whereas moderate to severe depression was observed in women with BMI ≥ 30.The few women who had BMI ≥ 40 had scores over 70. Participant’s with increased body fat and BMI values were most likely to feel disappointed, have an increased necessity to cry, decreased libido, and constipation problems.

Increased BMI was seen to negatively affect both physical and mental health. Gaining body weight seemed to limit the person’s ability to walk bent, sit and function properly. Even walking a couple of meters seemed as a struggle for overweight women. These were the participants that found difficulties in accomplishing a task and were found to be less concentrated in what they did. Increase of body fat also led to high levels of body pain, which in turn had a negative impact on daily life. Social interactions were found to be limited and energy short. Fatigue was found to be increased in overweight and obese participants as energy levels were noticed to be decreased through the day. This tiredness, prevented women from accomplishing their daily tasks and household chores. It also seemed to be among the major reasons as to why participation in any form of physical exercise was not carried out. Fatigue was found to be among the three most severe symptoms that overweight and obese women felt.

Total scores of "5" or greater were mostly seen in women categorized as overweight or obese. High BMI values were connected with less sleep quality as well as decreased quantity of sleep. Overweight women were more likely to wake up in the middle of the night and have breathing problems, along with cough and snoring. These participants mostly declared their sleeping quality as “bad”.

The intervention study of the project reveals that three months of low-resistance-high-repetitions (LRHR) exercise training could result in significant improvements in several physical fitness parameters including aerobic fitness. It also showed to positively affect body composition, precisely abdominal girth and visceral fat. Therefore such programs could be used as effective methods for counteracting obesity in adult women. Pilates, on the other hand, had a smallest contribution to body composition values. What did Pilates exercise show was, as scenically proven, it can increase flexibility values.

Exercise with any form of resistance (i.e. weights) can be considered as a way of increasing muscular strength. Results found from this intervention are of high importance, as we have revealed that depending on the amount of intensity used (i.e. resistance) and the number of repetitions, exercise with resistance can produce aerobic benefits and improvements in body composition. This is critical, as participants are given the opportunity to gain health benefits by participating in group fitness classes. Group fitness classes, which use weights and barbells are a form of resistance, are regularly seen in health clubs these days. Participants, no longer have to feel that aerobic fitness and body composition values are improved mainly via traditional methods of exercise (i.e. jogging). Today, an increased number of the population exercises by low resistance, high repetition group fitness in their exercise routine. With the recognition of the health benefits of these exercise routines; one can understand how these workouts aid in the promotion of decrease in cardiovascular risks, as well as in the decrease of the obesity epidemic. A decrease in obesity, directly leads to a reduction of a variety of chronic diseases.

Taking all into account, obesity in adult women is associated with impaired physical performance and higher depression scores, whilst group-based LRHR programs could be considered as effective and safe methods in terms of improving fitness and health related parameters in previously inactive adult women.

5.1 Directions for future research

An interesting future study might involve testing the effectiveness of LRHR exercise programs on other aspects of health such as insulin resistance and blood lipid profile. The study of mental related parameters, quality of life and their relation with LRHR would also be of interest. Additionally, biopsy of muscles fibers of the muscles that are involved in such programmes, would give the possibility to investigate the effects of such popular programs on muscle physiology and biochemistry. Finally whether such intervention could be used in a large scale community programs and nursing houses it is something to be shown and potentially it would have a significant impact in the society at large.

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Appendices

Ethical Approval: The ethical approval for the study was obtained by the Cyprus National Bioethics Committee (ΕΕΒΚ/ΕΠ/2015/34).

ΕΝΤΥΠΑ ΣΥΓΚΑΤΑΘΕΣΗΣ
για συμμετοχή σε πρόγραμμα έρευνας

(Τα έντυπα αποτελούνται συνολικά από ………..4…… σελίδες)

Καλείστε να συμμετάσχετε σε ένα ερευνητικό πρόγραμμα. Πιο κάτω (βλ. **«Πληροφορίες για Ασθενείς ή/και Εθελοντές»**) θα σας δοθούν εξηγήσεις σε απλή γλώσσα σχετικά με το τι θα ζητηθεί από εσάς ή/και τι θα σας συμβεί σε εσάς, εάν συμφωνήσετε να συμμετάσχετε στο πρόγραμμα. Θα σας περιγραφούν οποιοιδήποτε κίνδυνοι μπορεί να υπάρξουν ή ταλαιπωρία που τυχόν θα υποστείτε από την συμμετοχή σας στο πρόγραμμα. Θα σας επεξηγηθεί με κάθε λεπτομέρεια τι θα ζητηθεί από εσάς και ποιος ή ποιοι θα έχουν πρόσβαση στις πληροφορίες ή/και άλλο υλικό που εθελοντικά θα δώσετε για το πρόγραμμα. Θα σας δοθεί η χρονική περίοδος για την οποία οι υπεύθυνοι του προγράμματος θα έχουν πρόσβαση στις πληροφορίες ή/και υλικό που θα δώσετε. Θα σας επεξηγηθεί τι ελπίζουμε να μάθουμε από το πρόγραμμα σαν αποτέλεσμα και της δικής σας συμμετοχής. Επίσης, θα σας δοθεί μία εκτίμηση για το όφελος που μπορεί να υπάρξει για τους ερευνητές ή/και χρηματοδότες αυτού του προγράμματος. **Δεν πρέπει να συμμετάσχετε, εάν δεν επιθυμείτε ή εάν έχετε οποιουσδήποτε ενδοιασμούς που αφορούν την συμμετοχή σας στο πρόγραμμα.** Εάν αποφασίσετε να συμμετάσχετε, πρέπει να αναφέρετε εάν είχατε συμμετάσχει σε οποιοδήποτε άλλο πρόγραμμα έρευνας μέσα στους τελευταίους 12 μήνες. Εάν αποφασίσετε να μην συμμετάσχετε και είστε ασθενής, η θεραπεία σας δεν θα επηρεαστεί από την απόφασή σας. **Είστε ελεύθεροι να αποσύρετε οποιαδήποτε στιγμή εσείς επιθυμείτε την συγκατάθεση για την συμμετοχή σας στο πρόγραμμα.** Εάν είστε ασθενής, η απόφασή σας να αποσύρετε την συγκατάθεση σας, δεν θα έχει οποιεσδήποτε επιπτώσεις στην θεραπεία σας. Έχετε το δικαίωμα να υποβάλετε τυχόν παράπονα ή καταγγελίες, που αφορούν το πρόγραμμα στο οποίο συμμετέχετε, προς την Επιτροπή Βιοηθικής που ενέκρινε το πρόγραμμα ή ακόμη και στην Εθνική Επιτροπή Βιοηθικής Κύπρου.

Πρέπει όλες οι σελίδες των εντύπων συγκατάθεσης να φέρουν το ονοματεπώνυμο και την υπογραφή σας.Σύντομος Τίτλος του Προγράμματος στο οποίο καλείστε να συμμετάσχετε
Η επίδραση ενός ομαδικού προγράμματος με κυκλική άσκηση στη φυσική κατάσταση και στην ποιότητα ζωής γυναικών στην Κύπρο.
Υπεύθυνος του Προγράμματος στο οποίο καλείστε να συμμετάσχετε
Δρ. ΧριστόφοροςΓιαννάκη

Επίθετο:	………………………………………………………	Όνομα:	………………………………………
Υπογραφή:		Ημερομηνία:	

ΕΝΤΥΠΑ ΣΥΓΚΑΤΑΘΕΣΗΣ

για συμμετοχή σε πρόγραμμα έρευνας

(Τα έντυπα αποτελούνται συνολικά από ...4. σελίδες)

Σύντομος Τίτλος του Προγράμματος στο οποίο καλείστε να συμμετάσχετε
Η επίδραση ενός ομαδικού προγράμματος με κυκλική άσκηση στη φυσική κατάσταση και στην ποιότητα ζωής γυναικών στην Κύπρο.

Δίδετε συγκατάθεση για τον εαυτό σας ή για κάποιο άλλο άτομο;	
Εάν πιο πάνω απαντήσατε για κάποιον άλλο, τότε δώσετε λεπτομέρειες και το όνομα του.	

Ερώτηση	ΝΑΙ ή ΟΧΙ
Συμπληρώσατε τα έντυπα συγκατάθεσης εσείς προσωπικά;	
Τους τελευταίους 12 μήνες έχετε συμμετάσχει σε οποιοδήποτε άλλο ερευνητικό πρόγραμμα;	
Διαβάσατε και καταλάβατε τις πληροφορίες για ασθενείς ή/και εθελοντές;	
Είχατε την ευκαιρία να ρωτήσετε ερωτήσεις και να συζητήσετε το Πρόγραμμα;	
Δόθηκαν ικανοποιητικές απαντήσεις και εξηγήσεις στα τυχόν ερωτήματά σας;	
Καταλαβαίνετε ότι μπορείτε να αποσυρθείτε από το πρόγραμμα, όποτε θέλετε;	
Καταλαβαίνετε ότι, εάν αποσυρθείτε, δεν είναι αναγκαίο να δώσετε οποιεσδήποτε εξηγήσεις για την απόφαση που πήρατε;	

(Για ασθενείς) καταλαβαίνετε ότι, εάν αποσυρθείτε, δεν θα υπάρξουν επιπτώσεις στην τυχόν θεραπεία που παίρνετε ή που μπορεί να πάρετε μελλοντικά;	
Συμφωνείτε να συμμετάσχετε στο πρόγραμμα;	
Με ποιόν υπεύθυνο μιλήσατε;	

Επίθετο:	…………………………………………………………	Όνομα:	………………………………………
Υπογραφή:		Ημερομηνία:	

………………………………………………………………………………

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<u>ΠΛΗΡΟΦΟΡΙΕΣ ΓΙΑ ΑΣΘΕΝΕΙΣ ή/και ΕΘΕΛΟΝΤΕΣ</u>

Αγαπητή κυρία,

Το τμήμα Επιστημών Υγείας του Πανεπιστημίου Λευκωσίας πραγματοποιεί μια έρευνα με στόχο να εξετάσει την επίδραση ενός ομαδικού προγράμματος κυκλικής προπόνησης σε διάφορες παραμέτρους υγείας, φυσικής κατάστασης και ποιότητας ζωής όπως επίσης και να εξετάσει τα επίπεδα φυσικής κατάστασης και ποιότητας ζωής γυναικών στην Κύπρο.

Ο κύριος στόχος της παρούσας έρευνας είναι να εξετάσει την επίδραση ενός ομαδικού προγράμματος κυκλικής προπόνησης διάρκειας 3 μηνών στα επίπεδα φυσικής κατάστασης, υγείας και ποιότητας ζωής ενήλικων γυναικών, και να συγκρίνει τα αποτελέσματα του συγκεκριμένου προγράμματος με άλλα ομαδικά προγράμματα άσκησης όπως το Pilates. Μέσω της συγκεκριμένης έρευνας θα έχουμε την δυνατότητα να αξιολογήσουμε την επίδραση ενός τέτοιου προγράμματος όπου τόσο στην Κύπρο αλλά και στο εξωτερικό αποτελεί πλέον μια δημοφιλή μορφή εκγύμνασης, εναλλακτική σε άλλες παραδοσιακές μορφές εκγύμνασης. Επίσης θα μας δοθεί η δυνατότητα να αξιολογήσουμε το πρόγραμμα Pilates το οποίο αποτελεί και αυτό μια πολύ δημοφιλή μορφή εκγύμνασης.

Μέσω της παρούσας έρευνας θα γίνουν κάποιες μετρήσεις αξιολόγησης της φυσικής κατάστασης (ταχύτητας, δύναμης, ευλυγισίας, αντοχής, σωματικής σύστασης) και ποιότητας ζωής (μέσω ερωτηματολογίων) των συμμετεχόντων και στη συνέχεια θα ακολουθήσουν συγκεκριμένο πρόγραμμα εκγύμνασης στο γυμναστήριο στο οποίο ήδη είστε μέλος.

Τα προγράμματα άσκησης θα έχουν διάρκεια 3 μήνες. Μετά το τέλος των 3 μηνών θα επαναληφθούν όλες οι εξετάσεις της φυσικής κατάστασης και της ποιότητας ζωής όπως και στην αρχή των προγραμμάτων.

Επίθετο:	....	Όνομα:	....
Υπογραφή:		Ημερομηνία:	

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Όλες οι μετρήσεις και τα προγράμματα άσκησης θα γίνουν στο χώρο του γυμναστηρίου. Οι πληροφορίες που θα συλλέξουμε από τις διάφορες μετρήσεις θα μείνουν εμπιστευτικές και θα σας ανακοινωθούν και θα επεξηγηθούν στον καθένα ξεχωριστά.

Σωματομετρικά θα μετρηθούν το ύψος και το βάρος των συμμετεχόντων. Επίσης θα αξιολογηθεί το συνολικό λίπος του σώματος όπως επίσης το σπλαχνικό λίπος μέσω δύο μηχανημάτων βιοηλεκτικής αγωγιμότητας τα οποία είναι απολύτως ασφαλή και εντελώς ανώδυνα. Για το τεστ αερόβιας αντοχής θα γίνει η δοκιμασία με το παλίνδρομο τρέξιμο. Θα πραγματοποιηθεί αξιολόγηση ταχύτητας συνολικής απόστασης 20 μέτρων, τεστ αλτικότητας, τεστ αξιολόγησης δύναμης χεριού και τεστ ευλυγισίας.

Τα αποτελέσματα των δοκιμασιών θα σημειώνονται από τους ερευνητές, οι οποίοι σε καμία περίπτωση δεν θα φωνάζουν δυνατά το αποτέλεσμα μπροστά στους υπόλοιπους συμμετέχοντες προς αποφυγή διαφόρων παρεξηγήσεων. Όλα τα αποτελέσματα από τα τεστ φυσικής κατάστασης θα χρησιμοποιηθούν εμπιστευτικά από τους ερευνητές, και αποκλειστικά για τους σκοπούς της έρευνας και δεν θα δημοσιοποιηθούν σε καμιά περίπτωση τα ονόματα των συμμετεχόντων.

Επίσης με την χρήση ερωτηματολογίων θα αξιολογηθούν τα επίπεδα ποιότητας ζωής, άγχους, ποιότητας του ύπνου και προβλημάτων του ύπνου, επίπεδα κατάθλιψης και ημερήσιας υπνηλίας.

Μέσα από τη συμμετοχή στην έρευνα θα έχετε την ευκαιρία να ενημερωθείτε για τα οφέλη του προγράμματος άσκησης στη φυσική σας κατάσταση και την υγεία.

Σημειώνουμε ότι διατηρείτε το δικαίωμα του να αποσυρθείτε από την έρευνα αν το θελήσετε σε οποιοδήποτε σημείο της έρευνας, χωρίς να χρειάζεται να δώσετε οποιαδήποτε δικαιολογία ή εξήγηση. Όταν στο μέλλον παρουσιαστούν τα αποτελέσματα της έρευνας σε συνέδρια ή/και επιστημονικά περιοδικά αυτό θα γίνει μόνο όσο αφορά των μέσο όρο των αποτελεσμάτων όλων των συμμετεχόντων, και ποτέ ονομαστικά.

Επίθετο:	....	Όνομα:	....
Υπογραφή:		Ημερομηνία:	

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Για οποιεσδήποτε απορίες, επεξηγήσεις ή ότι άλλο θέλετε να ρωτήσετε, μπορείτε να επικοινωνήσετε με τους Δρ. Χριστόφορο Γιαννάκη (τηλ. 99194808) και κ. Χριστιάνα Ευαγγέλου (τηλ. 99533441)

Σε περίπτωση που για οποιοδήποτε λόγο επιθυμείτε να διαμαρτυρηθείτε για οποιοδήποτε λόγο σχετικό με την ερευνητική διαδικασία ή να ζητήσετε την ανεξάρτητη γνώμη κάποιο λειτουργού του Πανεπιστημίου μας σε σχέση με την έρευνα που λαμβάνετε μέρος, σας παρακαλούμε να μην διστάσετε να επικοινωνήσετε με την Επιτροπή Βιοηθικής του Πανεπιστημίου Λευκωσίας και συγκεκριμένα με τον Δρ. Κωνσταντίνο Αδαμίδη, τηλ: 22841675.

Ευχαριστούμε για την εθελοντική σας συγκατάθεση για συμμετοχή σε αυτή την

έρευνα.

Διάβασα το παραπάνω κείμενο και κατανόησα πλήρως τις διαδικασίες στις οποίες θα υποβληθώ. Δέχομαι να συμμετάσχω στην έρευνα διατηρώντας το δικαίωμα να σταματήσω ή να αποσυρθώ οποιαδήποτε στιγμή, σύμφωνα με την προσωπική μου κρίση

Επίθετο:	....	Όνομα:	....
Υπογραφή:		Ημερομηνία:	