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Investigation of physical parameters influencing body awareness in adults with obesity: An observational, controlled study

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ABSTRACT

Aim: The primary aim was to compare the body awareness (BA) level in adults with obesity and non-obese adults. The secondary aim was to investigate the physical parameters associated with BA and compare them between adults with obesity and non-obese adults.

Method: Thirty-two adults with obesity and age and sex-matched 32 non-obese adults were included in the study. The outcome measures were the Body Awareness Questionnaire, International Physical Activity Questionnaire-Short Form and Functional Reach Test to detect BA, physical activity (PA), and dynamic balance level, respectively. Reaction time was assessed by the Nelson Foot Reaction Test and knee and trunk position error by inclinometer.

Results: There was no significant difference between the obese and non-obese group in terms of BA score ($p = 0.18$) and PA level ($p = 0.50$). Lower dynamic balance was observed in the obese group ($p = 0.003$). Only the trunk position error was higher in the obese group in the measurement of joint position error ($p = 0.010$). There were no significant differences in the right and left feet reaction times between the groups ($p = 0.68$ and $p = 0.23$). There were no relationships between BA score and PA level ($p = 0.93$), dynamic balance ($p = 0.82$), joint position error ($p = 0.14$), and right ($p = 0.33$) and left ($p = 0.25$) reaction times.

Conclusion: There was no significant difference in body awareness between the non-obese and the obese group and there was no association between body awareness and the physical parameters. However, adults with obesity had impaired balance and proprioception compared to non-obese ones.

1. Introduction

Excessive weight and obesity are defined as abnormal or excessive fat accumulation that can adversely affect health, posing a serious public health problem (WHO, 2021). When the energy obtained from food exceeds the energy expended, there is an increase in body fat tissue, leading to obesity (Romieu et al., 2017). Obesity increases the risk of developing cardiovascular and metabolic disorders such as atherosclerosis, type II diabetes, and metabolic syndrome. It also contributes to certain types of cancer, musculoskeletal problems, and various psychosocial disorders (Burgess et al., 2017). In addition to these diseases and syndromes, one of the issues which may be negatively affected by obesity is body awareness (Mehling et al., 2009).

From a neuroscience perspective, body awareness refers to the brain's perception of the messages it receives from other parts of the body and the external environment. These messages encompass both corporal and extracorporeal awareness information. Over time, this information is integrated to form the body's experiences. These knowledge and experiences play a crucial role in an individual's understanding, interpretation, and social interactions with their own body and environment (Berlucchi and Aglioti, 2010). Individuals with obesity often experience changes in their perception of their bodies, experiencing a disparity between their actual and perceived bodies. Neuroscience suggests that one explanation for this lies in the challenges related to integrating and processing sensory information. Additionally, alongside the genetic, environmental, and psychological factors contributing to

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obesity, there is growing recognition of awareness deficits as concurrent risk factors in its development and persistence. (Liné et al., 2022).

Research has revealed several key findings regarding body awareness in adults with obesity. It has been found that women with obesity had lower levels of mindful eating compared to those with normal weight, suggesting a potential link between body awareness and weight management. Similarly, the importance of dietary habit awareness in obesity and weight control has been highlighted. Individuals with obesity have been shown to demonstrate awareness of their condition and its impact on their health, emphasising the role of self-perception in obesity. Collectively, these studies underscore the significance of body awareness in the context of obesity (Alasmari et al., 2017; Okop et al., 2016). Additionally, it has been shown that body awareness changes with sudden weight loss after bariatric surgery (Varli et al., 2022).

Over the years, there has been a change in individuals' perception of weight. It is stated that generally thin people define themselves as fatter than they are. Individuals with obesity define themselves as thinner without being aware of their weight which increases the risk of obesity (Morotti et al., 2013). For individuals with obesity to be treated, they must begin to recognize themselves as obese and to perceive their bodies in a real and conscious way (Ata et al., 2014). Therefore, it is important to examine how body awareness differs in individuals with obesity compared to those without obesity. However, studies examining how body awareness differs in adults with obesity and non-obese adults are limited.

1.1. Rationale

Considering this information, evaluating the level of body awareness and the parameters that may influence body awareness could be crucial in managing obesity since the complex relationship between body awareness and obesity, seeking to uncover important insights that could improve obesity management strategies. By investigating the differences between how individuals perceive their bodies and their actual physical states, particularly among those struggling with obesity is crucial.

1.2. Aim of the study

The primary aim of this study is to compare the level of body awareness in individuals with obesity and age and sex-matched non-obese individuals. The secondary objective is to investigate the physical parameters associated with body awareness and compare them between adults with obesity and non-obese adults. This study holds significant global importance as it addresses a pressing public health issue. With obesity rates on the rise worldwide, understanding the intricate dynamics of body awareness in relation to obesity becomes paramount.

2. Method

This was a cross-sectional, controlled study, approved by a university ethics committee and conducted in accordance with the Declaration of Helsinki. The protocol of the study was registered on ClinicalTrials.gov (NCT05974514).

2.1. Participants

Sixty-four adults who met the inclusion criteria were included in the study. Participants were grouped as 32 adults with obesity [body mass index (BMI) ≥ 30 kg/m^2], and 32 non-obese adults (BMI: 18.5–24.9 kg/m^2) who were age and sex-matched (control group) with the study group.

The inclusion criteria consisted of adults with obesity aged 18–65 years, who did not receive obesity-related treatment 6 months before the study, and non-obese adults. Exclusion criteria included musculoskeletal, neurological, and rheumatological disorders (fractures, sprains or strains, spine surgery, advanced respiratory or orthopaedic problems), malignancy and pregnancy within the last 12 months, which might interfere with evaluations were the exclusion criteria.

The G*power 3.1 calculator program was used to define the sample size. "Correlation bivariate normal model" was chosen to determine the relational status between the variables. According to the analysis performed with a 95% confidence level, 80% power, and standardized effect size (Cohen's large value: 0.60), it was calculated that a total of 60 individuals should be included (Cramer et al., 2016).

2.2. Measures

Data about the participants' sociodemographic information, anthropometric measurements, body awareness, PA level, dynamic balance, proprioception and reaction time were collected. Written informed consent was obtained from each participant at the time of enrolment.

2.2.1. Sociodemographic and clinical information

Sociodemographic information such as age, height, weight, educational status, and cigarette smoking, alcohol use of the participants was collected with the information form.

2.2.2. Anthropometric measurements

Weight was measured using the body analysis scale. Participants were asked to remove their shoes and socks, and then stand on the device with their heels touching the electrodes and their knees fully extended. For the measurement of height, the device was prepared with a tape measure fixed on a flat wall surface. Hip, thigh, calf and abdominal circumference were measured using a measuring tape (150 cm, 60 inches, accurate to 0.1 cm).

2.2.3. Body awareness

The Body Awareness Questionnaire (BAQ) was developed by Shields et al., in 1986 (Shields et al., 1989). The Turkish version, whose validity and reliability study were conducted by Karaca et al., was used in this study (Karaca and Bayar, 2021). This questionnaire includes physical, emotional, and social aspects of a person's susceptibility to normal or abnormal bodily conditions and processes, questioning susceptibility to physical reactions. There are 18 statements in the questionnaire, each scored between 1 and 7 points (1 = Not at all suitable for me, 7 = Completely suitable for me). The total score is 126 and higher indicates a better body awareness level (Karaca and Bayar, 2021).

2.2.4. Physical activity level

The Turkish reliable and validated version of the International Physical Activity Questionnaire-Short Form (IPAQ-SF) was employed to evaluate self-reported PA levels (Saglam et al., 2010). It comprises seven questions assessing the regularity and duration of walking, moderate and vigorous intensity exercises, and total sitting time on a weekday throughout the preceding week. PA level is categorized as low, moderate, and high (Healey et al., 2020).

2.2.5. Dynamic balance

Dynamic balance was evaluated with the functional reach test (FRT). FRT was performed as reported by Duncan et al. (1990). The subject stood next to the functional reach measurement device, extended one arm horizontally at approximately 90°, and placed a closed fist against the sliding bar of the device. The head of the third metacarpal was marked as the starting position. The participant was asked to go as far as he could without taking a step, and the final position of the metacarpal was recorded. Participants were given 2 attempts before the test. Then the test was repeated 3 times and the average of the 3 measurements was recorded in 'cm' (Duncan et al., 1990).

2.2.6. Joint position sense

The joint position sense assessment was conducted using a Baseline bubble inclinometer (model 12–1056, Fabrication Enterprises; White Plains, New York) by evaluating the position error in bilateral knee joints and the trunk. Knee joint measurements were performed in a sitting position, with the individual's eyes closed. The evaluated joint was bare, without socks or shoes, by attaching the apparatus designed to be perpendicular to the axis of knee flexion to the lower leg. Participants' knees were passively moved from the starting position [90-degree (°) flexion] to a 30° flexion position, and after a 5-s wait at this point, participants were instructed to hold this angle in mind before returning to the starting position. After a 5-s rest, individuals were asked to actively reproduce the target angle themselves. The same procedure was repeated three times at 45° and 60° of knee flexion. The absolute difference between the criterion and reproduced angle was taken as a measure for proprioceptive accuracy, and the average of the deviation amounts observed during the three repetitions was calculated. (Baert et al., 2018; Romero-Franco et al., 2019).

To evaluate trunk position error, participants were asked to sit in an upright position and perform a 30° trunk flexion for 3 s while being guided to feel the exact angle. Subsequently, they were instructed to return to the neutral position. The difference between the flexion angle performed by the individual during the test and the target 30° angle was recorded as the trunk position error. The tests were repeated 5 times, and the lowest and highest degrees of trunk position error were discarded, while the average of the remaining 3 test scores was used as the error magnitude (Jung et al., 2014).

2.2.7. *Reaction time*

The Nelson Foot Reaction Test was used to evaluate individuals' reaction speed. Participants were invited to remove their shoes and sit on a chair. During the test, the foot was positioned 2.5 cm away from the wall at the toes and 5 cm away at the heel. A physiotherapist held a 30 cm ruler against the wall at the level of the dominant foot's big toe to ensure consistent positioning. The physiotherapist counted backwards from three, one number at a time, and released the ruler when saying "zero." The individual was instructed to catch the falling ruler with their foot, and the position of the foot on the ruler was recorded in centimetres. This process was repeated 20 times. The average value was calculated by excluding the lowest and highest 5 values out of the 20 and recorded in centimetres. The obtained average value was then used in the formula "Reaction Time $= \sqrt{2}$ x Distance (cm)/980 cm/s^{2}" to calculate the reaction time in seconds and recorded accordingly (Tamer, 2000).

2.3. *Statistical analysis*

The Jamovi program (Version 1.0.7) was used for the statistical analysis of study data. The variables were defined with their mean, standard deviation, percentage, and median with minimum and maximum values. The normality of the data was evaluated using skewness, kurtosis values, Q-Q plots, Box Plots, and histograms, along with the Shapiro-Wilks test. Normally distributed data were analysed using a parametric test (Independent-Samples T-test) and non-normally distributed data were analysed using a non-parametric test (Mann-Whitney *U* test). The relationships between variables were examined using Spearman correlation coefficients. Values with $p < 0.05$ were considered statistically significant.

3. Results

Thirty-six adults with obesity (BMI ≥30 kg/m^2) who were followed at the internal medicine unit were invited to participate. Four individuals did not meet the eligibility criteria. Therefore, a total of 64 participants including 32 individuals with obesity and age and sex-matched 32 non-obese individuals (BMI: 18.5–230 kg/m^2) were

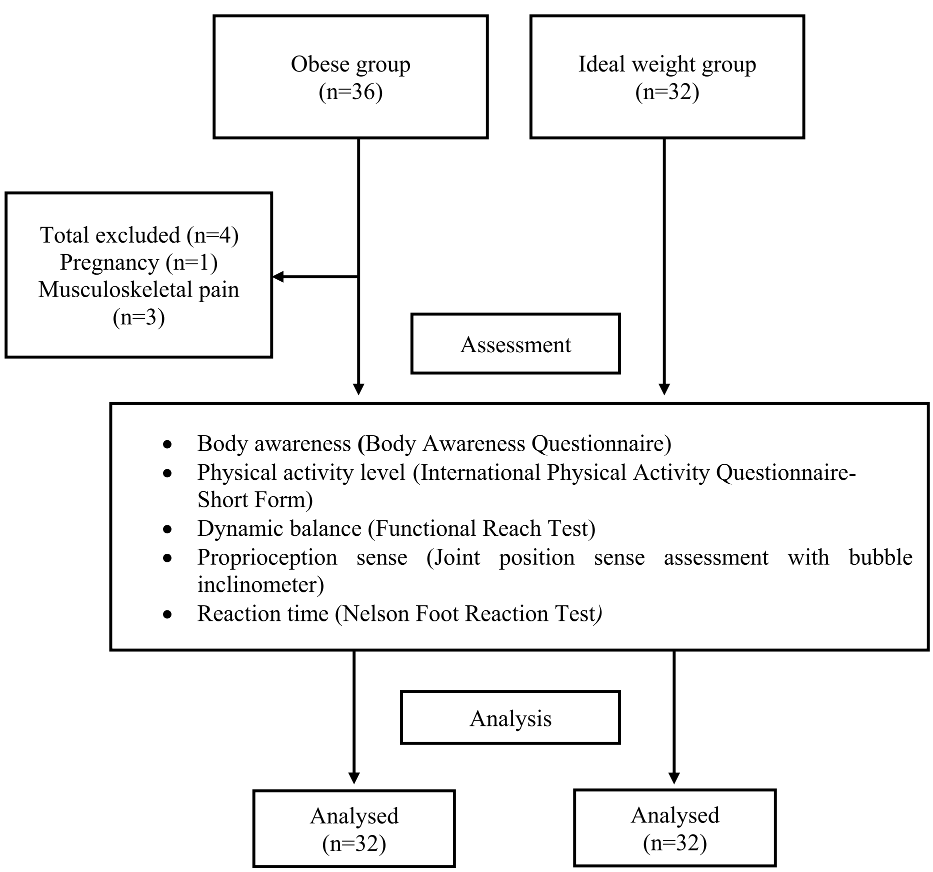

Fig. 1. Flow chart of the study.

included in the study. No unexpected effects were observed during the assessments. The flow chart of the study is shown in Fig. 1.

3.1. Sociodemographic and clinical characteristics

No significant differences were found in age, sex, marital status and smoking between the groups ($p > 0.05$). Education status and alcohol consumption were significantly different between the groups ($p < 0.05$). Additionally, 75 % of the participants (n = 24) of the obese group were class I obese (BMI: 30–34.9) (Table 1).

3.2. Comparison of differences in anthropometric measurement values, body awareness, PA level, and dynamic balance

No significant difference was found in height between the groups ($p > 0.05$). Weight, BMI, hip circumference, and right and left circumference of the thigh, calf and abdominal region were higher in the obese group ($p < 0.05$). No significant difference was found in body awareness score and PA level ($p > 0.05$). The dynamic balance scores were lower in the obese group ($p < 0.05$) (Table 2).

3.3. Comparison of differences in joint position sense and reaction time

A statistically significant difference was found between groups only in the trunk position error among the joint position assessment. In the obese group, the trunk position error was higher than in the non-obese group ($p < 0.05$). No significant difference was found in reaction times between the obese and non-obese groups ($p > 0.05$) (Table 3).

Table 1
Demographic and clinical characteristics of participants.

	Non-obese group (n = 32)	Obese group (n = 32)	p
	Median (Min-Max)/n (%)	Median (Min-Max)/n (%)	
Age	39.5 (18–59)	38 (22–59)	0.37[a]
Gender			0.76[b]
Female	25 (39.1)	24 (37.5)	
Male	7 (10.9)	8 (12.5)	
Marital status			0.80[b]
Married	17 (26.6)	18 (28.1)	
Single	15 (23.4)	14 (21.9)	
Education status			**0.02**[c,d]
Primary school	0 (0)	3 (4.7)	
Middle school	3 (4.7)	4 (6.3)	
High school	15 (23.4)	5 (7.8)	
Bachelor's degree	14 (21.9)	18 (28.1)	
Master's degree	0 (0)	1 (1.6)	
Doctorate	0 (0)	1 (1.6)	
Smoking			0.26[b]
Yes	7 (10.9)	11 (17.2)	
No	25 (39.1)	21 (32.8)	
Alcohol Consumption			**0.03**[c,d]
Never	32 (50)	28 (43.8)	
Rarely	0 (0)	4 (6.3)	
Classification of obesity			
Class I obesity		24 (75)	
Class 2 obesity		6 (18.72)	
Class 3 obesity		2 (6.25)	

[a] : Mann Whitney *U* test used.
[b] Chi-square test used.
[c] : Fisher's Exact test used.
[d] :<0.05.

3.4. Correlation of the body awareness score with PA level, dynamic balance, proprioception and reaction time

No statistically significant correlation was found between the body awareness score and other parameters ($p > 0.05$) (Table 4).

4. Discussion

Although there is an increasing number of studies examining the body awareness on general health, there is limited study which investigate body awareness in individuals with obesity. Therefore, our study is comprehensive research aimed to investigating body awareness in individuals with obesity and the parameters that may affect body awareness in this population. In general, the research results suggested that was no difference between the obese and non-obese group in terms of body awareness and body awareness was not associated with other parameters. However, dynamic balance and proprioception were negatively affected in adults with obesity. Since most of the individuals with obesity were class I obese individuals, authors aware that the results of the study cannot be generalised to all individuals with obesity. On the other hand, it is noteworthy that proprioception and balance were found to be affected even in class I which reflects the early obesity stage.

Studies have indicated that individuals with varying BMIs exhibit differences in body awareness (Ata et al., 2014). Moreover, individuals with binge eating disorder may experience changes in body awareness, perceiving themselves as having a different body (Albertsen et al., 2019). Furthermore, evidence suggests an increase in body awareness following bariatric surgery and this increase is found to be proportional to BMI and the amount of weight lost (Varli et al., 2022). On the other hand, according to the results of our study, the body awareness scores of obese and non-obese groups were similar. This result may be related to the heterogenous distribution of participants' BMI in study group. The mean BMI of the obese group was 34.1 kg/m^2 and the group consisted mostly of class I obese participants (%75). This may have caused the lack of a significant difference between the groups in terms of BA. Future studies comparing body awareness of individuals with obesity should have a more homogeneous distribution of obesity class. Additionally, the difference between the abovementioned studies and our study may be due to the fact that our study included a wider age range of participants, whereas the previous studies had more specific focus groups. Furthermore, gender, cultural backgrounds, social influences, and lifestyle factors may affect body awareness.

Obesity is affected by many variables such as gender and alcohol consumption. Studies consistently demonstrate a higher prevalence of obesity among women compared to men, a pattern observed across various age demographics (Keita et al., 2014; Fisher et al., 2012). This gender difference in obesity prevalence is influenced by multiple factors, including social structures, gender relations, and individual interactions with society (Fisher, 2015). Considering that most of our obese group involved female participants, this is consistent with the literature. Additionally, studies consistently demonstrate a positive correlation between alcohol intake and obesity-related health issues, particularly among men (Kim et al., 2021; Chakraborty, 2014). High alcohol consumption, including episodes of binge drinking, is associated with an increased likelihood of obesity, hypertension, and dyslipidaemia (Kim et al., 2021). Our study showed that obese participants had higher alcohol consumption consistent with the literature. Understanding the intricate interplay between factors like gender, alcohol consumption, and obesity is crucial for promoting body awareness and fostering healthier lifestyles.

Studies showed that that engaging in regular physical activity can enhance body awareness and individuals who have been practising exercise for an extended period demonstrate increased levels of body awareness (Tihanyi et al., 2016). Furthermore, different types of exercise may have varying effects on body awareness, with practices like

Table 2
Comparison of anthropometric measurement, body awareness, physical activity level and dynamic balance of the participants.

	Non-obese group (n = 32)		Obese group (n = 32)		
	Mean (SD)/n (%)	Median (Min-Max)	Mean (SD)/n (%)	Median (Min-Max)	P
Height (m)	160 (150–182)	163.5 (8.93)	164 (150–185)	165.9 (9.33)	0.29[c]
Weight (kg)	66.5 (45–85)	66.5 (9.37)	92.5 (75–141)	93 (13.47)	**<0.001**[a d]
BMI (kg/m^2)	24.8 (20–29.4)	24.8 (2.79)	33.9 (30.1–45.7)	33.8 (3.67)	**<0.001**[a d]
Hip C. (cm)	104 (84–113)	103.4 (6.25)	119 (100–150)	119.8 (10.75)	**<0.001**[a d]
R. Thigh C. (cm)	54 (44–65)	54 (5.25)	61.5 (48.5–74.5)	61.2 (6.72)	**<0.001**[a d]
L. Thigh C. (cm)	54 (45–64)	53.9 (5.06)	62.5 (48–72.5)	61.3 (6.46)	**<0.001**[a d]
R. Calf C. (cm)	38 (32–48)	38.1 (3.52)	42.0 (36–73.5)	43.2 (6.42)	**<0.001**[a d]
L. Calf C. (cm)	38 (31–48)	38 (3.65)	42.5 (36–70)	43.2 (5.94)	**<0.001**[a d]
Abdominal C. (cm)	89.5 (71–101)	88.3 (7.68)	107 (91.5–136)	107.4 (8.57)	**<0.001**[a d]
BAQ score	92.1 (15)	97 (66–121)	86.3 (11.9)	86 (63–108)	0.09[a]
IPAQ-SF category					0.55[b]
Inactive	15 (23.4)		13 (20.3)		
Minimally active	17 (26.6)		18 (28.1)		
Very active	0 (0)		1 (1.6)		
IPAQ-SF (MET-min/week)	1190 (1379)	711 (110–6930)	964 (1004)	792 (0–4158)	0.51[c]
Functional reach test (cm)	38.7 (7.07)	33.3 (26.0–52.3)	33.3 (6.93)	33 (18.6–54.6)	**0.003**[a d]

BMI: Body mass index, C.: circumference, R.: right, L.: left, BAQ: Body Awareness Questionnaire, IPAQ-SF: International Physical Activity Questionnaire-Short Form, MET: metabolic equivalent of task.
[a] : Student's t-test used.
[b] : Chi-square test used.
[c] : Mann Whitney *U* test used.
[d] :<0.05.

Table 3
Comparison of differences in proprioception sense and reaction time between the groups.

	Non-obese group (n = 32)	Obese group (n = 32)	
	Median (Min-Max)	Median (Min-Max)	P
Proprioception sense			
RKJPS 30°	1.60 (0–10)	1.60 (0–8.3)	0.55
LKJPS 30°	1.60 (0–6.6)	1.60 (0–10)	0.18
RKJPS 45°	1.60 (0–10)	1.60 (0–10)	0.13
LKJPS 45°	1.60 (0–6.6)	1.60 (0–11.6)	0.56
RKJPS 60°	0.80 (0–5)	1.60 (0–13.3)	0.11
LKJPS 60°	0.80 (0–5.3)	1.60 (0–6.6)	0.21
TPS 30°	2 (0–15)	3.15 (0–15)	**0.02**[a]
R. Nelson foot reaction test (sec)	21.45 (14.10–26.7)	22.37 (11.70–27.8)	0.61
L. Nelson foot reaction test (sec)	21.75 (16.40–26.9)	22.35 (7.20–27.8)	0.20

Mann Whitney *U* test used, RKJPS: right knee joint position sense, LKJPS: left knee joint position sense, TPS: trunk position sense, R.; right, L.: left.
[a] :<0.05.

Table 4
Correlation of the body awareness score with PAL, dynamic balance, proprioception and reaction time.

	BAQ Score	
	Spearman's rho	p
Physical activity level	0.02	0.86
Proprioception sense		
RKJPS 30°	−0.04	0.74
LKJPS 30°	−0.23	0.05
RKJPS 45°	−0.17	0.16
LKJPS 45°	−0.18	0.13
RKJPS 60°	−0.06	0.59
LKJPS 60°	−0.11	0.35
TPS 30°	−0.14	0.35
Functional reach test (cm)	0.07	0.53
R. Nelson foot reaction test (sec)	0.03	0.79
L. Nelson foot reaction test (sec)	0.05	0.68

RKJPS: right knee joint position sense, LKJPS: left knee joint position sense, TPS: trunk position sense, *: $p < 0.05$.
**: $p < 0.001$.

yoga being associated with higher levels of body awareness compared to other forms of exercise (Martin et al., 2013). Additionally, physical activity has been linked to positive effects on body awareness levels, particularly in non-obese individuals (Kalkisim et al., 2022). In our study, the PA level of the obese group was similar to that of non-obese individuals and there was no correlation between PA level and body awareness. This finding may be explained by the fact that the studies mentioned earlier suggest a positive relationship in non-obese individuals and those practising specific types of activities like yoga which are different from our study. Our results consistent with Varlı et al.'s study indicated that PA levels were the same between post-bariatric surgery patients and individuals with normal BMI levels and no correlation between the PA level and body awareness (Varli et al., 2022). This situation may differ for individuals with obesity and different interventions may be needed to improve body awareness and adopt a positive relationship with physical activity.

Several studies have demonstrated a significant relationship between body weight and balance impairment. It has been stated that obesity was associated with reduced postural stability on unstable surfaces and body weight may be an important risk factor for falling (Hue et al., 2007). It was showed that the increased body weight resulted in functional adaptation which was characterized by a reduced postural sway connected with an important reduction of the dynamic stability range (Blaszczyk et al., 2009). In our study, dynamic balance scores were lower in the obese group similar to the results from previous studies. These findings may be since when an individual with obesity is subjected to a small to moderate forward oscillation, the abnormal distribution of body fat in the abdominal region leads to an increased restorative ankle torque required to regain balance (Corbeil et al., 2001). In a study investigating the relationship between balance and body awareness level in active athletes showed that a moderate positive correlation between balance and BAQ (Bilgin U et al., 2023). Additionally, it was stated that balance was not related to body awareness in college students (Helmick, 2023). Due to our findings, there was no correlation between dynamic balance and body awareness in the obese group. To the best of our knowledge, there is no study investigating the correlation between balance and body awareness in individuals with obesity. The reason that there was no association between balance and body awareness, despite differences among groups, may be attributed to the outcome measure used to assess balance.

Body awareness is the subjective aspect of conscious awareness involving proprioception and inner perception. The emergence of body awareness gives individuals the sensation that they possess a new physical form (Albertsen et al., 2019; Spaniolas et al., 2016). According to our findings, position error in the trunk which indicates reduced trunk position sense was higher in the obese group consistent with the literature showing that obesity affects proprioception (Numanoğlu et al., 2014; Wang et al., 2008). In addition, there was no correlation between body awareness and proprioception sense. In a studyit was demonstrated that no significant association between proprioception assessed at the elbow joint and body awareness (Horvath et al., 2019). Conversely, Varli et al. stated that body awareness scores increase and the deviation in joint position sense decreases (Varli et al., 2022). The reason for different results in the literature might be due to the variation between the samples and joint position sense measurement areas of the body. Additionally, the reason for the lack of correlation between body awareness and balance and joint position sense in our study may be due to the high number of class I obese individuals in the obese group.

Individuals with obesity with excessive fat accumulation in the abdominal region have been shown to require faster ankle reactions and exert more effort to regain balance. This indicates a higher risk of falling. Therefore, we evaluated the foot reaction time of the participants. Several studies have stated a positive association between reaction time and obesity measured by BMI (Deore et al., 2012; Gentier et al., 2013). In contrast, our findings showed that foot reaction time was similar between the groups. A study reported no relationship between reaction tests and BMI in young males (Esmaeilzadeh et al., 2020). A different study, no differences were observed in reaction time between overall obesity or body composition groups consistent with our results in young adult men (Narimani et al., 2019). On the other hand, another study stated that only a significant association was detected between reaction time and % fat in 9–12-year-old schoolboys (Moradi and Esmaeilzadeh, 2017). In addition, Esmaeilzadeh stated that there was a weak positive association between waist circumference and reaction time (Esmaeilzadeh et al., 2020). The different results in the literature may stem from the use of various parameters in defining obesity, such as BMI, body fat percentage, waist circumference, and others (Corbeil et al., 2001). Moreover, no correlation was found between body awareness and reaction time.

Obesity, a complex condition characterized by excessive body fat accumulation, necessitates a comprehensive approach beyond simplistic views of diet and exercise. Central to this approach is body awareness, encompassing physical, emotional, and cognitive aspects of bodily experiences (Barbosa et al., 2020). Within the biopsychosocial framework, obesity arises from interactions among biological, psychological, and social factors. Genetic predispositions, stress, trauma, and cultural norms all play roles in weight regulation and eating behaviours. Body awareness is key in addressing obesity, empowering individuals to understand their eating patterns, hunger cues, and emotional triggers (Rosenbaum et al., 2016). While our study has primarily focused on relationship between the physical parameters and body awareness, it is important to address obesity from a biopsychosocial perspective.

4.1. Strengths of the study

Despite these limitations, we believe that our study will contribute to the field, since it assumes a comprehensive approach by comparing body awareness levels and various physical parameters between individuals with obesity and non-obese individuals. This holistic assessment provides an understanding of the impact of obesity on individuals. Additionally, the study's inclusion of matched groups based on age and sex enhances the comparisons' validity. For individuals with obesity, the results of the study could help them understand their body awareness and balance abilities. This could contribute to the development of personalized strategies for managing obesity. Additionally, the study is important for healthcare professionals and caregivers supporting individuals with obesity. The findings could help them understand the physical challenges associated with obesity and coping strategies, thereby enabling them to provide more effective support.

4.2. Limitations

The results of this study should be considered in view of some limitations. Firstly, in our study, the majority of the participants in the obese group had class 1 obesity, which is the lowest obesity classification and obesity was expressed only in terms of BMI. Secondly, the majority of females in both groups may create a gender effect. Lastly, there is a lack of assessment of conditions that may have an impact on body image, such as mental health.

5. Conclusion

Through comparing the levels of body awareness between individuals with obesity and those non-obese to understand how individuals perceive their bodies and their actual physical states, and examining relevant physical parameters, our goal was to provide clinicians and researchers a perspective for managing obesity. In conclusion, there was no significant difference in body awareness between the non-obese and the obese group which consisted mainly of participants with class I obesity and there was no association between body awareness and the physical parameters. However, adults with obesity had impaired balance and proprioception compared to non-obese ones. Although the hypothesis of this study that body awareness would be lower in individuals with obesity was not confirmed, findings shed light on the impact of obesity on balance and proprioceptive abilities. Further investigations should focus on examining body awareness in studies with a homogeneous distribution of obesity class.

Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Statement of the authors

We would like to inform you that this study has not been presented or published anywhere. The manuscript is not under simultaneous consideration by any other publication. All of the authors of the manuscript approve of the material submitted for publication.

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CRediT authorship contribution statement

Ezgi Eryıldız: Writing – review & editing, Writing – original draft, Supervision, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Elifnur Delibas:** Writing – review & editing, Writing – original draft, Methodology, Data curation, Conceptualization. **İlayda Melek Kesgin:** Writing – original draft, Methodology, Data curation. **İpek Beyza Ozturk:** Writing – original draft, Investigation, Data curation. **Burcu Ersoz Huseyinsinoglu:** Writing – review & editing, Writing – original draft, Visualization, Supervision, Methodology, Investigation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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