The relationship of perceived physical exertion and anxiety symptoms with the psychological needs from the self-determination theory in obese adults.

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European Master in Sport and Exercise Psychology

Master Thesis

02 November 2023

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Acknowledgments

With the completion of my master thesis, I consider it my duty to express my wholehearted thanks to all those who contributed to the realization of this work.

Firstly, I would like to express my thanks to my patient and supportive supervisor, Dr. Ioannis D. Morres, Assistant Professor at the Department of Nutrition and Dietetics, School of Physical Education Sport Science and Dietetics of the University of Thessaly, who has supported me and made this work possible. I am extremely grateful for his guidance, advice, and valuable knowledge he offered me the last four years and made this project an inspiring experience for me.

I would like to thank Dr. Antonis Hatzigeorgiadis, Professor at the Department of Physical Education and Sport Science, School of Physical Education Sport Science and Dietetics, University of Thessaly, for his support and willingness to provide informative answers to my questions.

I would also like to thank Dr. Charalampos Krommidas, Assistant Professor at the Department of Physical Education and Sport Science, School of Physical Education Sport Science and Dietetics, University of Thessaly, for the technical support he provided me continuously in the research part of this work.

I also thank Yannis Theodorakis, Professor at the Department of Physical Education and Sport Science, Sports Psychology, University of Thessaly, for his valuable help and guidance he provided me during my academic studies.

I sincerely thank all the participants, who helped me with great willingness. I thank them for their positive offer, the trust they showed to me, and the time they spent to

participate in the current study even though their everyday schedule was busy. Without them nothing would be possible.

It would be remiss of me not to say a special thank you to Christina Kalavrou, my bachelor and master's student friend and research colleague over the last six years. I would also like to thank her for her brilliant comments and suggestions.

From the bottom of my heart, I would like to say a big thank to all my friends who have been by my side in this effort by providing unlimited understanding, guidance, and psychological support.

Finally, I would like to wholeheartedly thank my parents and my sister for their unconditional trust and support, material and moral. Thank you for your advice, your patience, and your faith because you always understood. I have experienced your guidance day by day. I'm proud of you.

Contents

Abstract

Obesity is a serious and prevalent disease, often associated with increased depressive and anxiety symptoms. People with negative affective states show indications of disturbed perceived exertion during exercise, such as inaccurate or exaggerated sense of the intensity. Thus, disturbed physical exertion may explain why obese adults show increased dropouts and often no depression relief from moderate intensity exercise. Since psychological needs satisfaction predicts the participation of depressed people in physical activity (PA), this study aimed to examine if: a) obese adults show disturbed perceptual exertion during a moderate intensity walking testing by manifesting no correlation between heart rate and ratings of perceived exertion and b) the psychological needs satisfaction is associated with indications of non-disturbed perceived exertion. Participants were 67 adults with Body Mass Index (BMI) ≥ 30 (BMI: kg/m2), who were assigned to various baseline measures including the objectively measured daily life PA levels through a 7-day accelerometer use, and the completion of psychometrics regarding Basic Psychological Needs Thwarting and anxiety symptoms. After that, they performed a 30-min outdoor park-based exercise testing of moderate intensity walking while the recording of objectively measured exercise intensities, Heart Rate (HR) levels and perceived effort responses were implemented with, respectively, accelerometer devices, strapless HR monitors and the Borg's 6-20 Rating Perceived Exertion scale (RPE). Results showed that participants were severely anxious and showed a physically active lifestyle. Based on the 30-min walking test results, participants exercised at moderate intensity according to HR levels and accelerometer recording while experiencing low, but not moderate, RPE; the RPE did not correlate with HR suggesting disturbed physical exertion for obese adults. Based also on the 30-min walking test results, only the psychological need of competence thwarting was (positively)-related to RPE in total and after the 20th minute. To conclude, the satisfaction of the psychological need of competence for exercise may

contribute to a “normalized” perceived effort sensation and thus a balanced relationship with HR. This contribution may lead to beneficial influences on perceived exertion during exercise and prevent from dropouts. Further research with larger samples is needed.

Keywords: perceived physical exertion, heart rate, accelerometer devices, daily life physical activity, walking test, symptoms of anxiety, psychological needs, obesity, adults

Introduction

Physical activity and benefits

Physical activity (PA) is associated to health benefits that contribute on the prevention and treatment of various diseases and thereby improve quality of life. Caspersen's definition (1985) referred that PA is any skeletal muscle movement of the body that leads to energy expenditure. To begin with, PA positively affects both somatic and psychological health. The review by Reiner, Niermann, Jekauc and Woll (2013) showed that PA was long- termly and positively associated with noncommunicable diseases because PA has negative relationship with cardiovascular heart diseases (CHD), type 2 diabetes mellitus, dementia, Alzheimer's disease and the variables of weight gain and obesity. Another study confirmed the positive somatic and mental health benefits of PA by adding the improved outcomes on cancer, arthritis, sexual dysfunction, lower-back pain, chronic fatigue syndrome, chronic obstructive pulmonary disease, and psychological well-being (Penedo & Dahn, 2005). Regarding to mental well-being, PA can reduce depressive and anxiety symptoms (Stephens, 1988). Even though PA can help in the assurance of physical and mental health, more than 1.4 billion adults worldwide were physically inactive in 2016 (Guthold, Stevens, Riley, & Bull, 2018). At the same year, the percentage of adults who didn't get enough physical activity was 27.5% while in 2010 the same percentage was 23.3% (Sallis et al., 2016).

Obesity: Definition and relationship with PA

Over the last two decades, the prevalence of obesity is increasing with an alarming rate in Western and Westernized countries (Upadhyay, Farr, Perakakis, Ghaly, & Mantzoros, 2018). Obesity is a multifactor disease that is related to the excessively increased concentration of adipose tissue in body as a result of the imbalanced relationship between elevated energy intake and decreased energy expenditure (World Health Organization

[WHO], 2020). Body Mass Index (BMI) is an accepted measure of obesity in healthy and clinical populations. For obese populations, BMI is equal to or greater than 30 kg/m2. Also, obesity was officially recognized as a chronic, serious, and complex noncommunicable health disease (WHO, 2000) that is linked with lots of physical and psychological comorbidities affecting quality of life (Lin et al., 2013). Obesity could be characterized as a pandemic disease as in 2015 almost 604 million adults and a huge number of children (107.7 million) were obese (GBD 2015 Obesity Collaborators, 2017).

The evidence of another study revealed that the prevalence of obese and severe obese populations increased from 2007-2008 to 2015-1016. More specifically, the percentage of obese individuals in 2007-2008 was 33.7% while in 2015-2016 39.6%. The same percentages for severe obese adults were respectively 5.7% in 2007-2008 and 7.7% in 2015-2016 (Hales, Fryar, Carroll, Freedman, & Ogden, 2018). At the same year, in India is estimated to suffer from generalized obesity approximately 135 million people both of rural and urban areas (Pradeepa et al., 2015).

At the same time, there is a multitude of elements supporting that obese individuals don't experience a physically active lifestyle. According to the study of Hussien, Brunet, Romain, Lemelin and Baillot (2022) the majority of adults with severe obesity and BMI ≥ 35 kg/m2 spent their day being sedentary or by participating in just low intensity PA. Another study confirmed the negative relationship between obesity and PA. More specifically, the results of this study revealed that in obese populations the variable of BMI was negatively associated to all the PA intensities (low, moderate, vigorous) and positively related to sedentary time only. That means that the higher the BMI, the lower PA, and the higher sedentary time (Hemmingsson & Ekelund, 2007). In Canada, more than the half of (65%) residents with type I, II or III obesity (65%) live a non-physically active lifestyle because they dont meet the PA guidelines (Bastin, Romain, Marleau, & Baillot, 2019). Another study

with Canadian obese populations found that 84% didn't participate in PA environments as only the 15.9% of obese individuals engage in sufficient PA. At the same time, the majority of them spent approximately 9.9 hours per day on activities that are characterized sedentary (Statistics Canada & Canadian Community Health Survey, 2017).

Obesity and Anxiety Disorders

Obesity is strong contributory factor with negative effect on somatic and mental health. Obesity is linked with functional limitations and potential disability as a significant percentage (40%) of middle-aged adults report practical problems in physical functions (Martin & Schoeni, 2014). A sedentary lifestyle without sufficient doses of PA participation is a cause of obesity as it leads to a positive energy and fat balance by the decreased energy expenditure (Blair & Morris, 2009). Obesity may often be comorbid with various physical and mental health diseases. Some of the widely known physical comorbidities are asthma, osteoarthritis, hypertension, type 2 diabetes, heart disease, cancer, and stroke (Bastin et al., 2019). In addition to the above diseases, obesity often coexists with chronic mental health diseases too. More specifically, the most common mental diseases that are comorbid with obesity are depression, mood, and anxiety disorders (Bastin et al., 2019).

Anxiety is an emotion that protects us from potential threats or helps us to prepare ourselves for future challenges. Anxiety disorders belong to a category of psychological disorders characterized by both psychological and somatic symptoms. Symptoms may include excess worry, hyperarousal, fear, and fatigue, which have a negative and debilitating effect on peoples' mental health and quality of life. Anxiety disorders are classified into: panic disorder, agoraphobia, social phobia, specific phobia, posttraumatic stress disorder, acute stress disorder, separation anxiety disorder and obsessive-compulsive disorder (Simpson, Neria, Lewis-Fernández, & Schneier, 2010). Anxiety disorders are a continuously prevalent mental disease as in 2015 around 3.6% of people reported symptoms of anxiety

disorders globally (WHO, 2017). In 2010, more than 60 million people in European Union faced at least one type of anxiety disorders (Wittchen et al., 2011). In the United States, 40 million adults were diagnosed with an anxiety disorder in 2005. This number is socking as it corresponded to18% of the US adults' population just 18 years ago (Kessler, Chiu, Demler, & Walters, 2005).

Obesity coexists with certain psychological disorders, including anxiety disorders (Simon et al., 2006; Strine et al., 2008a). More specifically, obesity may be a risk factor for anxiety disorders as obese people seem to have increased symptoms of anxiety disorders (Strine et al., 2008a). First, the research of Scott, McGee, Wells and Oakley Browne (2008) showed the strong and positive association between obesity and anxiety disorders in a sample 12.992 adult obese participants. Until 2010, the research findings about the relationship of obesity with anxiety disorders weren't clear. The reason was that from twelve studies which identified the positive association between the variables of obesity and anxiety disorders, five of them showed a positive but non-significant link (Gariepy, Ntika, & Schmitz, 2010). Finally, Gariepy and his colleagues (2010) conducted an extensive meta-analysis including the previous twelve studies and they provided strong and statistically significant confirmations about the comorbidity of obesity with anxiety disorders. The most recently research was a review that summarized the evidence of 21 articles and revealed that obesity and anxiety disorders are closely linked with a positive, moderate relationship (Rajan & Menon, 2017). Accordingly, obesity may result in anxiety disorders and a significant number of obese adults (30.5%) had a diagnosis of anxiety disorders in 2007 in the US (Strine et al., 2008b). It is estimated that this percentage will be much higher after 16 years if we consider the increased prevalence of obesity nowadays. Maybe, the weight-related discrimination and stigma of obese (Cairney, Corna, Veldhuizen, Kurdyak, & Streiner, 2008) or the debilitating influence of obesity on health and quality of life (Sareen, Cox, Clara, & Asmundson, 2005;

Sareen et al., 2006) are some of the reasons that burden to adults with an elevated BMI with stressful symptoms.

Treatment of anxiety disorders and obesity in adults with increased BMI

The literature evidence yielded that obese people are sedentary because they don't adopt physically active lifestyle behaviors. As a result, they suffer from lots of psychological and physical comorbidities, which are linked with obesity and leads to reduced life expectancy. Given the existence of anxiety symptoms in obese populations, it is necessary to find relevant treatments.

To begin with, there are three methods that can be used to manage obesity, and these are the following: lifestyle modifications, bariatric surgery, and pharmacological treatment. Lifestyle interventions are linked with behavioral changes aimed at reducing caloric intake, such as dietary modifications and physical activity. The difficulty with the lifestyle interventions as a method of obesity treatment is the multiple team interaction that is needed to ensure safe, effective, and permanent changes with low possibles of relapse (Polonsky & Klein, 2008). From the other side, bariatric surgery is an effective strategy that leads to continuously weight loss and improvement of obesity-related health diseases, but it is linked to surgical difficulties and mortality and for this reason it is a treatment option for patients with severe obesity (National Institutes of Health, & National Heart Lung and Blood Institute, 1998). The lack of insurance and the risk of surgery in combination with the high cost of operative procedures are reasons that reduce the accessibility of this treatment (Iuzzolino& Kim, 2020).

The last solution for obesity's management is the pharmaceutical therapies. Although the anti-obesity drugs seemed to be efficient, some of them affect negatively obese patients by causing various symptoms with unacceptable risks (Ioannides-Demos, Piccenna, &

McNeil, 2011). Because of that, many drugs are of restricted use or withdrawn from the market. More specifically, four drugs' agents against obesity had the approval for long-term use but just one of them is available in Europe (Kakkar& Dahiya, 2015). These drugs didn't have safe, permanent, and efficient benefits as they were connected to just 8-10% loss of weight among a year with gradually increasing relapse risk (Klein, Wadden, & Sugerman, 2002). The study of Bolen and his colleagues (2010) showed that from 2002 to 2005 the use of anti-obesity medication was low and decreased significantly despite the high numbers of people suffering from obesity then in United States. Given these limitations of the three anti-obesity treatment strategies, it is clear that another treatment option for the management of obesity is important to be examined.

Anxiety disorders are a health disease that negatively contributes on mental health, and it is necessary the population with symptoms of anxiety disorders to receive care and appropriate therapy. In 2001 was conducted a national survey through telephone and more than the two-third of patients with anxiety symptoms didn't receive appropriate treatment (Young, Klap, Sherbourne, & Wells, 2001). In fact, treatment-seeking was limited in the first year of anxiety symptoms development as approximately 48-89% of adults, who suffer from anxiety disorders, didn't seek professional treatment (Wang et al., 2007). A recent qualitative study of Waumans and her coauthors (2022) examined the barriers for non-treatment-seeking in adult patients with a diagnosis of depressive or anxiety disorder. The results revealed that the lack of knowledge about mental health, stigma, negative attitude to the help that can provide a professional, the influence of significant members of social environment and the appointment waiting time were factors that negatively affected their willingness to seek professional treatment against anxiety. Another study added the financial factor because of patients' concerns for the cost of health services (Goetter et al., 2020).

Nowadays, there are two types of efficient treatment strategies for anxiety disorders: cognitive-behavioral psychotherapy (CBT) and pharmacotherapy (Bandelow et al., 2014). CBT is more consistent with cognitive and learning models while pharmacotherapy is based on biological models (Beck, Emery, & Greenberg, 1985). The results of two studies of literature suggested that patients with anxiety disorders refused to participate in treatment research that involved medication or CBT because of their unwillingness to receive pharmacological treatment (Hofmann et al., 1998; Huppert, Franklin, & Foa., 2003). This finding indicated people's negative perceptions against pharmacotherapy and positive attitude towards CBT. At the same time, one more study revealed that the treatment option of CBT was perceived as more favorable and preferred compared to pharmacological treatment for the management of anxiety disorders (Deacon & Abramowitz, 2005). Although Barlow (2004) showed the preference of adults with anxiety disorders to psychotherapy over pharmacological therapies, according to another study these patients are more positive to receive as a treatment psychotropic medication first (Wang et al., 2005). This finding may occur because pharmacological treatments of anxiety disorders are more available and efficient than psychotherapy services. More specifically, a meta-analysis focusing on the efficacy of medication and CBT showed that the effects of pharmacological therapies were higher than CBT on the treatment of anxiety disorders (Bandelow et al., 2015). On the other hand, medications for anxiety disorders seemed to be linked with negative health consequences. More specifically, 30-50% of patients using the selective serotonin reuptake inhibitors (SSRIs) drug experienced various difficulties, including nausea, diarrhea, headache, insomnia, jitteriness, restlessness and decreased sexual interest or satisfaction (Farach etal., 2012. Also, one more drawback of the anxiolytic drugs are the possibilities of non-response to treatment because of insufficient dose or duration of the drug use and poor engagement (Farach et al., 2012). Maybe all of these findings explain why 23% of the

patients in a study on the management of major depressive disorder discontinued their drug therapy within the first six months of the treatment (Warden et al., 2009).

Taking the aforementioned evidence into consideration, the contribution of pharmacological treatment to the improvement of mental disorders symptoms was low. Some factors negatively associated with poor patient adherence to medication therapy were stigma or negative attitudes about the medication due to perceived harmful effects (Aikens, Nease, Nau, Klinkman, & Schwenk, 2005; Warden et al., 2009). Considering that both psychotherapy and medication therapies present many limitations, it is alarming that between one-third and one-half of patients remained untreated for their anxiety symptoms (Pollack et al., 2008). To this extend, it is clear that the main/classical treatments of obesity and anxiety disorders are associated with many limitations and therefore they are unable to improve these important health diseases. Perhaps, studies directions should focus on other treatment options that could minimize anxiety symptoms in obese adults, reducing the aggravation of these two comorbidities.

Exercise as treatment of anxiety disorders in obese adults

Exercise is linked with many changes in multiple body systems and positively affects the health status and well-being of modern communities. In particular, exercise doesn't have the same meaning as PA because exercise is a subset of the category of PA, but it is planned, structured and repetitive and aims to maintain or improve physical condition (Caspersen et al., 1985). Exercise has many benefits on physical and mental health by contributing the prevention and treatment of cardiovascular diseases, osteoarthritis, blood pressure, obesity, diabetes, dyslipidemia, cancer, depression, mood, and anxiety disorders (Kramer, 2020). Since exercise has all these positive effects on the physical and mental diseases that are comorbid with obesity, some studies supported that exercise could be recommended as a possible lifestyle intervention for the treatment of obesity and the related health diseases,

including anxiety disorders. More specifically, the meta-analysis of Lee and Lee (2021) showed the effective contribution of exercise to obesity treatment as the majority of overweight and obese subjects that participated in moderate to vigorous intensity exercise interventions noted weight loss, decreased BMI, and reduced visceral fat without changes in lean body mass. On the impact of exercise on anxiety disorders, a meta-analysis provided evidence supporting that exercise is a facilitating intervention for patients with anxiety disorders as it recorded small to moderate effects on participants' anxiety symptoms (Ramos-Sanchez et al., 2021).

This encouraging evidence for the contribution of exercise to the management of obesity and anxiety combined with the limitations of previously documented anti-anxiety and anti-obesity strategies lead to consider whether exercise could be an alternative anxiolytic treatment option of populations with elevated BMI. Henriksson and his colleagues (2022) designed a randomized controlled clinical intervention study for 286 participants with mean BMI equal to 27 kg/m2 and diagnosed symptoms of anxiety disorders. Participants were randomly divided into three groups: the cardiorespiratory exercise group, the resistance training group, and the control group. The results of this study revealed that the patients who participated in both cardiorespiratory and resistance training group decreased their anxiety and depressive symptoms. In fact, the training intensity was an important factor as the patients' anxiety symptoms decreased more after a moderate to vigorous intensity training than a low intensity training.

Another study examined the effects of a yoga training intervention on anxiety and depressive symptoms of 272 obese subjects (Dhananjai, Tiwari, Dutt, & Kumar, 2013). In this study, the participants were assigned to two groups, the intervention group that focused on yoga practice and the control group assigned to aerobic exercise. The results confirmed the positive contribution of exercise on anxiety symptoms of obese individuals as both the

aerobic training as the yoga were capable of decreasing participants' BMI, anxiety, and depressive symptoms. However, at the end of a 6-month- exercise intervention, obese participants of yoga group decreased their weight, BMI, anxiety, and depression levels approximately 2 times more than the participants of aerobic group. This evidence supported the impact of yoga on the improvement of physiological parameters, such as BMI or weight management, or psychological variables, such as anxiety and depressive symptoms in participants with obesity.

Three years later, the study of Vancini, Rayes, Lira, Sarro, & Andrade (2017) confirmed that exercise positively affects anxiety symptoms in obese adults by using pilates and walking as the exercise intervention strategies. More specifically, the participants of Pilates training reduced their trait and state anxiety symptoms by 15.1% and 18.5%, respectively, while the participants of walking group improved the levels of trait anxiety at 14.1%. One more recent study demonstrated useful results for the exercise benefits on the anxiety levels of adults with severe obesity (Annesi, 2022). In particular, at the end of 6-months- exercise intervention, the exercise-related variables were improved to the majority of the participants. This improvement was linked to minimized depressive and anxiety symptoms in severe obese subjects as the exercise commitment was a significant predictor of decreased anxiety and depressive levels.

Finally, a meta-analysis, which included randomized controlled trials, showed controversial results regarding the effects of exercise interventions on obese' anxiety symptoms (Carraça et al., 2021). From the three studies, the two that were based on aerobic-only or resistance-only training didn't demonstrate statistically significant effects on the anxiety levels of patients with elevated BMI. Although there is scarce research on the effects of exercise on anxiety symptoms in obese adults, the majority of the previous studies showed that exercise may be a beneficial tool for minimizing the anxiety levels in obese populations.

So, exercise on prescription could be an alternative strategy with helpful impact on the improvement of anxiety symptoms in adults with obesity. However, literature findings stated that obese' adherence to exercise programs was low as many subjects dropped out. More specifically, a review of eight studies stated that the percentage of obese patients' non-adherence to interventions that combined structured exercise with dietary modifications was significantly high. In fact, 96 from the 310 women obese participants dropped out from the intervention and this amount corresponded to 31% of the total (Mutsaerts, Kuchenbecker, Mol, Land, & Hoek, 2013). Also, two early studies demonstrated that the increased body weight, BMI, and percentage of body fat were significant negative predictors of non-compliance and dropout in a 20-week exercise program (Dishman & Gettman, 1980; Dishman, Ickes, & Morgan, 1980). Additionally, one more important limiting factor of prescribed exercise adherence of obese was the duration of exercise interventions. For example, 24% of the 123 mildly to moderate obese adults dropped out from a 26-week exercise intervention (Peri et al., 1998) while this percent increased at 40% during a randomized controlled exercise program of 32 weeks (Slentz et al., 2004). The percentage of overweight or obese participants that dropped out from an exercise intervention was more than 50% when the programs lasted longer, such as over 16-18 months (Jacobsen, Donnelly, Snyder-Heelan, & Livingston, 2003; Donnelly et al., 2003). Inadequate participation and non-compliance of obese patients in prescribed exercise programs was a major reason for reducing the effectiveness of this therapeutic strategy. The most commonly reported barriers to obesity nonparticipation in lifestyle interventions, including exercise programs, were the lack of motivation, time or knowledge, the pressure of social environment, the health and physical difficulties that are related to pain or coexistence of chronic illness, the negative thoughts or expectations and the low levels of enjoyment during exercise sessions (Burgess, Hassmén, & Pumpa, 2017).

PA as treatment strategy of anxiety disorders in obese adults

Reporting these limitations for participation in exercise, it is clear that exercise couldn't be a widely accepted anxiolytic treatment strategy for obese populations. However, daily life PA, which is associated with an unstructured environment and non-planned behaviors, could be a positive contributor to the reduction of anxiety symptoms in obese adults. PA could be considered as a modern preventable and treatment method for various non-communicable health diseases because of its positive impact on peoples' somatic and mental health status. In particular, PA is linked with lower risk of mortality due to any cause, prevent and management of hypertension, cardiovascular disease, all types of cancer and type-2 diabetes. Also, PA is linked with better sleep and cognitive health, lower levels of mental diseases, reduced sedentary levels and as turn lower body fat and decreased obesity levels (World Health Organization, 2021). Because of these positive health benefits, PA is often recommended as a safe, effective, and necessary daily life strategy that improves quality of life and well-being. First of all, WHO (2021) guidelines recommended at least 150 minutes per week of moderate-intensity aerobic PA or 75 minutes of vigorous intensity aerobic PA per week for obese populations aged 18-64 years old. These recommendations are consistent with PA guidelines from the 2020 American Cancer Society (ACS), American Heart Association and American Diabetes Association for the prevention of cancer, coronary heart disease and diabetes, respectively (Mozaffarian et al., 2012; Rock et al., 2020). Also, Tudor-Locke and his coauthors (2011) showed that a good recommendation for adopting a physically active lifestyle is to walk around 10.000 steps per day. According to the mental health, the study of Schuch and his colleagues (2018) revealed that a dose of 150 minutes of moderate to vigorous PA weekly was enough to decrease the risk of depression at 22%.

However, there is scarce literature evidence that demonstrate the anxiolytic role of PA in obese adults. To begin with, Purnomo, Doewes, Suroto, Murti and Giri (2019) confirmed

the positive effect of brisk walking on the reduced anxiety symptoms in adults with central obesity in Bali. The 80 obese participants were divided into 4 groups: the brisk walking group, the relaxation group, the combination group that involved both brisk walking and relaxation techniques and the control group. The results revealed that the participants of all the groups decreased their anxiety symptoms but the most effective group in lowering the anxiety levels in obese subjects was the combination of brisk walking and relaxation. So, this recent study proved the significant role of brisk walking intervention -alone or combined- on obese' decreased levels of anxiety. Another study examined the effect of walking as a PA intervention on the psychological and health-related variables of obese individuals (Castres, Tourny, Lemaître, & Coquart, 2017). More specifically, 35 obese adults participated in this 6-month walking intervention that aimed to walk 10.000 steps daily. After the intervention, all the body composition variables, including BMI, decreased and anxiety levels also significantly improved, decreasing by approximately 11.9%.

On the other side, a part of literature research mentions that PA is a behavioral strategy with no or small effects on decreasing the anxiety symptoms in individuals with elevated BMI. More specifically, a cross-sectional study for young, overweight to obese student nurses examined if PA is a significant contributor to better mental health (Hawker, 2012). The two variables reflecting mental health, anxiety, and depression, didn't have a statistically significant relationship with the PA variables, including total PA/ week, vigorous intensity PA/ week, and moderate intensity PA/week. Also, the results of regression analysis demonstrated that PA and BMI together were predictors of just 2% and 4% for anxiety and depression variance, respectively. Additionally, Banting, Gibson-Helm, Polman, Teede and Stepto (2014) investigated the role of PA on anxiety and depression levels in young women with or without Polycystic Ovary Syndrome and with BMI of 29.23. The results of this study reported that the relationship between PA and anxiety symptoms was non-significant and as a

result the positive influence of PA on lowering the anxiety levels in populations with increased BMI wasn't supported. Although, there is evidence demonstrated that PA isn't an intervention that can decrease the anxiety in obese subjects, the majority of the most recent studies of literature confirmed that PA is an effective anxiolytic method.

The overwhelming positive impact of PA on anxiety symptoms of obese populations could be considered as an encouraging solution for the treatment of mental disorders that are comorbid with obesity. Nevertheless, a big number of obese adults with or without anxiety symptoms tend to adopt an inactive lifestyle with low adherence to PA. In particular, a review referred to adults that did a bariatric surgery as obesity treatment, demonstrated that PA levels among these patients were disappointing (Hood et al., 2016). Before the surgery, the number of obese subjects that didn't meet the recommended PA guidelines was 39% while post-surgery, the rate of PA non-compliance was between 51-70%. At the same time, another study of 32 overweight to obese adults aimed to objectively measure PA levels in order to examine its relationship with participants' anxiety sensitivity (Hearon, Quatromoni, Mascoop, & Otto, 2014). The results of this study revealed that obese adults with increased anxiety sensitivity were less physically active as they participated in lower levels of moderate intensity PA compared to obese participants with low anxiety sensitivity. These findings suggest that adopting adequate PA levels is particularly difficult for obese individuals and may be because they experience less pleasure and higher levels of exertion-related symptoms during PA (Ekkekakis & Lind, 2006).

Perceived Exertion

Some literature findings revealed that perceived exertion may be a significant inhibitory factor for PA engagement in obese individuals. To begin with, perceived exertion is a variable that quantifies the subjective sense of intensity of a stimulus during exercise or PA. More specifically, perceived exertion helps an individual better understand and monitor

his/her intensity of effort, strain, discomfort, or fatigue that are experienced during PA participation (Robertson, & Noble, 1997). A tool that is recognized as a subjective psychophysical marker of the intensity during exercise and PA is the 6-20 Rating of Perceived Exertion (RPE) scale. In the early 1960's, the Swedish researcher Gunnar Borg first developed a preliminary version of the RPE scale. The RPE evaluates, and measures subject's effort, breathless and fatigue during physical work (Borg, 1982; 1998). It estimates how hard someone feels that his body is working, combining all sensations and feelings of physical stress and fatigue, including increased heart rate, increased sweating and muscle fatigue or increased breathing rate (Borg, 1998). Additionally, the scaling from "6" to "20"and not from "0" to "20" is due to the high relationship between a person's perceived exertion rating with actual heart rate (HR), which is also an indicator of physical effort and fatigue during PA. In particular, the minimum Borg scale's intensity of "6" corresponds to an HR of 60 beats/min and the maximum RPE intensity of "20" corresponds to an HR of 200 beats/min. Otherwise, on a Borg scale with scores from "0" to "20", this correlation between the "objective" variable of HR and subjective index of RPE wouldn't be statistically significant and reliable as an intensity of "0" would correspond to an HR of 0 beats/min (Borg, 1998). Interpreting the Borg scale, the higher the RPE ratings, the higher the physiological stress and fatigue.

There is scarce literature evidence regarding the way obese adults perceive the intensity of exercise. In particular, Jakicic, Donnelly, Pronk, Jawad and Jacobsen (1995) conducted a 12-week exercise and weight loss intervention program with 122 obese females in order to examine if the objective variables, heart rate reserve (HRR) and oxygen uptake (VO2), are associated with the RPE, the only subjective index of physiological stress. The results of this study revealed that there was a relationship between HRR, VO2 and RPE in obese populations, as the 70% of HRR and VO2 corresponded to a score of 13-14 in the RPE

scale. Also, this study supported that RPE could be used as a reliable subjective index of exercise intensity in women with obesity. Also, the study of Borg (1998) demonstrated that RPE shows a positive, moderate to high, linear relationship with HR values across various populations. More specifically, the higher the ratings of RPE, the higher the values of HR and vice versa. The previous results conflicted with more recent research findings on how the perceived exertion is affected in obese individuals. More specifically, an interventional study for overweight and normal weight participants examined whether there were differences in levels of HR, VO2, RPE and pleasure due to BMI during a 20-min prescribed or self-selected treadmill exercise (Ekkekakis & Lind, 2006). The findings showed that the BMI affected the perceived exertion ratings because the overweight female group reported higher VO2 and RPE vs. the normal-weight group during the prescribed and self-determined exercise interventions. Additionally, a meta-analysis confirmed the negative influence of BMI on the relationship of actual exercise intensity and perceived exertion (Yu, Sun, Sun, Chen, & Tan, 2021). More specifically, in overweight and obese subjects the RPE scores during a standard intensity exercise intervention were higher than in normal weight subjects. However, this difference wasn't statistically significant. According to these findings overweight and obese populations vs. normal weight people perceive their exertion as higher and more difficult because they overestimate the actual exercise intensity.

Because there is an unbalanced relationship between perceived exertion and actual/subjective PA intensity in overweight and obese adults, it is important to examine if the presence of anxiety symptoms in adults influences this relationship and as turn the PA adherence. To begin with, a submaximal aerobic walk test was performed by 157 adult smokers to examine whether anxiety sensitivity had impact on RPE and HR (Farris et al., 2017). This study demonstrated that participants with higher levels of anxiety sensitivity overestimated their effort compared to those with lower levels of anxiety sensitivity. During

the test, the participants with elevated anxiety sensitivity perceived the intensity of exercise stimulus as more difficult. Also, these participants stabilized the ratings of RPE and HR during the last minutes of the test while the subjects with lower anxiety sensitivity symptoms stabilized these variables earlier. According to another study by Morgan (1973), the majority (90%) of participants accurately sensed the intensity of exercise, but 10% wasn't capable of accurately perceiving the stimulus intensity; this 10% was diagnosed with anxiety, depressive or neurotic symptoms. According to this finding, the higher the anxiety and neurotic symptoms in subjects, the more inaccurate the perceived effort. Morgan (1994) also added that the anxious, depressive, and neurotic populations may be more likely to experience higher perceptual ratings. From these two evidence, it is clear that anxious, depressive, and neurotic subjects tend to either overestimate or underestimate exercise intensity demonstrating indications of disturbed perceived exertion. One more study supported evidence that individuals with mental disorders experience exaggerated sense of the intensity during exercise. More specifically, a group of mentally retarded young male subjects and a group of young male subjects with psychiatric symptoms performed a bicycle ergometer test recording the HR and RPE values (Borg, Freeman, Egerman, & Gust, 1969; Borg, 1970). The findings revealed that these two mentally diagnosed groups collectively reported 15% lower physical work capacity than a group of young students at University of Pittsburgh and 40% lower workload than two groups of student athletes of State College in Pennsylvania (Skinner, Borg, & Buskirk, 1969). In comparisons with a group of young but heavy sedentary students at State College, the physical capacity of the young psychiatric patients was 30% less while at the same time the sense of perceptual intensity was significantly higher than in all the other comparative non-psychiatric young student groups. The inaccurate sense of subjective exertion in patients with depression was also supported by Morres, Hinton-Bayre, Motakis, Carter and Callaghan (2019). In this study, 43 depressed middle-aged women

participated in a 4-week walking intervention. These participants were divided into two groups: the experimental group that could choose preferred intensity training and the control group that followed the instruction of prescribed intensity training. Individualized improvements in depression (recovery from depression) were found more often in the preferred intensity group (32% of the patients) than the prescribed intensity group (5% of the patients). Regarding perceived exertion and HR rates, all the participants recorded RPE scores between 6-11 that reflect low intensity exercise while the HR rates reflected moderate intensity exercise. The recovered group showed a small, positive, statistically significant relationship between the RPE and HR. On the other hand, the non-recovered from depression group showed a non-statistically significant, negative, and almost zero relationship (-.05) between the actual HR and the subjective ratings of exertion. This study concluded that maybe the disturbed perceived physical exertion is a cause of non-relief from depression in depressed subjects who participated in moderate intensity intervention. To this extent, the identification of predictors of perceived exertion among vulnerable populations appears to be essential.

However, the literature findings that examine perceived exertion in individuals with both obesity and anxiety symptoms are a few. More specifically, obese individuals tend to experience higher levels of negative affective states than the normal weight people during exercise and this was a reason of non-adherence and low attendance in prescribed exercise (Ekkekakis, & Lind, 2006; Williams et al., 2008). At the same time, subjects with increased levels of anxiety sensitivity report higher levels of distress and other symptoms such as increased HR, sweating and breathless during their sedentary lifestyle that are similar to these symptoms that experience during exercise (Reiss, 1985). In particular, anxiety sensitivity may often appear in people that experience fear in response to exertion and anxiety related somatic symptoms (Reiss, 1985). Because during participation in moderate to vigorous

exercise the bodily sensations and exertion are higher, the participants with elevated symptoms of anxiety sensitivity perceived these symptoms as more distressing and negative. Perhaps this is a factor that turns them away from long-term exercise adherence. Additionally, obese, and overweight adults experience greater physical and exertion-related difficulties due to symptoms of dyspnea or musculoskeletal pain (Hulens, Vansant, Claessens, Lysens, & Muls, 2003). Also, obese subjects with higher levels of anxiety sensitivity experienced greater fear levels of arousal sensations and exertion during exercise because of discomfort and distress (Smits, Tart, Presnell, Rosenfield, & Otto, 2010). To the author's best knowledge, this is the only research that applied in obese adults with anxiety symptoms and confirmed that perceived exertion is higher in obese with anxiety sensitivity, and this is a possible reason of less commitment in PA and exercise environments.

Self-Determination Theory (SDT)

The low levels of adherence in PA and exercise environments, led the researchers to focused on motivation theories to direct clinical and non-clinical populations in healthy behaviors, such as the adaptation of daily PA. The Self-Determination theory is a commonly used motivational tool that approaches human motivation and more specifically the quality and type of motives, which are associated with the individual's behavior (Deci and Ryan, 1985; 2017). Motivation is defined the total number of psychological factors that push an individual to accomplish a specific and intended aim (Ryan & Deci, 2000). Motivation is divided in three different types: intrinsic motivation, extrinsic motivation and amotivation. Intrinsic motivation is connected with behaviors through which the individual derives joy and pleasure while extrinsic motivation is related with behaviors the ultimate goal of which is to achieve an outcome, which is independent of the activity itself (Deci & Ryan, 1985). Amotivation is when the person is not motivated or intended to engage in an activity. The intrinsic motivation ranks at the top of self-determination theory because of the degree of

autonomy and self-regulation of behavior, as the individual's participation in activities comes from the individual itself and reflects only personal goals.

The theory of three psychological needs was developed from Deci and Ryan (1895, 2017) in order to push an individual in higher levels of intrinsic motivation. The three basic psychological needs that have to be satisfied during PA in order to intrinsically motivate an individual to the maximum level are autonomy, competence, and relatedness. To begin with, autonomy is the individual's desire to have the ability to control, regulate and choose his behavior and actions. The individual must feel responsible for his decisions and behaviors, and this can be achieved by creating a climate that provides choices, positive feedback, initiative, and self-selection (Morres, Stathi, Martinsen, & Sorensen, 2014). Competence is the second psychological need and refers to the individual's need to feel that he is capable, sufficient, and effective in achieving his goals. To satisfy this need it is good to create an environment that avoids criticizing the individual and providing rewards and external incentives (Morres et al., 2014). Finally, relatedness is the need for association with others, which is connected to the feeling of belonging. More specifically, the third psychological need of relatedness refers to the human need for social interaction, creating relationships with those around him and feeling socially accepted (Ryan & Deci, 2000). The more the three psychological needs are satisfied, the more the individual become intrinsic motivated and as turn the more the individual is committed with his chosen behavior (Deci & Ryan, 1985; Ryan & Deci, 2017). The combination of intrinsic motivation and the psychological needs' satisfaction is the most effective and long-term type of motive for PA participation according to SDT, as the personal desire and joy is the basic cause of adherence to this behavior (Ryan & Deci, 2000).

Taking account of the previous literature evidence, the aim of this study is to investigate in obese adults with anxiety symptoms if they showed disturbed perceived

exertion during a submaximal walking test by indicating no correlation between heart rate and ratings of perceived exertion. Also, it was examined if the satisfaction of the three basic psychological needs of SDT was associated with non-disturbed perceived exertion.

Methods

Participants

In this descriptive study participants were obese adults. The inclusion criteria were the following: (a) men, or women, aged 18-65 years old, (b) obese with BMI ≥ 30 kg/m2, (c) with ambulatory ability, (d) with knowledge and of the Greek language. The total sample was consisted of 67 obese participants that met the eligibility criteria.

Participation in this study was voluntary and recruitment took place through advertising material on social media platforms and by word of mouth. This study was conducted according to the ethical guidelines and was approved by the Internal Ethics Committee of the Department of Physical Education and Sport Science of University of Thessaly.

Study design/ Procedure

The process of informing the interested participants was based on steps that will be presented below in chronological order. To begin with, a study consent form was given to all prospective participants in order to participate in this study. The written consent form informed the participants that participation in the study was anonymous and that had the right to cancel their participation at any time even after their first positive response to participate in this study. In the consent form, there were, also, extensive information about the aim of the study, the participation process, the publication of the data, the potential risks, and inconveniences as well as the expected benefits from participating in this research. Regarding the study process, the prospective participants were informed for the accelerometer device that they were going to wear. The participants were asked to wear the device for 7 consecutive days (except from sleep/bath hours), at the height of the right hip without any change in their usual lifestyle. Also, it was pointed out that the participants didn't have any legal responsibility in case of possible loss or damage of the accelerometer device. After

relevant questions were answered, if participants agreed with the consent form, they signed the relevant consent form. After that, the accelerometer device was given to them for a 7-days use. Immediately after the end of the accelerometer use (day-7), an appointment with the participant was arranged in order to return accelerometer device and to complete the questionnaires and walking test. The meeting with the participant took place at stable and predetermined athletic parks which were convenient for the participant's location/municipality/village. All parks met specific requirements/criteria to avoid the impact of confounding variables on our measures. To note with, only half of the participants worn the accelerometer device for 7 days in order to objectively measure the daily life PA levels. Participants were randomly assigned with a 1:1 way to the group of 7-days use of accelerometer device plus walking test or the group of walking test only. The researcher of this study wasn't blind to the process of participant allocation.

During the meeting where the measures were administrated, all the participants, regardless the group allocation, completed the State Trait Anxiety Inventory (STAI) (Spielberger, Gorsuch, & Lushene, 1968) and the Hospital Anxiety and Depression Scale (HADS) that assess symptoms of anxiety. Self-report questionnaires recorded SDT psychological needs for PA (Vlachopoulos & Michailidou, 2006), whereas self-reported PA were assessed through the International Physical Activity Questionnaire (IPAQ). The time required to be completed all the questionnaires was approximately 25-30 minutes. After that all participants performed a 30-minute moderate intensity walking test with recording of Heart Rate (HR), perceived effort of walking, and intensity of walking by using, respectively, wrist worn HR monitors, the Borg's 6-20 Rating Perceived Exertion scale (RPE) (Borg, 1998) and a waist-worn accelerometer device. More specifically, before the beginning of walking test, participants worn the accelerometer device at the height of the right hip and the HR monitor at the left wrist.

After that, the Borg's 6-20 scale was demonstrated to participants to read carefully. It was explained that during the 30-min walking test, every 5 minutes the participant would be asked to give his/her HR levels and to report how difficult the effort during the walking test was perceived based on the Borg scale by showing the specific number that reflected the subjective sense of effort. The intensity of walking test was moderate meaning that the participant will not pant. In case the participants would feel tired or any other difficulty or discomfort, they could stop their participation immediately. All the Borg's 6-20 and HR measures during the walking test were taken at the following time-points: 30 seconds, 5 minutes, 10 minutes, 15 minutes, 20 minutes, 25 minutes, and 30 minutes. The participants were informed that the first 5 minutes of the walking test they could walk in a light intensity as it was pre-determined as a warm-up. After that, they were prompted to increase their intensity to moderate levels (approximately at 64-75% of HRmax) according to the age predicted maximal heart rate (APMHR) using the equation HRmax = 220-Age. If it was difficult to participant to complete the 30-min walking test in moderate intensity, it was possible to keep the intensity that made the participant feel comfortable.

Measures

State – Trait Anxiety Inventory (STAI)

The State – Trait Anxiety Inventory (STAI) (Spielberger, Gorsuch, & Lushene, 1968) is a self-reported questionnaire that assesses the symptoms of anxiety for the last seven days. The STAI questionnaire was developed by Spielberger in 1970 and it is one of the most often used and valid tools for the measurement and assessment of anxiety symptoms. The STAI questionnaire consists of two different subscales. The first one subscale (state anxiety) assesses the occasional anxiety that comes from the emotional state of the participant at the time of completing the questionnaire. On the other hand, the second subscale (trait anxiety) evaluates anxiety as a characteristic of the person's personality, reflecting the general context

of their daily life. STAI is consisted of 40 items in total from which 20 items assess trait anxiety and 20 assess state anxiety. In particular, the 20 items of state anxiety subscale evaluate how the participant feels "at this moment" whereas the remaining 20 items of trait anxiety subscale measures "how the participant feels in general" and more specifically in a period of 7 days. For example, state anxiety items include statements such as: “I am tense; I am worried” and “I feel calm; I feel secure.” While trait anxiety items include statements such as: “I worry too much over something that really doesn’t matter” and “I am content; I am a steady person.” The assessment of the intensity of anxiety symptoms was carried out through a four-point Likert scale (1-2-3-4), where 1 = 'not at all' and 4 = 'very much'. Specific findings on both subscales are reverse scored. The total score can range from 20 to 80 (Spielberger, Gorsuch, LusheneVagg, & Jacobs, 1983), with higher scores indicating greater anxiety symptom severity. The total score for both the STAI-state and STAI-trait subscales ranges from 20 to 80. In particular, scores from 20 to 37 characterized/classified as “no or low anxiety”, from 38 to 44 as “moderate anxiety” and from 45 to 80 as “high anxiety” (Spielberger, 1980).

Hospital Anxiety and Depression Scale (HADS)

The Hospital Anxiety and Depression Scale (HADS) is a questionnaire that developed by Zigmond and Snaith (1983) and measures the level of anxiety and depressive symptoms HADS is a valid self-reported scale that can evaluate the severity of depressive and anxiety symptoms in both clinical and general/healthy populations (Bjelland, Dahl, Haug, & Neckelmann, 2002). It consists of 14 items, from which 7 items are corresponded to anxiety subscale (HADS-A) and 7 items to depression subscale (HADS-D). The assessment of the intensity of anxiety and depressive symptoms was carried out through a four-point Likert scale of 0 to 3. The maximum score is 21 for anxiety and depression subscale of HADS. In particular, scores from 0 to 7 classified as “normal”, from 8 to 10 as “mild”, from 11 to 15 as

"moderate", and from 16 to 21 as "severe". Higher score in this scale indicates higher level of anxiety or depression.

Generalized Anxiety Disorder (GAD-7)

The Generalized Anxiety Disorder (GAD-7) questionnaire is a self-reported tool that consists of seven items that aim to evaluate patient's anxiety status during the previous 2 weeks (Spitzer, Kroenke, Williams, & Löwe, 2006). This questionnaire is valid for use in primary care (Ruizet al., 2011) and in healthy patients (Löwe et al., 2008). GAD-7 assesses the degree to which the patient has been felt nervous, anxious, worried, afraid, annoyed, or irritable of different situations and causes. The assessment of intensity and frequency of experiencing anxiety symptoms became through a four-point Likert scale of 0 to 3, where 0 = "not at all" and 3 = "nearly every day". The total range can range from 0 to 21, with higher scores representing greater anxiety symptom severity. Scores from 0 to 4 classified as "normal", from 5 to 9 as "mild", from 10 to 14 as "moderate", and from 15 to 21 as "severe". More specifically, the cut-off point is ≥ 10 indicating clinical importance of the symptom severity of anxiety.

Psychological Needs Thwarting

The three basic psychological needs of the Self-Determination Theory (SDT) during PA were evaluated with a self-reported modified questionnaire (Vlachopoulos & Michailidou, 2006) that is called Psychological Need Satisfaction in Physical Activity Scale (PNSE-PA). More specifically, the modified PNSE-PA focuses on the three psychological needs during the participation in PA environments in contrast with the original Psychological Need Thwarting Scale (PNTS) that is used to measure the degree of frustration of psychological needs that athletes feel while participating in sports or exercising. The need of integration of the PA variable was the reason that PNTS modified into the form of PNSE-PA. The specific questionnaire is a tool for evaluating the degree of frustration of the

psychological needs that people feel during their participation in the PA. The rating scale was from 1 (strongly disagree) to 5 (strongly agree) for each question, meaning that the higher scores the more frustration of basic psychological needs. The specific questionnaire regarding its internal structure is satisfactory constructed (Bartholomew Ntoumanis, Ryan, & Thøgersen-Ntoumani, 2011).

International Physical Activity Questionnaire (IPAQ)

The International Physical Activity Questionnaire (IPAQ) is a common and practical tool, which was developed in the late 1990s in order to measure and evaluate the daily lifestyle PA and sedentary levels in adult populations with age from 18-65 years old (Craig et al., 2003). More specifically, there are four long and four short questionnaire versions, which are consisted of 31 items and 9 items, respectively. All the versions can be self-administered and self-reported and they focus on the daily life PA during the last seven days or the "usual week". The IPAQ short form measures the time spent walking, sitting, and in vigorous and moderate intensity PA during the last seven days. The short-form IPAQ demonstrated good reliability and validity results and might be more preferred and widely used because of its feasibility properties (Craig et al., 2003).

Accelerometer device

The accelerometer device used in this study is a small (3.8cm x 3.7cm x 1.8cm), light (27gr) and triaxal motion sensor. This device has an elastic strap and works with a watch battery and for this reason doesn't carry radiation. Also, it is hypoallergenic and unbreakable in case of drop or pressured by weight. More specifically, the accelerometer device has the ability to record and quantify body movement and immobility through vibration. Relevant quantification refers to sedentary time, and PA levels corresponding to light, moderate, and vigorous intensity PA. The participants that randomly allocated to the group of 7-days use of accelerometer device plus walking test, wore this device for 7 consecutive days, excluding

sleeping and bathing hours, at the height of the right hip while were instructed not to change anything behaviorally from their usual lifestyle. The accelerometer device was required to be worn for ≥ 8 hours per day for at least 3 days (Miller et al., 2013; Trost, McIver, & Pate, 2005) in order to be considered that data of accelerometer device were reliable. Also, all the participants, regardless the group allocation, worn the accelerometer device for 30 minutes during the moderate intensity walking test.

Heart Rate (HR)

Heart rate is a commonly used indicator of PA intensity as it assesses cardiovascular and physiological responses during PA participation. During the 30-minute moderate intensity walking test, HR was measured with HR monitors (POLAR IGNITE WR 30M), which were worn at the left wrist of each participant. The desired intensity was moderate and for this reason the range of HR was proposed/calculated to be at 64-75% of HRmax, using the equation HRmax = 220-Age.

Borg Scale

The Borg's 6-20 Rating of Perceived Exertion (RPE) scale is a marker that monitors and measures subject's perceived effort and exertion during PA participation (Borg, 1982; 1998). The minimum Borg scale's score of "6" refers to "extremely light" intensity and corresponds to an HR of 60 beats/min whereas the maximum RPE score of "20" refers to "extremely hard" intensity and corresponds to an HR of 200 beats/min. The scoring reflects that the higher the RPE ratings, the higher the physical responses (Borg, 1998). Every 5 minutes till the end of the 30-minute walking test, each participant had to answer to the question "How difficult the walking test is?" by pointing out a number from 6 to 20 that represented the perceived sense of effort.

Statistical Analysis

The analysis of the data were carried out at the Exercise Psychology and Quality of Life Laboratory of the Department of Physical Education and Sports Science of the University of Thessaly. The procedure of extracting, processing, and analyzing the collected data, drawn from the accelerometer devices, was carried out with the software program ActiLife version (6.5.2). All remaining data of this study were entered and analyzed using the Statistical Package for the Social Sciences (SPSS-22).

Regarding the descriptive statistics, it was calculated the mean and standard deviation (SD) of the following variables: age of participants, BMI, kilocalories (kcals), steps, sedentary time and light, moderate and vigorous intensity of PA during the 7 days of accelerometer device use, state anxiety (STAI-state), trait anxiety (STAI- trait), total anxiety (STAI-total), HADS-anxiety, GAD-7, and the scores of three basic psychological needs (autonomy, competence, relatedness). Also, it was calculated the mean of days that the participants worn the accelerometer device through the 7 days and the mean wearing time per day. It was analyzed the descriptive statistics of objectively measured PA during 30min walking test, including sedentary time and the different intensities of PA. Finally, it was calculated the mean and standard deviation of the HR and Borg's scale ratings in total and during all the time-points of walking test.

Furthermore, three Pearson correlation analyses were used to examine the relationships between the following variables: HR and Borg's ratings during all the time points of walking test, STAI-total, STAI-trait and STAI-state, HADS-anxiety, GAD-7, sedentary time, and PA intensities (light, moderate and vigorous) and three basic psychological needs (autonomy, competence, relatedness).

Results

Descriptive Statistics

The descriptives of the sample are presented in Table 1. From the 68 participants of the study, 38 were assigned to wear the accelerometer device for 7 days and after to perform the questionnaires and walking test. The other 30 participants were randomized to complete only the questionnaires and the walking test. From 38 participants, 1 did not wear the accelerometer device for the prescribed time (≥ 8 hours per day for at least 3 days), thus being excluded. A total of 67 participants were included in statistical analysis. The mean age was 43.27 ± 11.32 years old, and the mean BMI was 35.31 ± 5.09 kg/m^2. The sample consisted of 67 adults with type II obesity. Also, 51% of participants was regular exercisers, 32.35% was smokers.

Table 1

Descriptives of the sample and the 7-day PA levels measured by accelerometers.

Variables	M	*SD*
Age (years)	43.27	11.32
BMI (weight/height^2)	35.31	5.09
Accelerometers		
Wear time (hours/day)	12.02	3.48
Wear days	5.47	1.93
Kcals/day	331.51	292.44
Steps/day	8.441,07	4.344,52
Sedentary time (minutes/day)	1.717,98	1.993,92
Light intensity PA (minutes/day)	1.258,53	5.543,90

Moderate intensity PA (minutes/day)	39.07	25.52
Vigorous intensity PA (minutes/day)	1.22	4.33

BMI: Body Mass Index, PA: Physical Activity, M: Mean, SD: Standard Deviation.

In Table 2 are presented the descriptives statistics of all the mental health variables that were measured through the questionnaires, including psychological needs. The mean score in STAI-total was 68.79, indicating clinical importance of the symptom severity of anxiety. More specifically, this score interprets severe levels of anxiety. In the subscale of HADS-anxiety, participants recorded a low score in anxiety symptoms compared with the cut off score that it is equal to 8. In GAD-7, the mean score of sample was 5.82, interpreting mild levels of anxiety. Regarding psychological needs, a score of 10 (half-score) from the maximum score of 20 was recorded for competence indicating moderate levels of frustration. For autonomy, relatedness, and psychological needs in total, the corresponding scores were < 10, indicating low levels of frustration of these psychological needs.

Table 2

Descriptives of anxiety symptoms and psychological needs thwarting.

Variables	M	SD
STAI-trait	39.36	11.09
STAI-state	29.42	9.51
STAI-total	68.79	18.38
HADS-anxiety	5.73	4.33
GAD-7	5.82	4.76
Psychological needs (Total)	26.75	8.15
Psychological need of Autonomy	8.86	3.78
Psychological need of Competence	10.27	3.63

Psychological need of Relatedness	7.64	3.21

STAI: State Trait Anxiety Inventory; HADS: Hospital Anxiety Depression Scale; GAD-7: Generalized Anxiety Disorder-7; M: Mean, SD: Standard Deviation.

During the 30-min waking test, the mean time of moderate intensity PA was 25.39 minutes (Table 3). That means that participants accomplished to keep the walking intensity in moderate levels for more than 25 minutes after following the suggested 3-5min warm up period.

Table 3

Descriptives of PA intensities measured with accelerometers during the 30min walking test.

Variables	M	SD
Sedentary time (minutes)	.63	4.04
Light intensity PA (minutes)	.80	1.17
Moderate intensity PA (minutes)	25.39	8.00
Vigorous intensity PA (minutes)	2.58	6.86
Steps	3.123,90	762.16
Kcals	337	380.59
Distance (meters)	2.428,97	471.61
Temperature (Celsius degree)	21.85	6.43

PA: Physical activity; Kcals: Kilocalories; M: Mean, SD: Standard Deviation.

According to the descriptives statistics of HR and RPE (Table 4), it seems that HR total was also in moderate intensity levels during the walking test as the mean HR total value was ≥ 113.10 beats/min. In particular, the participants walked in the range of moderate intensity from the time point 10 min until 30 min. On the contrary, the RPE values weren't at

moderate levels at any time point during the 30min walking test as they corresponded to low levels of perceived physical exertion.

Table 4

Descriptive statistics of HR and RPE during the 30-min walking test at time points.

Variables	M	SD
HR 30 sec	99.24	10.92
RPE 30 sec	6.75	1.02
HR 5 min	110.37	12.49
RPE 5 min	7.79	1.89
HR 10 min	113.33	19.60
RPE 10 min	8.36	2.35
HR 15 min	117.66	14.53
RPE 15 min	9.06	2.48
HR 20 min	120.50	13.33
RPE 20 min	9.45	2.40
HR 25 min	120.52	12.75
RPE 25 min	9.85	2.74
HR 30 min	122.71	13.26
RPE 30 min	10.27	2.98
HR total	115.33	11.82
RPE total	8.74	1.86

HR: Heart Rate; RPE: Rating of Perceived Exertion; M: Mean, SD: Standard Deviation.

Correlation analysis

The first correlation analysis examined the relationship between HR, perceived exertion, BMI, mental health variables and psychological needs. The results of correlation analysis are presented in Table 5. The variable of HR had a low, positive, and statistically significant relationship with BMI and STAI-total. Regarding RPE total, only the psychological need of competence was correlated in a low, positive, and statistically significant way (r = .26, p < .05). The three psychological needs of autonomy, competence and relatedness showed a low to moderate, positive, and statistically significant relationship with STAI-total, STAI-trait, GAD-7, HADS-anxiety (Table 5). Also, the variable of RPE total showed no correlation with HR total (r = -.04, p > .05)

Table 5

Correlation analysis between HR and perceived exertion during PA with BMI, mental health variables and psychological needs thwarting.

	Correlations										
	1	2	3	4	5	6	7	8	9	10	11
1. HR total	-										
2. RPE total	**-.04**	-									
3. STAI-total	.26*	.07	-								
4. STAI-state	.25	.05	.86**	-							
5. STAI-trait	.21	.07	.91**	.57**	-						
6. HADS-anxiety	.14	.19	.75**	.55**	.76**	-					
7. GAD-7	.09	.05	.68**	.47**	.72**	.76**	-				
8. Autonomy need	-.10	.04	.35**	.34**	.28*	.23	.20	-			
9. Competence need	.13	**.30***	.38**	.23	.43**	.42**	.39**	.45**	-		
10. Relatedness need	.13	.10	.36**	.22	.41**	.18	.37**	.30*	.39**	-	
11. BMI	.37**	.20	.14	.20	.05	.06	.02	-.13	.13	.10	-

HR: Heart Rate; RPE: Rating of Perceived Exertion; STAI: State Trait Anxiety Inventory; HADS: Hospital Anxiety Depression Scale; GAD-7: Generalized Anxiety Disorder-7; BMI: Body Mass Index; *p<.05, **p<.001

Table 6

Correlation analysis between psychological needs thwarting and perceived exertion at all time points during the 30min walking test.

	Autonomy	Competence	Relatedness
RPE-time points			
RPE 30 sec	.04	.09	.09
RPE 5 min	.05	.15	-.01
RPE 10 min	.01	.15	.00
RPE 15 min	-.15	***.20***^	-.00
RPE 20 min	.06	**.30***	.09
RPE 25 min	.07	**.36****	.10
RPE 30 min	.10	**.35****	.15
RPE total	.04	**.30***	.10

RPE: Rating of Perceived Exertion; *p<.05, **p<.001, ^p = 0.10

Correlation analysis examined if the three psychological needs had a statistically significant relationship with perceived exertion (RPE) at all the time points during the 30 min walking test (Table 6). Only the psychological need of competence had a low, positive, and statistically significant relationship with RPE from the 20th minute on and in total. This relationship tended to become statistically significant from the 15th minute of walking test (p = .10).

The last correlation analysis examined if the three psychological needs of autonomy, competence and relatedness had a statistically significant relationship with the objectively measured PA intensities (light, moderate, vigorous) and other PA variables (steps and kcals) during the 30-min walking test. The results are presented in Table 7 and indicated that

competence had a low, positive, and statistically significant relationship with light intensity of PA (r = .28, p < .05) and a low to moderate but negative and statistically significant association with moderate intensity of PA (r = -.32, p < .05). Further, relatedness showed a low to moderate, positive, and statistically significant relationship with the variable of light intensity of PA (r = .36, p < .001). Autonomy showed no correlation with any PA intensity during the 30-min walking test.

Table 7

Correlation analysis between psychological needs thwarting and PA variables during the 30min walking test.

	Correlations								
	1	2	3	4	5	6	7	8	9
1. Autonomy need	-								
2. Competence need	.45**	-							
3. Relatedness need	.30*	.39**	-						
4. Sedentary time	-.00	.17	.10	-					
5. Light intensity PA (minutes)	.17	**.28***	**.36****	-.04	-				
6. Moderate intensity PA (minutes)	-.10	**-.32***	-.15	-.43**	-.06	-			
7. Vigorous intensity PA (minutes)	.14	.19	.11	-.06	-.18	-.78**	-		
8. Steps	-.03	-.18	.04	-.57**	-.24	.35**	.17	-	
9. Kcals	-.16	-.21	-.15	-.13	-.08	.10	.01	.20	-

PA: Physical Activity; Kcals: Kilocalories; *p< .05; **p < .001.

Discussion

One of the main findings of this study showed that there is no statistically significant relationship between heart rate and perceived exertion ratings. More specifically, the correlation between these variables was almost zero (r = -.04). This finding suggests indications of disturbed sense of perceived exertion during a 30-min walking test in class-II obese adults.

Regarding the role of psychological needs in perceived exertion, it was found that only competence thwarting was positively related with perceived exertion ratings. More specifically, the higher the competence thwarting, the greater the ratings of perceived exertion or vice - versa. Focusing on the relationship of psychological needs thwarting with perceived exertion during all the time points of a 30-min walking test, the results revealed that after the 15th minute of walking test there was a tendency to a statistically significant relationship that was confirmed after the 20th minute. In particular, the lower the psychological need of competence was satisfied, the higher the sense of exertion was perceived by obese participants in 20th min, 25th min and 30th min. The results of correlation analysis between the three psychological needs and objectively measured PA intensities during the 30min walking test showed that even though the needs of competence and relatedness thwarting were positively associated with light intensity PA, only the need of competence thwarting was negatively associated with moderate intensity PA. In particular, the more the needs of competence and relatedness weren't satisfied, the more the light intensity PA increased while the moderate intensity PA decreased. In other words, the more the need of competence was satisfied, the more the light intensity PA decreased, and the moderate intensity PA increased.

According to the descriptive results of the study, our sample was classified as class-II obese adults, who were physically active in their every daily life (39.07 minutes/day) as they met the WHO's guidelines. During the walking test, the accelerometer devices' results showed that the participants walked in moderate intensity for more than 25.39 minutes of the total 30-min test. This evidence was confirmed from the recorded HR rates that also indicated moderate levels of PA, as our participants walked at exercise intensities between 64-75% of HRmax. From the other hand, the RPE scores reflected low effort corresponding to low intensity PA because they range between 6-10 against 13-14 that is the RPE score that corresponds to moderate intensity exercise (Jakicic et al., 1995). More specifically, while the objective and physiological tools (HR monitors and accelerometer devices) evaluated the intensity of walking test as moderate, the subjective index of perceived exertion classified the intensity as low. This result revealed that our sample underestimated the exercise intensity as they perceived and evaluated their exertion as lower than the actual intensity of the walking test.

Based on this indication of disturbed perceived exertion and the result of correlation analysis, the first hypothesis of this study was confirmed. In particular, the results of the first correlation analysis showed that a negative, almost zero, and non-statistically significant relationship was found between the RPE and HR in obese adults with severe symptoms of anxiety during a 30-min walking test. Morres and his colleagues (2019) supported similar results regarding the inaccurate sense of perceived exertion but in patients with depression that participated in a 4-week walking intervention. In this study all the participants also perceived the exercise intensity as lower than the actual intensity they preferred to exercise, which was moderate intensity according to their HR value. This means that the total sample's RPE scores corresponded to low intensity exercise as they ranged between 6-11 while the HR rates reflected participation in moderate intensity exercise as they met the recommendations

of 64-75% of HRmax. Additionally, the study of Morres et al., (2019) found a small, positive, and statistically significant relationship between the RPE and HR only for the group of participants who recovered from depression whereas the non-recovered from depression group showed a non-statistically significant, negative, and almost zero relationship (-.05) between the variables of actual HR and perceived exertion. These findings agree with ours as they supported the existence of disturbed perceived physical exertion in obese adults during a moderate intensity-walking test.

Based on the previous correlation finding, obese adults with severe anxiety symptoms demonstrated indications of perceived exertion. First of all, a reason that is connected with the inaccurate sense of perceived effort and intensity may be the variable of BMI. More specifically, the results of this study presented that although the BMI wasn't correlated with RPE, the relationship with HR was statistically significant, positive, and moderate. The meaning of this relationship is that the higher the BMI is, the higher the HR rates are. Thus, the normal conclusion has to be that the higher the HR is in obese, the higher the perceived exertion ratings will be. However, Ekkekakis and Lind (2006) supported that during a 20-min prescribed or self-selected aerobic exercise intervention, the perceived exertion ratings and VO2 but not HR were higher in females with increased BMI compared to normal-weight participants. Also, the meta-analysis of Yu and his colleagues (2021) revealed that populations with increased BMI perceived their exertion as higher and more difficult than normal weight populations during a standard intensity exercise intervention. This correlation result wasn't statistically significant, so further research is needed to totally accept the exaggerated sense of exercise intensity in obese and overweight people because of the role of BMI.

Taking account that obesity is a serious disease that comorbid with psychological disorders that affect the cognitive function, maybe anxiety and depression disorders are

connected with the imbalanced relationship between HR and RPE in obese populations. Our sample reported severe levels of anxiety symptoms in STAI while in HADS-anxiety and GAD-7 scales the scores were in low to mild levels. Following the STAI scores, our sample indicated clinical importance of the symptom severity of anxiety as the corresponding STAI levels suggest severe symptomatology.

This clinical severity of anxiety symptoms maybe is associated with the existence of inaccurate or exaggerated perceived exertion in obese adults. More specifically, depression and anxiety disorders have a negative impact on cognitive function of young adults by affecting the way of processing information (Castaneda, Tuulio-Henriksson, Marttunen, Suvisaari, & Lönnqvist, 2008). Morgan (1973) supported that there was agreement in "what the individual was doing" and "what he thought he was doing" on mentally healthy individuals while participants diagnosed with anxiety, depressive or neurotic symptoms had difficulties in their perceptual processing of information relating to exertion during exercise. A negative relationship was found between perceived exertion and anxiety, depressive and neurotic symptoms, indicating that the higher the existence of the previous mental symptoms in subjects, the lower the perceived exertion during exercise. As a result, individuals with negative affective symptoms weren't capable of accurately perceiving the exercise intensity as they experienced the actual exercise intensity as lower and easier than it was expected based on the corresponding HR values. Later, Morgan (1994) designed a similar study demonstrating that anxious, depressive, and neurotic populations showed indications of overestimated perceived exertion ratings. In particular, this finding meant that the higher the negative psychological symptoms, the higher the perceptual ratings of effort during exercise. Morgan's findings underlined the negative role of affective symptoms in disturbed perceived exertion by emphasizing the misjudgment of exercise intensity that led to overestimation or underestimation of the actual exercise intensity.

Another factor that explains why there was disturbed perceived exertion in our obese adults with anxiety symptoms may be the social desirability and sense of self-efficacy. To begin with, social desirability refers to the tendency of respondents to give answers to questions that they believe are more socially acceptable, concealing their true opinions or feelings (Crowne & Marlowe, 1960). Individuals high in social desirability appear to not only respond differently on self-reported measures, but they perceive themselves differently, and they sometimes behave differently than individuals low in social desirability (McCrae & Costa, 1983). Moreover, perceived self-efficacy can positively impact behavioral change and influence the amount of effort expended in pursuing a goal (Bandura, Freeman, & Lightsey, 1999). Social desirability can negatively affect treatment outcomes in obese patients. For example, despite obese -bariatric surgery- patients with high social desirability reported greater weight loss self-efficacy and adherence than the participants low in social desirability before an intervention, after the 6-month intervention they reported lower levels of weight loss (Carels, Cacciapaglia, Rydin, Douglass, & Harper, 2006). The results of the study of Carels et al. (2006) demonstrated that obese high in social desirability tended to overestimate their ability to succeed in a behavioral weight loss program and they found obstacles to accurately self-monitor important diet-related behaviors.

Additionally, Pender, Bar-Or, Wilk and Mitchell (2002) examined the relationship of self-efficacy and perceived exertion during exercise in overweight and obese girls aged 8 to 17 years old. The results showed the negative relationship between pre-exercise self-efficacy and perceived exertion, indicating that the higher the pre-exercise self-efficacy, the lower the perceptual ratings during exercise. Pender et al. (2002), also, investigated the negative relationship of perceived exertion with post-exercise self-efficacy. The last result of the aforementioned study reflected that the lower the perceived exertion in girls with increased BMI, the higher the post-exercise self-efficacy.

Considering the previous findings in combination with the evidence that obese populations experience low self-confidence and self-efficacy during exercise, maybe the cause of disturbed perceived exertion could be explained in our sample. In particular, the participants may want to become more self-efficient and social-desired by pointing out ratings during the walking test that they weren't tired, and they experienced lower levels of perceived exertion to avoid disappointing us and their own expectations. To conclude, maybe we could hypothesize that the imbalanced relationship between heart rate and perceived exertion in our obese sample may also be connected to the participants' feel to appear self-efficient, social desired and competent.

The second finding of the present study emerged from the correlation analysis between the three psychological needs and perceived exertion. From the results it appeared that the more the psychological need of competence was thwarted, the more the RPE scores increased. More specifically, the more the frustration of the need of competence was, the more the RPE scores were, or conversely the more the psychological need of competence was satisfied, the less the perceived exertion ratings were (Table 5). In terms of the RPE at all the time points during the 30 min walking test, the results indicated that the psychological need of competence had a low, positive, and statistically significant relationship with RPE after the 15^{th} minute (Table 6). The meaning of this finding is that the more the psychological need of competence was satisfied, the more the perceived exertion ratings decreased at 20^{th} min, 25^{th} min and 30^{th} min of walking test. The study of Adie, Duda, Ntoumanis (2008) presented similar results by using the variable of perceived, emotional, and physical exhaustion instead of perceived exertion. A statistically significant, almost zero, and negative relationship was found between the two psychological needs of autonomy and competence and perceived emotional and physical exhaustion in adult athletes (r = -.01, p > .01). The more the needs of autonomy and competence were satisfied, the more the perceived emotional and physical

exhaustion decreased. Therefore, it seems that the satisfaction of the competence need during participation in PA could play an important role in setting the perceived effort in obese adults.

Furthermore, this study examined the relationship of the three psychological needs with the objectively measured PA intensities via accelerometers during the 30-min walking test. The results indicated that the psychological needs of competence and relatedness were positively associated with the objectively measured light intensity of PA. In particular, the more the needs of competence and relatedness were thwarted, the more the light intensity PA increased. In other words, the more these two needs were satisfied, the more the light intensity PA decreased. In parallel, the same correlation analysis showed that there was a negative, moderate, and statistically significant relationship between the psychological need of competence and moderate intensity PA. That reflected that the more the higher the frustration of the need of competence was, the lower the levels moderate of intensity were by meaning that the greater the satisfaction of need of competence was, the higher the participation in moderate intensity of PA was.

Silva and her colleagues (2010a) agreed with the above results as their findings showed that the relationship between autonomy and competence and the moderate to vigorous exercise was positive, moderate, and statistically significant. The same correlation was also found for the two psychological needs and the lifestyle PA. These relationships indicated that the higher the satisfaction of autonomy and competence need, the higher the moderate to vigorous exercise and lifestyle PA. Furthermore, a 1-year randomized controlled trial for overweight and obese adult women supported the findings of Silva et al. (2010b). The intervention group that participated in a 12-month weight management program based on the SDT reported higher levels of moderate plus vigorous exercise (+138 min/day), higher number of steps (+2049 steps/day), higher levels of weight loss (-7.29%) and higher exercise

adherence compared to the control group that participated in a general health education program. Additionally, Markland and Tobin (2010) confirmed that the basic psychological needs of autonomy and competence had a statistically significant and positive association with the current levels of PA. This was a general accepted finding that meant that the more the competence and autonomy needs were satisfied, the greater the current and general PA levels were. To conclude, these findings underlined the significant role of competence, first of all, and after of relatedness in the promotion of PA as they were the two psychological needs that correlated with the light and moderate intensity of PA.

The above findings confirmed the second hypothesis of our study regarding the association of psychological needs satisfaction with non-disturbed perceived exertion. If the need of competence is satisfied and participants feel capable of successfully joining PA and exercise programs, the subjective perceived exertion may turn lower. As a result, maybe, participants will stop experiencing their PA participation as tiring and painful. In fact, a positive, autonomous, and self-determined PA environment could help improve psychological health by reducing the stressful stimuli that increase the anxiety symptoms in obese populations. On the other hand, they may perceive it as more enjoying as they will be more intrinsic motivated according to SDT. A qualitative study that was applied in morbid obese subjects could confirm the above conjecture (Megías et al., 2018). In particular, Megias et al. (2018) found that the psychological need threatening was connected with increased body image concerns, lower levels of self-esteem, higher anxiety and depressive symptoms and increased behaviors of avoidance or non-adherence to dietary or PA programs. Also, the study of Schelling and his colleagues (2009) suggested that a motivation group of obese patients that participated in an 8-week aerobic exercise intervention reported fewer dropouts, higher levels of PA adherence and greater number of minutes of weekly PA compared with the control group. The control group was assigned to one session of relaxation instead of

motivation before the beginning of the intervention program. Wasserkampf and other co-authors (2014) supported that the psychological needs satisfaction was a positive contributor to different types of PA. In particular, the autonomy positively predicted participation in both the short-term and long-term moderate to vigorous intensity PA and lifestyle PA. The competence was also a positive predictor for adherence to short-term and long-term moderate to vigorous intensity PA and long-term daily PA but not for short-term daily life PA. So, the conclusion is that the satisfaction of psychological need of competence and afterwards of relatedness may have lots of benefits on perceived exertion by balancing the disturbed relationship between heart rate and perceived exertion.

The present study includes various strengths. In particular, this study provides important insight into how obese adults perceive their effort during exercise and if the perceived sense of exertion was attached with the actual exercise intensity, that was recorded with heart rate monitors and accelerometer devices. The first strength is that this is the first to examine the relationship of perceived exertion with heart rate and psychological needs in obese adults with severe levels of anxiety symptoms. More specifically, there is a gap in literature on this topic and more specifically in clinical populations. Also, the innovation of this study was that the perceived exertion was examined during exercise in pragmatic settings. Furthermore, another strength of this study is that the exercise intensity during the 30-min walking test was measured with three different and reliable methods. The first two methods were objective and the third was subjective. The two objective tools were the heart rate monitors and the accelerometer devices while the subjective tool was the Borg's perceived exertion scale.

Some limitations should also be recognized. To begin with, the nature of this study was descriptive instead of interventional. Also, the half of the participants (51%) was physically active. This is a second limitation because our sample doesn't represent the PA

levels for the majority of obese adults. More specifically, the literature supports that obese adults adopt a sedentary lifestyle and show increased dropouts from PA.

Conclusion

The findings of the present study suggested that there is an almost zero relationship between perceived exertion and heart rate in class-II obese adults with elevated anxiety symptoms and a physically active lifestyle. The literature evidence appears to be consistent with previous findings regarding obese populations with increased anxiety symptoms. Perhaps cognitive dysfunction due to anxiety symptoms or perceived social desirability and self-efficacy are factors influencing the disturbed perceived sense of exercise in obese individuals. Thus, the unbalanced relationship between perceived exertion and heart rate is needed to be examined through an interventional study that monitors and records HR and RPE during exercise over a longer period while evaluating the effect of social desirability and perceived self-efficacy. In line, this study demonstrated that the satisfaction of the psychological need of competence is related with lower perceived exertion and higher moderate intensity PA levels. The valuable role of the competence need in the adoption and adherence to PA participation suggests the examination of the application of the self-determination theory in structured exercise environments; if the trainer is capable of applying the SDT principles during structured exercise, the subjects' psychological needs will be presumably satisfied, especially the competence need. As a result, the subjects may accurately perceive the actual exercise intensity and be more committed to exercise, which is a weight-loss and anxiolytic intervention for obese populations. All these hypotheses and the findings of this study require further research with larger samples.

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