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Original Article

Effect of Self-perceived Fatigue on Balance and Functional Mobility in Middle-Aged Obese Women

Sabriye Ercan[a*], Ferdi Başkurt[b], Zeliha Başkurt[b] and Cem Çetin[c]

[a]Department of Sports Medicine, Suleyman Demirel University, Medicine Faculty, Sports Medicine Department, Isparta 32200, Turkey, [b]Department of Physiotherapy and Rehabilitation, Suleyman Demirel University, Health Sciences Faculty, and [c]Department of Sports Medicine, Suleyman Demirel University, Medicine Faculty, Isparta 32200, Turkey

The aim of this study was to examine effect of fatigue levels on functional mobility and balance in middle-aged obese females. The study included 98 healthy females aged 40-60 years with BMI ≥ 30 kg/m^2. Self-perceived fatigue was evaluated with a self-administered questionnaire, the Checklist of Individual Strength in Turkish (CIS-T), on which 62.3% of the study subjects identified themselves as fatigued. The body weight and BMI values of fatigued subjects were found to be higher than those of the non-fatigue group ($p < 0.05$). The reported exercise habits of the fatigue group were found to be significantly lower than their non-fatigued peers ($p < 0.05$). The level of functional mobility (Timed Up and Go Test), static balance (One-Legged Stance Test with Eyes Open) and dynamic balance (Functional Reach Test and the 3-meter Timed Tandem Walk Test) were measured, and statistically significant differences were found between fatigue and non-fatigue groups on all of them ($p < 0.05$). In addition, correlations were found between the sub-parameters of the CIS-T scale and the functional tests at different levels. Increased fatigue has negative effects on functional mobility and balance in obese females.

Key words: fatigue, obesity, mobility, balance, woman

Self-perceived fatigue is defined as "the subjective experience of perceived low energy, characterised by apathy and a state of physical and mental burnout" [1]. However, this terminology used to explain fatigue is not sufficient to define different etiologies, different presentations and the experience of fatigue [2]. Self-perceived fatigue is complex and multi-dimensional in nature. There may be different types of fatigue in the same person at the same time, and this can prevent the identification of etiological factors [3]. Moreover, according to the findings of previous studies, self-perceived fatigue generally shows a relationship with chronic diseases such as obesity, rheumatological diseases, fibromyalgia and cancer [4].

The correlation of fatigue and obesity can be determined in both paediatric and adult populations [5]. In obese individuals who develop fatigue, there are thought to be underlying mechanisms of endocrine, metabolic and inflammatory processes. This view is supported by evidence of the development of systemic inflammation and changes occurring in the endocrinological system in low-level obesity [6]. It is also known that inflammation creates changes in the biosynthesis of monoamines such as dopamine, noradrenaline and serotonin, which are known to have important roles in the pathophysiology of fatigue symptoms [6]. Furthermore, it is difficult to determine the definition

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*Corresponding author. Phone : +90-2462112000
E-mail : sabriyeercan@gmail.com (S. Ercan)

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and degree of fatigue by an individual stating that they are tired, as there is no laboratory method which can be used to confirm a diagnosis of fatigue.

Laboratory methods are only useful for the discounting of other chronic diseases [7]. However, scales such as the Fatigue Severity Scale (FSS), the Cohen-Hoberman Inventory of Physical Symptoms (CHIPS), the Multi-dimensional Fatigue Inventory (MFI) and the Checklist of Individual Strength (CIS) have been developed to facilitate the diagnosis of fatigue [8-10].

It has been reported in literature that fatigue reduces the desire for activity and thereby causes an increase in morbidity rates [8]. For example, elderly individuals with fatigue take approximately 1,150 fewer steps per day than those who are not fatigued. There has been determined to be a relationship between the degree of fatigue felt and physical activity, body mass index (BMI), and physical condition [8]. The muscle strength and motor control of upper, and particularly lower, extremities, and the balance control of obese individuals are known to be lower than those of normal weight individuals [11-13]. However, information is lacking on the subject of the effect created by fatigue on functional mobility and balance in obese individuals [8].

The aim of this study was to be able to prove with objective findings the hypothesis that high levels of perceived fatigue in obese individuals are correlated with worse functional mobility and balance and therefore may be a causative factor.

Materials and Methods

The study included 98 healthy females, aged 40-60 years with BMI ≥ 30 kg/m^2, who were selected from among relatives accompanying patients in a tertiary level healthcare institution. Participants reported their medical problems with self-declaration in subject interviews and were examined by physician. All the participants had no history of joint surgery within the previous year, had not received treatment for lower back pain, had no musculoskeletal or neuromuscular problems that could significantly affect walking performance, and were without cognitive or psychiatric disease; further, they had no unstable angina or uncontrolled arterial hypertension, severe pulmonary hypertension, recent cardiac arrhythmia or myocardial infarct, malignancy or any other clinical state that could be exacerbated with physical effort [14].

Approval for the study was granted by the Local Ethics Committee of Suleyman Demirel University (Date: 21/12/2016, approval number: 206). All procedures were in accordance with the principles of the Helsinki Declaration.

Test evaluating fatigue. The CIS-T perceived fatigue scale used in the study is the most widely used scale in the determination of chronic fatigue. The validity of the scale in Turkish was previously demonstrated by Ergin *et al*. In the scale, chronic fatigue is evaluated in 4 areas: subjective experience of fatigue (CIS-SEF), reduction of concentration (CIS-RC), reduction of motivation (CIS-RM) and reduction in physical activity level (CIS-PAL). The total points range from 20-140 points for the 20 items in the scale, and high total points indicate a high level of fatigue. A total CIS score of 76 was used as a cutoff to distinguish between individuals with and without fatigue [15].

Tests evaluating functional mobility and balance. After application of the CIS-T perceived fatigue scale [15], the following tests were administered to all the participants by a researcher blinded to the fatigue score: the 3-meter Tandem Walk Test [16], the Functional Reach Test [17], The Timed Up and Go Test [16] and the Single Leg Stance Test [16].

1. The 3-meter Timed Tandem Walk Test is a functional test that is used to evaluate mobility and dynamic balance. The test is applied on a flat surface marked as 3 meters long. The patient is requested to walk this distance at a comfortable pace. The time starts from the foot on the starting line and finishes when the foot crosses the finishing line. To determine the 3-meter tandem walk time, 2 measurements are taken and the average of the 2 measurements is used for analysis. The average walk time is recorded as seconds and the walking speed as meters/sec [16].
2. The Functional Reach Test was developed to evaluate dynamic balance. The subject is positioned next to a wall, the dominant arm is raised to 90°, a fist is made of the hand, and the patient is requested to reach as far forward as possible, following a measure placed at shoulder level, without moving the feet or losing balance. Care is taken that the feet are not moved or raised from the ground. In the test, the distance between the first and last measurement values is recorded, taking the 3rd metacarpophalangeal joint as reference criteria. The test is applied twice to the subject and the best measurement is

used in the evaluation [17].

3. The Timed Up and Go Test evaluates balance and functional mobility together. At the beginning of the test, the patients sit on a chair, with their feet flat on the floor and their arms placed on the armrests. The test starts with the command of "walk". The patient is instructed to rise from the chair, walk 3 meters at a safe and comfortable pace, turn around, walk back to the chair and sit. The time of the test is recorded using a chronometer. Before the test, the patients have a trial run, which is then repeated for the recorded measurement [16].
4. The One-Legged Stance Test with Eyes Open is a functional test which examines static balance. The subject is asked to raise one foot to the level of the other knee at 90°, and when the position is taken, the timer is started and continues for a maximum of 30 secs. The test is concluded if the raised foot touches the ground, the position is changed, the subject touches the foot to the ground or the eyes are opened. The test was repeated 3 times, and the best result was used in the analysis [16].

Statistical analysis. The data were analyzed statistically using the SPSS program for Windows, version 20.0. Results for continuous variables are given as means ± standard deviations, and categorical variables such as sociodemographic characteristics of participants are given as number and frequencies. For comparisons between the groups, the Student *t*-test for independence was used. Correlations between CIS-T scores, functional mobility and balance parameters in participants with obesity were calculated with Pearson correlation analysis. Statistical significance was set at $p < 0.05$.

Results

The study was completed with 98 middle-aged females with BMI ≥ 30 kg/m^2. By CIS-T questionnaire, fatigue was identified in 62.3% of the subjects. The bodyweight and BMI values of the obese individuals with fatigue were determined to be statistically significantly higher than the values of the obese individuals without fatigue ($p < 0.05$), (Table 1).

No significant difference was determined between groups with respect to marital status, education level, occupation, regular medication use or smoking status ($p > 0.05$). The exercise habits of the fatigue group were determined to be statistically significantly lower than those of the non-fatigue group ($p < 0.05$), (Table 2).

In the evaluation of the data of all the participants, the CIS-SEF points were determined as 34.8 ± 10, CIS-RC as 19.2 ± 6.5, CIS-RM as 15.8 ± 5.1, CIS-PAL as 11.1 ± 3.9 and the total scale points (CIS-T) as 80.9 ± 21.2.

Statistically signifcant differences were found between the fatigue and non-fatigue groups in the results for the 3-meter Tandem Walk Test, the Functional Reach Test, the Timed Up and Go Test, and the Single Leg Stance Test ($p < 0.05$), (Table 3).

Correlations were determined at different levels between the tests applied and the CIS-SEF, CIS-RC, CIS-RM and CIS-PAL sub-parameters of the CIS-T scale (Table 4).

Discussion

The results of the current study showed symptoms of fatigue in almost two-thirds of the middle-aged, obese females included in the study. Inactivity may be a factor in the development of fatigue. Increased fatigue is considered to have a negative effect on functional mobility and balance.

There are known relationships between fatigue and high BMI, increased waist circumference and low levels of physical activity [18]. The findings of a study which examined the physical activity levels of individuals aged over 70 years who were fatigued (BMI: 26.7 kg/m^2) and those without fatigue (BMI: 25.8 kg/m^2) showed that

Table 1 Physical characteristics of participants

	Nonfatigue (n = 37, %37.7)	Fatigue (n = 61, %62.3)	*P* value	All participant (n = 98, %100)
Age (year)	50.1 ± 5.7	50.4 ± 6.9	0.8	50.3 ± 6.4
Heigth (cm)	159.9 ± 6.1	159.2 ± 5.3	0.5	159.5 ± 5.6
Weigth (kg)	81.6 ± 6.9	87.9 ± 9.9	0.001*	85.5 ± 9.4
BMI (kg/m^2)	31.9 ± 2.4	34.6 ± 3.4	0.001*	33.6 ± 3.3

Datas are reported as means ± standard deviations. BMI = body mass index, $^*p < 0.05$.

Table 2 Sociodemographic characteristics of participants

	Nonfatigue (n = 37, %37.7)	Fatigue (n = 61, %62.3)	*p* value	All participant (n = 98, %100)
Marital status (n/%)				
Married	29 (78.4)	48 (78.7)	0.9	77 (78.6)
Widowed	6 (16.2)	11 (18)		17 (17.3)
Single	2 (5.4)	2 (3.3)		4 (4.1)
Level of education (n/%)				
Illiterate	2 (5.4)	5 (8.2)	0.6	7 (7.1)
Elementary school	19 (51.3)	28 (45.9)		47 (48)
Secondary school	4 (10.8)	9 (14.8)		13 (13.3)
High School	9 (24.3)	13 (21.3)		22 (22.4)
Univertisy	3 (8.2)	6 (9.8)		9 (9.2)
Work status (n/%)				
House wife	28 (75.7)	44 (72.2)	0.8	72 (73.5)
Retired	4 (10.8)	6 (9.8)		10 (10.2)
Actively Working	5 (13.5)	11 (18)		16 (16.3)
Medications (n/%)				
Not using	27 (73)	43 (70.5)	0.9	70 (71.4)
At least one regular	10 (27)	18 (29.5)		28 (28.6)
Tobacco use (n/%)				
Yes	3 (8.1)	11 (18)	0.06	14 (14.3)
No	32 (86.5)	42 (68.9)		74 (75.5)
Give up smoking	2 (5.4)	8 (13.1)		10 (10.2)
Physical Exercise (n/%)				
None	25 (67.6)	53 (86.9)	0.007*	78 (79.6)
Regularly	12 (32.4)	8 (13.1)		20 (20.4)

*$p < 0.05$.

Table 3 Comparison of functional mobility and balance in fatigued and non-fatigued individuals

	Nonfatigue (n = 37, %37.7)	Fatigue (n = 61, %62.3)	*p* value
3-meter Timed Tandem Walk test	12.4 ± 5.7	15.7 ± 7.1	0.02*
Functional Reach Test	27.2 ± 10.1	22.7 ± 9.6	0.04*
Timed Up and Go Test	10.9 ± 2.6	14.1 ± 6.4	0.001*
One-Legged Stance Test with Eyes Open	22.9 ± 7.4	17.8 ± 9.1	0.005*

Datas are reported as means ± standard deviations.
*$p < 0.05$.

those with fatigue took fewer steps per day and had shorter periods of daily activities and moderate level exercise [8]. The present study's findings that the middle-aged obese females with fatigue had a higher BMI, lower levels of exercise habits and longer times in the results of the 3-meter Timed Tandem Walk Test support those of the previous study by Egerton *et al.*

Fatigue lays the groundwork for several deficiencies that affect the daily life of the individual. However, in the current literature it can be seen that there has been little research on walking and balance parameters of patients with fatigue [19]. Furthermore, the effect of fatigue on mobility and balance in obese individuals who have lost balance and mobility functions because of obesity has not been sufficiently evaluated [20].

One study found that 30-50% of patients with chronic fatigue syndrome show a loss of static and dynamic balance, which are vital for daily living activities [19]. Walking is a basic activity, as is balance, and walking is affected by almost all neuromuscular disor-

Table 4 Correlation analysis between CIS-T scores and 3-meter Timed Tandem Walk Test, Functional Reach Test, Timed Up and Go Test, OLST parameters

	3-m TTW	FRT	TUG	OLST
	r value	r value	r value	r value
CIS-SEF	0.14	−0.12	0.09	−0.20*
CIS-RC	0.18	−0.25*	0.17	−0.30**
CIS-RM	0.45*	−0.17	0.29**	−0.21*
CIS-PAL	0.51**	−0.17	0.17	−0.09
CIS-T Total	0.31*	−0.21*	−0.22*	−0.26*

3-m TTW: 3 meter Timed Tandem Walk test, FRT, Functional Reach Test; TUG, Timed Up and Go Test; OLST, One-Legged Stance Test with Eyes Open; CIS-T, Checklist Individual Strength-Turkish; CIS-SEF, Checklist Individual Strength-subjective experience of fatigue; CIS-RC, Checklist Individual Strength-reduction of concentration; CIS-RM, Checklist Individual Strength-reduction of motivation; CIS-PAL, Checklist Individual Strength-physical activity level; r value, correlation coefficient. *Correlations significant at the 0.05 level, **Correlations significant at the 0.01 level.

ders [19]. Rasouli *et al*. examined dynamic balance during gait analysis of young females with chronic fatigue syndrome compared with a healthy control group, and reported that in the group with fatigue, the acceleration phase in walking was prolonged, peak velocity was reached later, and the deceleration phase was shortened; in other words, dynamic balance control was weakened during walking [21]. The current study, in which the distance in the Functional Reach Test was shorter and a longer duration was recorded in the Timed Up and Go Test, which was used to evaluate mobility and dynamic balance together, supports these results of other researchers. In addition, the dynamic and static balance test results showed a correlation with the concentration effect of fatigue.

The most frequently used marker of mobility is walking pace. A slow walking pace is a strong indicator of age, health status, insufficient dailing living activities, restricted mobilisation, cardiovascular disease, a need for care and mortality [22]. In a study which evaluated patients diagnosed with Parkinson's disease, a close relationship was found between physical fatigue and both the balance of patients and their walking pace [23]. Richardson *et al*. separated healthy elderly individuals into 2 groups according to their walking pace and reported that the slower-paced group had reduced aerobic capacity, expended more energy while walking and felt more tired [22]. Similar results were obtained in the current study in the Timed Up and Go Test and the 3-meter Timed Tandem Walk Test. A correlation was found between these two tests and physical activity and /or motivation.

In a study by Boda *et al.*, the walking kinematics of individuals diagnosed with chronic fatigue syndrome were evaluated at a slow walking pace (*i.e.*, 0.45, 0.89 and 1.34 m/sec) and a 30-meter running time, and the running times of the fatigued individuals were found to be slower. The researchers attributed the latter finding to balance problems, muscle weakness or central nervous system disorders [24]. Although very few studies have examined the walking patterns of patients with chronic fatigue syndrome, in another study, while a difference was observed in the gait parameters of young patients with CFS compared to a healthy control group without fatigue, no statistically significant difference was determined between the groups in respect of postural sway measured with eyes open and closed. When a mild-level exercise program was applied to the groups, the fatigue group was found to feel significantly more tired after the exercise despite the same exercise burden. However, although an increase in postural sway after exercise was expected in the fatigue group, no statistically significant difference was found between groups [19]. During the One-Legged Stance Test with Eyes Open, the duration that static balance could be maintained by the obese females with fatigue was determined to be significantly shorter. Static balance was seen to be correlated with the subjective effect of fatigue, concentration and motivation.

Risk factors that can be modified that affect fatigue include lifestyle factors, BMI, fat ratio in the diet, and the amount of physical activity [18]. Cognitive behavioural therapy and exercise therapy are effective in reducing fatigue and increasing physical functions and are recommended in the treatment of fatigue [25]. Because these problems are 'circular' nature. Especially when planning exercise for the treatment of obesity, the fatigue status of the patient must be evaluated and exercise programs must be personalised according to the functional losses and degree of fatigue of the individual patient [26].

The strengths of this study were the matched design and the fact that validated tests and questionnaires were used. Its limitations lay in the fact that it was a cross-sectional design in a single centre, only females within a relatively narrow age range were included and in the evaluation of this small case group, parameters which could affect balance and mobility, such as muscle strength, were not examined.

In conclusion, fatigue observed in obese females is correlated with low physical activity. Increased fatigue is seen to have negative effects on functional mobility and balance. Several studies have shown that fatigue increases together with ageing. Therefore, it is possible that reducing fatigue symptoms in obese, middle-aged women could prevent functional limitations that may develop at an advanced age. This possibility can explored with future research.

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