

**Investigating the Relationship of Perceived Exertion during Exercise  
with Depressive Symptoms and Motives from Self- Determination  
Theory in Adults with Obesity**

Kalavrou Christina

University of Thessaly

School of Physical Education, Sport Science and Dietetics

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Supervising Professor: Assistant Professor Dr. Ioannis D. Morres

Three-member committee:

Assistant Professor Dr. Ioannis D. Morres,

Professor Dr. Antonis Hatzigeorgiadis,

Assistant Professor Dr. Haralambos Krommidas

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## Abstract

The purpose of this study was to evaluate in obese adults, if perceived exertion during exercise is associated with depressive symptoms and with the motives based on the Self-Determination Theory (SDT). Perceived exertion is how a person is feeling during a physical task such as exercise. The inclusion criteria were: a) adults 18-65 years old b) Body Mass Index (BMI)  $\geq 30$  c) no restrictions on walking. The total sample was 67 obese adults with mean age of 43.27 years  $\pm 11.32$  and mean BMI of  $35.31 \pm 5.09$ . The sample was randomly assigned into two experimental conditions, one group wore an accelerometer device for 7 days to objectively record daily life Physical Activity (PA) and on the 8<sup>th</sup> day participated in 30-minutes exercise (walking) trial, while the second group participated only in the 30-minutes exercise (walking) trial. Before the 30-minute walking trial, both groups completed the Hospital Anxiety Depression Scale (HADS), the Patient Health Questionnaire-9 (PHQ-9) while for the SDT motives we used the Behavioral Regulation in Exercise Questionnaire-2 (BREQ-2). During the walking test, PA was measured with accelerometer devices while perceived exertion and Heart Rate (HR) were measured respectively, with the 6-20 Borg-Rating of Perceived Exertion scale (RPE) and strapless wrist- worn HR monitors every 5 minutes. Correlation analyses examined the relationships between RPE with HR, BMI, motives and depressive symptoms and the relationship between motives and the walking test measures of RPE and HR. Results showed that the average 7-day wear time of the accelerometer devices was 5.47 days/ week  $\pm 1.93$  and 12.02 hours/ day  $\pm 3.48$ . The sample showed moderate depression severity and was physically active in daily life with moderate intensity of PA 39.07 minutes/ day  $\pm 25.52$ . The PA moderate intensity

and the RPE and HR mean values during the walking trial were, 25.38 minutes  $\pm$ 8, 8.75  $\pm$ 1.86 and 115.34  $\pm$ 11.82 respectively. No statistically significant correlation was found between the RPE with HR and moderate intensity PA. There was a low negative relationship of the RPE with the introjected motive in the 30<sup>th</sup> second and in the 5<sup>th</sup> minute. RPE and BMI showed a positive relationship in the 30<sup>th</sup> second, 5<sup>th</sup> and 10<sup>th</sup> minute. There was no relationship between the accelerometer-based light, moderate and vigorous PA with motives during the walking test, although the external motive tended to be statistically significant correlated with moderate, vigorous and VPA intensity. Therefore, we concluded that there is an indication of disturbed exertion during the walking test, since the accelerometer devices and the HR values showed moderate intensity of exercise while the RPE values showed a light intensity. We also need to consider that a shorter duration of exercise, will reduce depressive symptoms and the introjected motive which eventually will lead to a higher RPE and a correctly perceived exertion.

**Keywords:** Perceived exertion, Exercise, Depressive symptoms, Motives, Obesity

# Introduction

## Physical Activity (PA)

### Definition

Physical activity is defined as any movement that is produced by the skeletal muscles and results in energy expenditure (Caspersen, Powell, & Christenson, 1985). In our daily life, PA can be divided into many categories such as housework, sports, our occupational (especially if it is manual), our daily movements and many other activities (Caspersen et al., 1985). It is prominent to separate the two definitions of PA and Physical Exercise (PE), as there are many times that is believed they are the same. PE, is an organized form of PA whose goal is the improvement of fitness (Caspersen et al., 1985).

### Physical and Mental Health Benefits

Nowadays, PA is a very important tool in people's lifestyle, because the benefits are distinguished in mental and in physical health. Those benefits are the ones that led the World Health Organization (WHO) to announce that PA must be a part of our daily life style (WHO, 2019). The help offered by PA to the physical health of people, branches out many types of different diseases and mainly its role is to reduce the risk of their occurrence. More specifically, research has shown that PA can play an important role in managing body weight (Jakicic, 2009). However, apart from the PA, researchers emphasize that to achieve this maintenance of body weight, people need to follow also, a specific diet program (Jakicic, 2009). On the part of diseases, in a literature review study, it has been concluded that PA can be responsible for reducing the risk of various types of cancer and also, for decreasing blood pressure, especially in a state of rest (Miles, 2007). Diabetes type 2, is one of the most dominant diseases nowadays,

especially to people who are obese or the ones whose blood glucose composition is below normal limits (Miles, 2007). PA is capable of contributing to the reduction of the risk of the appearance of this disease in a percentage of 33-50% (Miles, 2007). Population is also affected by various cardiovascular diseases. The scientific community researched whether PA can help to reduce the spread of these diseases and the results of some studies were positive, referring in particular to light PA (e.g. walking) (Miles, 2007; Wahid et al., 2016).

In the above paragraph, were listed some of the main benefits of PA in people's physical health. Therefore, it is necessary to also mention, with the same degree of importance, and the benefits in mental health. From several years ago it has been proved that PA can be beneficial in various mentally clinical conditions such as anxiety but also is responsible for the improvement of the quality of life as it has a significant effect on people's mood and also on their self-esteem (Miles, 2007). If we focus on the last few years, the opinions remain relatively close, but there is greater depth, especially on the subject of the intensity of PA (Blodgett, Mitchell, Stamatakis, Chastin, & Hamer, 2023). More specifically, moderate PA, seems to be more capable of reducing the risk of depressive symptoms, even if its duration is comparatively short (Blodgett et al., 2023). Another research that innovated in the last year as it examined PA activity in every minute of the day (by mobile technology), showed that PA was associated with improved positive action mainly in people suffering from depression and anxiety (Difrancesco et al., 2022). The researchers did not omit to mention that the effects of PA in depression and anxiety may not have a positive outcome in all the people due to the differences each person has (Difrancesco et al., 2022). Based on the fact that every person differs in the perspective of PA and how it can be helpful to him it is worthy of consideration what type of PA might be most useful in improving mental health. The answer to this thought is given by a very recent study, in which one of the

groups that have been consisting the participants, was healthy people (Xu et al., 2022). The results showed a 17% betterment in their mental health in all types of PA, with the two dominant ones being jogging and hiking (cross- country) (Xu et al., 2022).

## **Sedentary Lifestyle**

Everyday life has changed a lot in the last 20 years. One of the main reasons for this dramatic alteration is the attachment of technology to all branches of our lives. People seem to prefer spending their free time by watching TV or being on their mobile phone. The hobbies of children and adults are mainly electronic and minimally connected to any kind of PA. As for the part of the transportation, we notice that it is mostly done by cars or public transport, which is also proven by research (Guthold, Stevens, Riley, Bull, 2018). Biking or even walking is rarely chosen by the modern lifestyle. The last major sector of everyday lifestyle that has been directly affected by technology is the occupational. More and more occupations tend to turn into sedentary with result people are grounded in a chair for their occupation (Guthold et al., 2018). This tension of the sedentary life is very dangerous and there is an immediate need to solve this phenomenon. In 2009, the WHO declared that sedentary lifestyle is the fourth hazard factor for all diseases that are not considered by the medical community as communicable (WHO, 2009). Sedentary rates worldwide are constantly altering. Changes are observed over time and unfortunately they are all with an increasing slope. For example, in 2012, the percentage of adults (15 years and above), who were physically inactive, worldwide, is 31.1% (Hallal et al., 2012). The research that concluded the above percentage, also added to its results the percentage of adults who tended to spend at least 4 hours daily in sitting, is 41.5% (Hallal et al., 2012). In 2016, a study was published, that collected data from 2001 to 2016 and with a participation rate of 96% of the entire population (Guthold et al., 2018). In this study it is reported that over a



quarter of the global population, in 2016, was physically inactive with the females outnumbering males (Guthold et al., 2018).

## **Obesity**

### **Definition- Sedentary Lifestyle**

Obesity is chronic disease characterized by increased body fat. According to the Body Mass Index (BMI:  $\text{weight/ height}^2 \text{ kg/ cm}^2$ ), people are considered obese when their values are equal or above to BMI of 30 (obesity  $\geq 30$ ). Obesity in recent years has increased excessively both in adults and children. In 2019 up to 2021, it was calculated that all states had over 20% of their adult population in the category of obesity (Center for Disease Control and Prevention, 2022). The WHO, in a related paper on obesity, published that in 2016, over 1.9 billion adults were diagnosed as overweight, with 650 million of them being obese (WHO, 2021). In Greece, the national obesity risk, is reaching the 75% and that declares the country in a high risk of having a great percentage of obese population (Global Obesity Federation, 2022). As we can notice, the scourge of obesity is spreading rapidly and needs to be addressed immediately. It is now classified as a non-communicable disease and has been found to be a higher cause of death compared to the underweight (WHO, 2021).

### **Physical and Mental Health Problems**

Obesity is directly linked to many other diseases, both physical and psychological. The coexistence of all these diseases is one of the main reasons that make obesity very dangerous for the human organism. Even several years ago, it became clear that diseases like diabetes 2, high blood pressure, various types of cancer, heart diseases and arthritis are the main ones that appear in people with high body weight (Ezzati, Lopez, Rodgers, & Murray, 2004). As far as the mental health is concerned, people with BMI  $\geq 40$  are facing lower quality of life than those that have

BMI between that ranges of 30- 39.9 kg/cm<sup>2</sup> (Xu et al., 2022). In general terms, it has been established that high BMI, which indicates obesity, is related to low quality of life and this leads to the creation of poor mental health (Xu et al., 2022).

One of the biggest sub-categories of mental health is depression, which seems to dominate the entire population, especially the obese one. In general, the relationship between depression and obesity has been researched a lot through years and the conclusion of many studies was that it is bidirectional (Luppino et al., 2010; Vittengl, 2018). More specifically, one of the first meta-analyses of longitudinal studies, investigated the relationship between obesity and depression (Luppino et al., 2010). Their results showed that the relationship between obesity and depression is bidirectional as it was appeared that there was 55% danger of coming into view depressive symptoms in people that were obese and at the same time there was a 58% danger of people that were diagnosed with depression to be obese (Luppino et al., 2010). It is important to mention that many studies found mostly statistically significant relationships between obesity and depression in women (Vittengl, 2018; Preiss, Brennan, & Clarke, 2013), while some others found data for both sexes (Luppino et al., 2010). Furthermore, a recent study by (Chae et al., 2022) showed that the comorbidity between depression and obesity in male adults differed among the young ones and the older ones. In other words, as the age of men was rising, the prevalence of this comorbidity was increasing too (Chae et al., 2022). The percentage of these indicators, in the above study was higher in women (2.0%) compared to men (1.3%) (Chae et al., 2022).

## **Treatment of Depression and Obesity**

To this extent obese people are in a great need of treatment, both for depression and obesity. So, due to the seriousness of this phenomenon, various branches of health and wellness have

been developed the past few years, in order to promote alternative methods for the combat of obesity and depression. One of the most well-known methods of combating depression is the various drugs that are prescribed to patients. In a related study, where the sample was consisted by obese depressed adults, came up to the result that patients who were obese tended to choose the pharmaceutical pipeline to a greater extent than the patients with normal weight (Puzhko et al., 2020). This shows us that the method of treatment, a patient will choose in order to retaliate depression, is something that is influenced by many factors, such as in this case by body weight. However, if we isolate depression in the scientific research, various studies have been conducted to found the appropriate weapon to combat it. Here we come to the point where one of the most common accepted treatments should be mentioned, which is the combination of psychotherapy with antidepressant drugs. A recent study showed that the combination of psychotherapy with drugs led to better acceptance by the patients and resulted in better outcomes compared to the treatment with drugs only (Cuijpers et al., 2020). In another study that dealt with major depression, it was observed that psychotherapy with antidepressant did not show any difference between those two (Kappelman et al., 2020).

Since some of the basic treatments for depression have been mentioned, it is time to present the treatments of obesity. As it is known, the most widespread form of cure for obesity is diet. General population and mostly obese people, constantly tend to consult a nutritionist for the reduction of their body weight and lose the excess fat. In 2013, the descriptive statistics of Andres, & Saldana (2014), with participation of 608 people, showed that 38.1% of them was dieting while the most of them were with an increased BMI. Despite the high percentage of people that dieting, the main problem of this is not the first steps of a nutritional plan but the remain on following it. At first, obese patients see very clear results on their bodies, but over the

time they find it difficult to maintain the body weight they have achieved through the diet plan, leading them to give up trying. A systematic review and meta-analysis study, tried to observe the above phenomenon by conducting various clinical weight loss trials such as diet, exercise, combination of these two, etc. The results showed a 4,8 % up to 8% weight loss the first 6 months and in one year the percentage dropped 3% up to 4,3% and remained like that three years in total (Franz et al., 2007). The researchers concluded that the weight loss in all types of clinical trials tend to reach a plateau, so it is important for people to keep accepting professional guidelines and support in order to maintain this weight loss (Franz et al., 2007). A secondary problem that relates with the diet, is the wrong standards that are presented by the media and the way they project the ideal body weight and body type. In an old study, researchers attempted to find what could be assumed as the reasonable weight loss (Foster, Wadden, Vogt, & Brewer, 1997). Obese women underwent in a 48-week treatment in order to minimize their body weight (Foster et al., 1997). Before the treatment started, each woman set a goal for her weight loss after 48 weeks (Foster et al., 1997). The results showed that women had lost an average of 32% of their body weight and despite that big accomplishment 47% of those women had not achieved their original goals (Foster et al., 1997). Based on these results, we can wonder how incorrect people's goals are when it comes to the expectations they have for strive against obesity.

Another treatment for the fight against obesity belongs to the field of cosmetic medicine, which has been in the foreground the last decades. The repeated advertising by the media and the very effective and fast results offered by liposuction make it more and more in demand every day. In 2017, over 700.000 plastic surgeries were performed involving liposuction, rhinoplasty and breast augmentation (American Society of Plastic Surgeon, 2018)

## **Exercise as treatment of depression in obese adults**

Exercise is known to provide significant benefits to physical and mental health. Therefore, we think it can be used as an important tool for the reduction and avoid appearance of depressive symptoms. At this point it is noteworthy to refer to the term of exercise. According to Caspersen and his co- authors (1985) exercise is characterized by three principals: organized, structured and repetitive. Exercise's goal is to maintain or improve physical condition (Caspersen et al., 1985).

Through the past years there have conducted many systematic reviews and meta- analyses where their main purpose of them was understand if eventually it is true that exercise can be beneficial to people with depression or to people that tend to develop this mental illness. As it comes to the normal weight population many studies have been conducted where the results seem to not be optimistic for the antidepressant effect of exercise (Cooney et al., 2013; Perez Bedoya et al., 2023)

If we focus in the obese population we will find similar results with the normal weight population. The first systematic review that will be mentioned is from Baillot and his colleagues (2018) which main purpose was the evaluation if exercise can be beneficial on psychological outcomes. Results showed that exercise was not capable in reducing depression in obese adults, despite the fact that it could have a positive effect on psychological outcomes in the normal weight population. (Baillot et al.,2018). In agreement with the above results comes Carraca's met-analysis (2021) which concluded that exercise can be a useful tool for the improvement of quality of life but not for depression. At the same year Oppert and his colleagues (2021) made a statement from the European Association about exercise and obese adults. The evidence statement was that exercise is not capable to be considered as a treatment for depression in obese adults. Lastly, the systematic review of Jones and his colleagues (2021) studied the impact on

mental health that is caused due to the behavioral weight management. The intervention was the behavioral weight management which consisted by diet and PA programs which were targeting to the weight loss (Jones et al., 2021). In this meta-analysis results were positive for the intervention since the outcome was the reduction of the depression (Jones et al., 2021).

From all the above systematic reviews we can understand that exercise tends not to have a role as a treatment of depression in the obese population.

### **Drop- outs of exercise**

Despite the advantages of organized exercise regarding the obese population, the cessation of exercise and drop-outs of weight loss programs are constantly increasing for various reasons. Over the years, the causes that could account for this phenomenon have been researched a lot and it seems that the most articles come to the same main ones. There are, lack of motivation (Lantz, Peltonen, Agren, & Torgerson, 2003; Orten Hadziabdic, Mucalo, Hrabac, Matic, Rahelic, & Bozikov, 2015)], family related problems (Lantz et al., 2003), increased working hours (Inelmen et al., 2005), health problems (physical and mental) (Orten Hadziabdic et al., 2015) and lastly undesirable consequences of exercise (Orten Hadziabdic et al., 2015).

Due to this increasing abandonment of obese individuals, a new solution was promoted, which is the establishment of PA in their daily life. According to WHO (WHO, 2020), in order for PA to promote better mental health in obese population, it needs to be carried out at least 5 days per week in a moderate intensity for 30 minutes per day or 75 minutes per week of high intensity PA.

However, it is observed that obese people tend to be physically inactive. A study, part of whose sample was obese German adults, found that the prevalence of physical inactivity was highest in obese grade 3, with percentage 56.7%, followed by overweight people with 34% and

finally people with normal BMI with 26.2% (Linder et al., 2021). In the same research, it was also examined the daily PA in the same categories. The results are opposite with the above ones as people with normal BMI had at least 4 hours per week participation, while overweight people were fewer and the lowest rates were given by the obese people grade 2 and 3 (Linder et al., 2021).

The reasons for the phenomenon of the obese people avoiding PA may be many. In the present study we will focus on one possible cause which is the disturbed perceived exertion of exercise.

## **Perceived Exertion**

Through the years perceived exertion has been established more in the literature of psychology and physiology. Borg (1998) refers that perceived exertion is a connection between emotions, musculoskeletal (muscle fatigue, physical stress) and cardiovascular (increased HR, increased breathing) systems. Therefore, a first definition that it was given for perceived exertion is how a person is feeling during his participation in a physical task. In order to get a clearer view of how to measure the amount of heaviness and strain through a physical task Borg's Rating Perceived Exertion Scale (RPE) has been created (Borg, 1998). The final RPE scale has as a starting point number 6 which represents no exertion at all during an exercise while the ending point is number 20 which represents maximal exertion. A value information that should be mentioned is that each number in the RPE scale is attached to a specific HR, since humans HR can be considered a variable indicator of fatigue and physical effort during any kind of exercise. In more details, number 6 indicates an HR of 60 beats per minute (resting HR) while number 20 indicates an HR of 200 beats per minute (maximum HR). Borg (1998), reported that perceived exertion shows a linear relationship with HR measures across various population. It is important

to understand that when HR is increasing the same will happen in the RPE and the same applies with the decrease of HR, RPE also decreases (Borg, 1998).

It is important to be mentioned that through the years many scales have been created for the measurement of perceived exertion although Borg's RPE scale is the most popular. One of the reasons of this popularity is the simplicity of its use. Another main reason is the reliability of it which has been examined from many studies in different circumstances (Borg, Karlsson, & Ekelund, 1977; Ceci & Hassmen, 1991).

Regarding the literature of obesity, there are some studies that have interesting results in the way obese adults perceive the intensity of the exercise they attend to. For example, the research of Coquart, Tourny- Chollet, Lemaitre, Lemaire, Grosbois, and Garcin (2012) concluded that the use of Borg's RPE scale can be considered as a reliable tool with useful properties in the treatment of obesity, but strongly indicating that further research is needed. An interesting research is the one of Ekkekakis and Lind (2006) where they focused their attention on the intensity imposed on the obese population and how this can negatively affect their maintenance in exercise. Their results showed that when the overweight women were submitted to participate in a pre-selected intensity, a decrease in reported pleasure was observed, thus leading to the conclusion that if this exercise was continued with the specific intensity, the women would lose their interest in exercise over time along with their enjoyment (Ekkekakis & Lind, 2006). The following meta-analysis is considered that is the first which aimed to demonstrate the existence of a strong relationship between the actual exercise intensity and the RPE in overweight and obese individuals. The results presented by the researchers, were in agreement with their initial hypothesis, meaning that the relationship between actual exercise intensity and RPE is positive (Yu, Sun, Sun, Chen, & Tan, 2021). Also, comparing the RPE's scales of the three groups



(overweight, obese and normal weight), the first two groups showed higher scores, which shows us that they felt the exercise more difficult compared to the normal weight group. The researchers confirmed through the review that the reliability of the scale is valid for overweight and obese individuals who are following two criteria: 1. To belong to the age range of 21,5 – 58,6 and not have any other illness 2. To exercise lightly in an indoor place with a standard temperature (Yu et al., 2021).

From the above studies, we realize that it is still unclear if the RPE scale has a positive effect on obese people. It is important to see what opinions prevail in people with depression. The question that dominates this literature is whether the predetermined intensity of exercise contributes to the reduction of depression. In the research of Callaghan, Khalil, Morres and Carter (2011), two conditions of exercise sessions were carried out, one with a preferred intensity and one with a pre- prescribed intensity. The results showed that the women with depression, who participated improved their quality of life and depressive symptoms (Callaghan et al., 2011). Meanwhile the researchers emphasized that the key to achieving these results is due to the participation of depressed women in a monitored exercise program where they could select the intensity they felt more comfortable, guided by trained staff and also participate in a motivational support group (Callaghan et al., 2011). The study of Morres, Hintan- Bayre, Motakis, Carter and Callaghan (2019) performed a secondary analysis of the data of the study of Callaghan et al., (2011). The type of exercise was on a treadmill and the one group of women chose their preferred intensity based on their personal perceived exertion, while the active control group of women followed an exercise program on a treadmill with fixed prescribed intensities based on the national guidelines. One of the results of this research (Morres et al., 2019), was that the greatest effect against women's depression came from the preferred intensity's exercise model,

as was also found in the research of Callaghan et al., (2011). More specifically, 32% of women experienced a reduction in depression compared to the prescribed intensity group. At the same, 68% of the group with the preferred intensity of exercise did not show statistically significant reliable improvement in depression rates after the end of the intervention, although some of them had the tendency to show (Morres et al., 2019).

As far as obese people who sufferer also from depression, relevant literature is lacking. This is one of the main reasons that we conducted the present study, which aims to provide more information about the population that is struggling from these two serious diseases and how it's perceived exertion can be helpful to the journey against these two.

### **Self Determination Theory (SDT)**

SDT was created to motivate people to perfume health behavioral patterns, such as participating in exercise programs. The achievement of this motivational theory is done through the satisfaction of three psychological needs and the enforcement of two types of motives. The psychological needs are: the sense of autonomy, the sense of competence and the sense of social relatedness (Vallerand, 2000). More specifically the sense of autonomy in an exercise activity offers to the participant many opportunities over it, while at the same time he has the option of performing in it by being happy and pleasant (Theodorakis [ ], 2010). Some examples of the autonomy need are: The participant is choosing what activity will perform today, or in which intensity etc. As it comes for the competence it seeks to offer the person the satisfaction of the need to feel that he can achieve a skill and reach his goals. Lastly, the relatedness need is responsible for providing to people the interaction the seek with other people by creating relations with them.

Another aspect of SDT is that people's motivation is divided in three motivational states. These are intrinsic motivation, extrinsic motivation and lack of motivation. Intrinsic motivation is manifested by a person's liking to participation of an activity because he/her is actually enjoying it (Ryan, R, & Patrick, 2009). On the other hand, extrinsic motivation is manifested by a person's participation in an activity because he/her seeks to gain something from it, for example a medal, or lose weight or to be accepted etc. (Ryan et al., 2009).

Extrinsic motivation is divided into four types of motives according to how a person is managing his/hers self-regulation. Those four types of motives will be mentioned in ascending order. The first type is the external motive, in which the individual perceives externally controlled punishments or rewards (Ryan et al., 2009). This motive provides him/her with motivation from external factors (Ryan et al., 2009). Next is the introjected motive, which refers to an individual who participate in an activity with the goal of fulfilling their self-esteem (Ryan et al., 2009). The third type of motive is the identified one, in which the individual seeks by participating in an activity and identifying with this behavior to remove desires related to external rewards (Ryan et al., 2009). The fourth type is the internal motive, in which the individual is characterized mostly, by feelings of self-esteem and autonomy (Ryan et al., 2009).

It is important to mention that SDT can be used in many behaviors, although since the main behavior in this study is the exercise and PA, the theory was written according to this specific behavior.

# Methodology

## Participants

This research is a descriptive study, in which 67 adults both male and females were recruited. The criteria for the selection of the participants were three: 1) 30 (obese people) 2) age should be among 18 to 65 and 3) they should have the ability to walk. The participants were found in a variety of ways with dominants being the press releases in social media and by word of mouth among family-friendly-work environment places of the researchers and of the participants.

## Procedure

Below is the participants' information/participation on the process as it evolved over time: Firstly, we contacted the interested participants by asking him his age, height and weight in order to see if he/she pre-matches the research criteria. Then if those criteria were suitable we initially reported to him/her that his/her participation in our research will be anonymous and he/she will have every right to stop it whenever wishes it. The last part of our communication was the description of the procedure. We would inform him/her that he/she would be in a list with other participants and by randomized selection would be selected to wear an accelerometer, which would be placed on an elastic belt at the hip, for 7 days for the entire duration of each day except sleeping hours and personal hygiene hours, without changing anything in his/her daily schedule and at the 8<sup>th</sup> day he/she would participate in a 30-minutes walking test and completion of self-report questionnaires or he/she would participate only in the 30-minute walking test and the completion of self-report questionnaires.

After we conducted the 1 to 1 random selection of participants we were informing them in which of the two trials there will be participating.

Then each participant should read the consent form and then add his/her signature if he/she remains in agreement.

For the participants who wore the accelerometer device for 7 days, the information was the following:

Each participant received the accelerometer and was informed about its characteristics and the correct application of it. In more details, he/ she was informed that the device does not carry radiation, is small and light (3.8cm. × 3.7cm. × 1.8cm., 27g), does not break in case of a possible fall, nor when exerting weight pressure, and that the belt in which it is attached is elastic and can adapt in the body of each person, specifically at the hip level. We also explained that the function of the device is to measure and record body movement- vibration, mobility as well as immobility. Then, after we had finished describing the device and answered to any possible question, we gave the instructions on the correct way to wear the belt. More specifically we emphasized that the device had to be placed on the right side of the body and at the height of the hip, without being necessary to have direct contact with skin. An important reference was that the participants did not bear any responsibility in case the device is lost or damaged. Once the 7 days' trial was completed each participant delivered the accelerometer device the day that he/ she would conduct the walking test and the filling of questionnaires.

Second part of the study that was conducted by all the participants. This phase was the 30-minute walking test and the completion of the self-report questionnaires

Each participant completed individual self-report questionnaires. For the measurement of depressive symptoms, we used the Hospital Anxiety and Depression Scale (HADS) (Zigmod &

Snaith, 1983) and the Patient Health Questionnaire- 9 (PHQ-9) (Kroenke, Spitzer, & Williams, 1999). Secondly, self-reported questionnaires that record motives (Markland & Tobin, 2004) were used. The time that was consumed in the completion of those questionnaires was 20-25 minutes.

After the completion of the questionnaires, participants had to wear a strapless polar heart rate monitor on their left wrist and an accelerometer device on their right side and in the height of the hip. Then we had to explain to them what would the process be like. A 30-minutes walking trial had to be conducted in a moderate PA intensity. This intensity would be calculated and estimated by their heart rates (HR) and their age predicted corresponding values of 64%- 75% HRmax based on the equation of  $220 - \text{age}$ . We also explained to them what is the Borg Scale (Borg, 1970) and how it works.

During the 30-minute walking trial, in the first 30 seconds and then every five minutes the researcher was recording participants' HR (according to the polar watch) and after showing to the participant the Borg Scale in the height of his eyes she was making the question "How difficult does the exercise seem to you right now?". Then the participant had to point out with his/ her finger which number is more accurate according to the above question. In total these specific measurements have been conducted 6 times.

At the end of the trial, each participant was delivering to us the polar watch and the accelerometer device and he was doing some stretching to drop his HR.

## **Questionnaires**

The questionnaires that have been used to measure depression were Hospital Anxiety and Depression Scale (HADS) and Patient Health Questionnaire (PHQ-9). The HADS was created 38 years ago by (Zigmond & Snaith, 1983) and the reason of its creation was for the evaluation of

depression and anxiety. HADS is consisted by 14 questions, seven of its target to anxiety and the remaining seven concern depression. Each question includes four possible answers in which the participant is asked to choose only one of them that believes it's more representable in his feelings. The scoring of the answers is a scale from 0 to 3 points. The higher the total score (depression- anxiety) is, or the separate score of its category the higher the participant is showing anxiety or depression or even both. Below we will mention some norms of HADS that concern only the two categories separated and not the total questionnaire. More detailed, if the score is below 7 then the person is not appearing any symptom severity of anxiety or depression, then if the score is between the values of 8 to 10 then the person shows mild symptoms of depression or anxiety disorder, if the values are between 11 to 14 it shows that he is facing moderate depression or anxiety and lastly if his scoring id between 15 to 21 the severity of the appearance of the symptoms is increased. We used HADS as it is considered one of the most valuable tools for the measurement of depression and anxiety as it can provide knowledge about people that are already been diagnosed with these disorder but also to detect new possible patients. Another advantage is that it has been translated in a variety of languages and one of them is Greek.

As it come for the PHQ-9 it is a questionnaire were we can measure depression (Kroenke et al., 1999). The questionnaire is included by 9 questions that are used as diagnostic criteria for major depression (Williams, 2014). The content of these questions include some experiences that someone may be facing in a time period of two weeks. These experiences are failure, disturbed sleeping schedule, disturbed speech (rapid or very slow), thoughts of self- destruction or suicide, concentration difficulties, appetite, energy levels, pleasure and feeling down. The participant is asked to answer how often is he dealing with the above symptoms. The answer scale of each question is from 0 (not at all) to 3 (almost every day). PHQ-9 is a useful tool for treatment and

diagnose of major depression. It also a reliable questionnaire for research. If the person scores less than 5 it is directed to the absence of depression. If the score is between 5-9 the person is in subthreshold of depression, between 10-14 are persons that belong to the spectrum of depression and lastly if the score is 15 and above the persons are diagnosed with major depression.

For the measurement of motives from the Self Determination Theory we used the Behavioral Regulation in Exercise Questionnaire 2 (BREQ-2) that was modified in its latest version by (Markland & Tobin, 2004). This questionnaire assesses to the reasons why participants do PA. The questionnaire is evaluating four main dimensions of motives (integrated regulation, external pressure, identified regulation and internal regulation). The total questions are 19 and each of the questions have five possible answers with a scale 0 (Definitely no) to 5 (Definitely yes).

## **Statistical Analysis**

The data that were collected by accelerometer devices were examined, processed and analyzed with the program ActiLife version 6.5.2 while it was also conducted statistical analysis. The analyzes that were performed were the descriptive statistics and correlation analyses.



# Results

## Descriptive statistics

In Table 1 are presented the descriptive data of participants that wore the accelerometer device for 7 days. From the 67 participants (51% were regular exercisers), 38 of them wore the accelerometer device for 7 days with 36 finishing successfully this trial. The results showed that the participants are considered to be physically active according to the national guidelines of WHO (2022), (Average moderate intensity PA per week= 175 minutes). In table 2 we can see the descriptive statistics of the walking test.

**Table 1:** Descriptive statistics for participants and for their daily PA recording through accelerometer devices.

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	Mean	Standard Deviation	N
BMI	35.31	5.09	68
Age	43.27	11.32	67
Wear days validation	5.47	1.93	38
Wear time validation-(hours)	12.02	3.48	38
Kcals per day	1.417,6	292,44	36
Sedentary min per day	1.717,98	1.993,92	36
Light PA min per day	1.258,53	5.543,9	36
Moderate PA min per day	39.07	25.52	36
Vigorous PA min per day	1.22	4.34	36
Steps per day	8.441,07	4.344,52	36

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BMI: Body Mass Index; PA: Physical Activity

**Table 2:** Descriptive statistics for the walking test.

	Mean	Standard Deviation	N
Temperature (C)	21.85	6.43	67
Distance in meters	2.428,97	471.6	67
Light PA in minutes	.79	1.17	59
Moderate PA in minutes	25.38	8	59
Vigorous PA in minutes	2.58	6.85	59
Steps	3.123,9	762.16	60
Kcals	337	380.58	60

C: Celsius; PA: Physical Activity

Table 3 includes the descriptive data for the mental health and the SDT motives. We can see that participants scoring from the PHQ-9 questionnaire, is above 5 so it shows us that the participants experience mild symptoms of depression. In Table 4 are presented the descriptive data of the RPE scale and the HR of the walking test. From the HR we can observe that the scores are high, so it is illustrated that the participants corresponded to our guidelines to exercise at moderate intensity during the 30-minutes walking test. Also, from the participant” number we can see that the total number of the people that started the walking test, was 67, however, 66 participants reached the 20<sup>th</sup> minute, 65, the 25<sup>th</sup> minute and 59 of them had successfully reached the finish line of the 30 minute’ walk.

**Table 3:** Descriptive statistics for depression symptoms and for motives.

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	Mean	Standard Deviation	N
HADS-Depression	5.85	3.51	67
HADS-Total	11.58	6.8	67
PHQ-9	6.84	4.82	67
SDT External motivation	4.39	3.76	67
SDT Introjected motivation	5.78	3.36	67
SDT Identified motivation	11.13	3.11	67
SDT Internal motivation	12.43	3.3	67
SDT Amotivation	2.37	3.28	67

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BREQ-2: Behavioral Regulation in Exercise Questionnaire; HADS: Hospital Anxiety Depression Scale; PHQ-9: Patient Health Questionnaire; SDT: Self Determination Theory

**Table 4:** Descriptive statistics for heart rate and perceived exertion during the walking test.

	Mean	Std. deviation	N
HR-30sec	99.24	10.92	67
RPE-30sec	6.75	1.02	67
HR-5min	110.37	12.5	67
RPE-5min	7.79	1.89	67
HR-10min	113.33	19.6	67
RPE-10min	8.36	2.35	67
HR-15min	117.66	14.53	67
RPE-15min	9.06	2.48	67
HR-20min	120.5	13.33	66
RPE-20min	9.45	2.4	66
HR-25min	120.52	12.75	65
RPE-25min	9.85	2.74	65
HR-30min	122.71	13.26	59
RPE-30min	10.27	2.98	60
HR-overall	11.34	11.82	59
RPE-overall	8.75	1.86	60

HR: Heart rate; RPE scale: Rating Perceived Exertion scale; min: minutes; sec: seconds

## Correlation analysis

Correlation analysis examined the relationship of RPE with HR during the walking test. The results showed that there is no statistically significant correlation between any of these values, so RPE scale and HR are not correlated at any time during the 30-minute walking test (Table 5).

Correlation analysis examined the relationship of RPE at each time point during the walking test with the STD-motives (Table 6). There was a low, statistically significant negative correlation between the RPE value and the introjected motive at the 30<sup>th</sup> second of the walking test. In the 5<sup>th</sup> minute of the walking test, there was also a low negative correlation between RPE and the introjected motive that tended to be statistically significant. There was also, no statistically significant relationship between any motive with the overall value RPE-total (Table 5).

Correlation analysis also examined the relationship of RPE at each time point during the walking test with the BMI (table 6). Results showed a low, statistically significant positive correlation with the RPE values on the 30<sup>th</sup> second, 5<sup>th</sup> minute and 10<sup>th</sup> minute.

Correlation analyses examined the relationship between SDT-motives and the values of the walking test which were light PA, moderate PA, vigorous PA, kcals and steps. Results showed no statistically significant correlations, although there was a low, negative correlation between external motive and the moderate PA that tended to be statically significant. Also, there were two low positive correlations between the external motive and the vigorous PA and the VPA that tended to be statistically significant.

Lastly, correlation analysis examined the relationship between the depression values with the RPE and HR values during the walking test. Results showed no relationship between HADS-depression and any RPE, while there was a low positive relationship between HADS-total and

the values RPE-25<sup>th</sup> min and RPE-20<sup>th</sup> min (Table 7). As it comes for the relationship between PHQ-9 and RPE values, it was found a low positive correlation with three RPE values, RPE-30<sup>th</sup> min, RPE-25<sup>th</sup> min and RPE-20<sup>th</sup> min (Table 7).

There was no statistically significant relationship with any HR values and the mental health variables.

**Table 5:** Correlation analysis between RPE and HR of walking test with BMI, depression symptoms and motives.

	Correlations										
	1	2	3	4	5	6	7	8	9	10	11
1.HR-total	-										
2.RPE-total	-.04	-									
3.HADS-total	.20	.23	-								
4.HADS-depression	.20	.20	.83**	-							
5.PHQ-9	.22	.23	.77**	.68**	-						
6.External	.22	.11	.21	.25*	-.21	-					
7.Internal	-.12	-.15	-.23	-.34*	.06	-.25*	-				
8.Introjected	.12	-.19	-.01	-.10	-.07	.18	.48**	-			
9.Identified	-.16	-.13	-.06	-.14	-.01	-.15	.68**	.58**	-		
10.Amotivation	-.01	-.14	.09	.13	-.08	.15	-.50**	-.30*	-.49**	-	
11.BMI	.37**	.20	.17	.25	.04	.05	-.10	-.16	-.24	-.17	-

\*\*Correlation is significant at the 0.01 level; \*Correlation is significant at the 0.05 level.

HR: Heart Rate; RPE: Rating Perceived Exertion; BMI: Body Mass Index.

**Table 6:** Correlation analysis between BMI, RPE and motives during the walking test.

	Correlations												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1.RPE-30 sec	-												
2.RPE-5min	.65**	-											
3.RPE-10min	.51**	.85**	-										
4.RPE-15min	.34**	.71**	.85**	-									
5.RPE-20min	.32**	.64**	.74**	.91**	-								
6.RPE-25min	.19	.53**	.56**	.79**	.90**	-							
7.RPE-30min	.22	.48**	.57**	.75**	.86**	.95**	-						
8.External	-.01	.04	-.00	.08	.08	.11	.18	-					
9.Internal	.002	-.11	-.09	-.08	-.15	-.14	-.06	-.25*	-				
10.Introjected	-.26*	-.22^	-.14	-.10	-.12	-.04	.004	.18	.48**	-			
11.Identified	-.13	-.08	-.01	-.02	-.08	-.06	-.06	-.15	.68**	.58**	-		
12.Amotivation	-.12	-.06	-.10	-.13	-.13	-.14	-.19	.15	-.50**	-.30*	-.49**	-	
13.BMI	.40**	.28*	.29*	.24*	.11	.05	.09	.05	-.10	-.16	-.24	-.17	-

\*\*Correlation is significant at the 0.01 level; \*Correlation is significant at the 0.05 level; ^: p value at 0.07  
: Body Mass Index; RPE: Rating Perceived Exertion.



**Table 7:** Correlation analysis between RPE and depression symptoms.

	<b>Correlations</b>									
	1	2	3	4	5	6	7	8	9	10
1.RPE-30sec	-									
2.RPE-5min	.65**	-								
3.RPE-10min	.51**	.85**	-							
4.RPE-15min	.34**	.71**	.85**	-						
5.RPE-20min	.32**	.64**	.74**	.91**	-					
6.RPE-25min	.19	.53**	.56**	.79**	.90**	-				
7.RPE 30min	.22	.48**	.57**	.75**	.86**	.95**	-			
8.HADS-total	.08	.03	.07	<b>.07</b>	<b>.29*</b>	<b>.26*</b>	<b>.22</b>	-		
9.HADS-depression	.04	.04	.11	<b>.10</b>	<b>.24</b>	<b>.19</b>	<b>.20</b>	.83**	-	
10.PHQ-9	.06	-.06	-.02	<b>.03</b>	<b>.25*</b>	<b>.27*</b>	<b>.32*</b>	.77**	.68**	-

\*\*Correlation is significant at the 0.01 level; \*Correlation is significant at the 0.05 level.

RPE: Rating Perceived Exertion; HADS: Hospital Anxiety Depression Questionnaire; PHQ-9 Patient Depression Questionnaire.

## Discussion

The main result that concerned this study was the fact that the perceived exertion, which was evaluated with Borg's scale did not correlate with the participants' HR in any minute of the 30-minute walking test. This lead us to tell that our sample with obese adults with mild depressive symptoms, had an unusual relationship between their perceived exertion from exercise and their body symptoms throughout the walking trial.

More specifically, most of the participants chose numbers from Borg's scale that indicated an effort perception that corresponded to light intensity of exercise while both their HR and the values of the accelerometer devices showed that they participated in a mainly moderate and even sometimes in a vigorous intensity of exercise. The study of Meyer, Koltyn, Stegner, Jim and Cook (2016), that had a sample with adult women who suffered from major depressive disorder, tested with a 30-minute exercise the relationship with participants RPE and HR. Their results showed a clear relationship between these two values (Meyer et al., 2016), something that differs with our results. The randomized controlled trial of Callaghan and his co-authors (2011), who had two exercising groups (exercise with preferred intensity and exercise on prescription), showed in their results that the relationship of perceived exertion and HR was improved in both groups but their differences were not statistically significant. Also, as it comes with the RPE values, the perceived exertion in the active comparator group was higher than the values of the preferred intensity group (Callaghan et al., 2011).

We can take the results from Callaghan and his co-authors (2011) into a consideration since they were the first one that tested the preferred intensity with the prescribed in a sample with depression although it is important to stand also to the results of the secondary analysis which

was made, by Morres and his co-authors (2019). So, the results from the secondary analysis did show a small relationship between the HR and the RPE at the recovery group only, leading the authors to conclude that these results are accurate for a sample that do not receive the necessary treatment to combat depression and who also receives antidepressant treatment twice size than men (WHO, 2017). Morres and his co- authors (2019) came to the conclusion, participants who were recovered from depression trained at higher intensities with lower RPE values comparing to the non-recovered participants who trained in lower intensities of exercise and yet their perceived exertion was higher. It is important to take in our consideration that our sample do experience depressive symptoms and while their HR's are high and their RPE's level low there might be other reasons like the combination of physiological and psychological factors that led to the result of no relationship or even some somatic symptoms that caused pain due to the exercise (Borg, 1998).

Another important result that came up from our study was that the introjected motive from the SDT theory had a relationship with perceived exertion in the begging of the walking trial. While our sample is considered, according to national guidelines from WHO, physically active the relationships that tended to be significant indicate that obese adults, had higher their introjected motive and lower their perceived exertion values at the begging of the 30-minute walk. So, participants' feeling for being guilty about PA participation was associated with lighter PA effort. In general, in the global literature, it has not been adequately evaluated how exercise affects motivation in obese adults with depressive symptoms. The research of Guerin, Fortier and Sweet (2013), selected physically active women to evaluate perceived exertion of PA, with positive effect. Monitoring the women's daily life for two weeks, the results showed that internal motivation and positive affect before PA and RPE values had a positive correlation with the

positive effect after PA (Guerin et al., 2013). Also, only the introjected motive was related to the RPE (Guerin et al., 2013), which is also confirmed by our own research study. The results of the above research have several differences compared to the results of ours, however, one important difference in terms of the structure of the two studies is that our study dealt with people with obesity. Another study that investigated the relation between motives from SDT and exercise showed with its results that the introjected motive had no relationship with exercise (Kwan, Hooper, Magnan, & Bryan, 2011). Although it is important to take into consideration that the sample of the above research (Kwan et al., 2011), was young adults and specifically undergraduate students. Therefore, they did not have daily pressure like a middle-aged person who feels guilty because it is difficult to find enough time to take part in an exercise program or to be more physically active.

Another result that emerged from our research regarding to the relationship between motives and exercise intensity was that only external motive showed at the latter time points of the walking trial that was correlating through non-statistically significant coefficients. More specifically, the more stimulated the feeling of the participant to receive a reward because of exercising, the less he performs moderate intensity and more vigorous. The research of Duncan, Hall, Wilson and Jenny (2010), comes to contradict the results of our study as they showed that the two motives that were mostly correlated with the intensity of exercise were the introjected and the identified ones. However, this particular research chose a very different sample as it comprised young adults who were physically active and mainly intrinsically motivated (Duncan et al., 2010). The systematic review of Teixeira, Carraca, Markland, Silva and Ryan (2012), mentioned that the identified motive is perhaps the one that correlates best with exercise, but pointing out that further investigation should be conducted. On the other hand, Silva's and her

co- assistants (2010), intervention showed that the motive which is a predictive factor of moderate and vigorous exercise is the internal and not the identified motive. Based on the results of the present study, the internal motive did not show any relationship with the exercise intensities, however, further research needs to be carried out.

Obesity and perceived exertion is a subject that is still rowing and new evident are coming up. Our findings confirm that exercise in a moderate intensity was a positive relationship with BMI only in the beginning of the exercise trial. That means that at the begging of any exercise which is moderate intensity, people's perceived exertion is adversely affected by the BMI.

The last result that we should mention is the relationship between perceived exertion and depressive symptoms. As it is mentioned and above our sample, according to the mental health questionnaires was with moderate depression. Our findings showed that perceived exertion had a positive relationship with depression in the last 10 minutes of the walking trial. So as the depressive symptoms began to appear in the individuals, perhaps due to the physical and cognitive fatigue of the last 10 minutes, the RPE values also increased. This lead us to think that maybe exercise for 20 minutes or more is related with depressive symptoms, so maybe shorter bouts of exercise would be more beneficial to the obese adults. It was already mentioned above that the motive that dominated in its relation with the RPE was the introjected. Therefore, it is important to consider whether depressed, obese adults, in their effort to satisfy themselves or society, are leading to a disturbed exertion that is not helping to reduce or eliminate depressive symptoms.

The above results come into conflict with the global literature as many studies have shown that RPE has an anti- depressant role in individuals. Meyer and his colleagues (2016), repost that

30-minute exercise reduced depression to the women who suffered from depression but this result was not influenced by the intensities of exercise. The controlled trial by Callaghan and his colleagues (2011) also reported that when the depressed women chose intensity of exercise by their own their psychological outcomes were improved. This opinion is confirmed by the secondary analysis of Morres and his colleagues (2019), who concluded that preferred intensity of exercise, recorded lower depression values, in women with depression, adding also, that the exertion was not disturbed in patients who had been recovered from depression. This leads us to think that maybe physically active and obese adults who show depressive symptoms, need to choose by their own the intensity they will exercise, so that their exertion can improved and this, in turn, can help reduce depression levels.

## **Limitations and Strengths**

This study was designed to be a descriptive so our findings should be examined more. Also, half of our sample was physically active during their life something that comes in contrast with the literature since the most obese adults tend to have a sedentary lifestyle. Lastly, our study had a small number of participants. By increasing the number of them we could speak more confidence about our results.

This study was, to our best knowledge, the first one which explored perceived exertion during exercise in a public park (pragmatic trial) for obese adults. Moreover, he evaluated PA intensity with multiple measures (accelerometer devices, HR monitors and RPE scale)

## Conclusion

Obese people with mild depressive symptoms show a disturbed perceived exertion. This might be caused by the depression and the wrong motives that dominate during the exercise. Since there was found no relationship with HR and RPE during the walking trial we can say that participants had a disturbed perceived exertion because while they were exercised in a moderate intensity, they were perceiving the exercise effort as light. Due to the fact that depressive symptoms emerged at the last minutes of the exercise we can assume that a shorter duration of exercise might help in the reduction of depression and the introjected motivation. By minimizing the introjected motive which is the one that had an inverse relationship with the RPE we can assume that RPE might be increased, so perceived effort will be moderate. Of course, more research needs to be done in order to speak more confidently about our results, however, the current study give us the impetus to discover more information about exercise, depression and perceived exertion in obese adults.



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