ORİJİNAL ARAŞTIRMA ORIGINAL RESEARCH

Different Normalization Strategies Could Be Applied to Evaluate the Resting and Walking Energy Expenditures of Individuals with Different Body Mass Index

Farklı Beden Kitle İndeksine Sahip Bireylerin Dinlenim ve Yürüme Enerji Tüketimlerini Değerlendirmek İçin Farklı Normalizasyon Yöntemleri Uygulanabilir

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ABSTRACT Objective: The energy expenditure can be measured either during resting condition or performing a particular type of a physical activity. The purpose of this study is to evaluate the resting and walking energy expenditure at preferred walking speed (PWS) with different body mass index (BMI) and to determine the effect of normalization techniques to these data. **Material and Methods:** Four groups are formed as underweight, normal, overweight, and obese according to BMI of individuals. A total of 64 healthy young adults with no known gait disabilities were recruited. The gross resting energy expenditure (REE) was measured with indirect calorimeter method for 30 min and walking energy expenditure was measured during subjects' walk in their PWS on treadmill for 7 min. **Results:** The gross REE was significantly higher in obese subjects compared to underweight and normal subjects (p<0.0001). When REE was normalized to body weight, it was higher in underweight and normal groups than overweight and obese groups (p<0.0001). However, when REE was normalized to fat-free mass, it did not differ significantly between groups. The gross walking energy expenditure in PWS was higher in obese and overweight groups than underweight and normal groups (p<0.0001). **Conclusion:** In order to eliminate fat-mass effect on REE of obese individuals, REE normalized to fat-free mass should be used to acquire more accurate results. On the other hand, the fat-mass increment raises energy requirement while walking to retain the body balance. Thus, gross walking energy expenditure should be taken into consideration for the evaluating energy expenditure of walking.

Keywords: Energy expenditure; body composition; obesity

ÖZET Amaç: Enerji tüketimi, hem dinlenim hem de belli bir fiziksel aktivite sırasında ölçülebilmektedir. Bu çalışmanın amacı farklı beden kitle indeksi (BKİ)'ne sahip bireylerin dinlenim ve tercih edilen yürüme hızı (TEYH)'ndaki yürüme enerji tüketimlerini değerlendirmek ve normalizasyon yöntemlerinin bu veriler üzerindeki etkisini belirlemektir. **Gereç ve Yöntemler:** Bireylerin BKİ'sine göre zayıf, normal, vücut ağırlığı fazla ve obez olmak üzere 4 grup oluşturulmuştur. Yürüme bozukluğu olmayan 64 sağlıklı genç birey çalışmaya dahil edilmiştir. Brüt dinlenim enerji tüketimi indirekt kalorimetre yöntemiyle 30 dakika ve yürüme enerji tüketimi bireylerin TEYH'de 7 dakika boyunca ölçülmüştür. **Bulgular:** Brüt dinlenim enerji tüketimi zayıf ve normal bireylerle kıyaslandığında obez bireylerde anlamlı olarak daha yüksektir (p<0,0001). Dinlenim enerji tüketimi vücut ağırlığı ile normalize edildiğinde zayıf ve normal gruplarda vücut ağırlığı fazla ve obez gruplara göre daha yüksek bulunmuştur (p<0,0001). Ancak dinlenim enerji tüketimi yağsız kütle ile normalize edildiğinde gruplar arasında anlamlı bir fark olmamıştır. TEYH'deki brüt yürüme enerji tüketimi vücut ağırlığı fazla ve obez gruplarda zayıf ve normal gruplara göre yüksek bulunmuştur (p<0,0001). **Sonuç:** Obez bireylerde dinlenim enerji tüketimi üzerinde yağ kütlesinin etkisini elimine etmek için dinlenim enerji tüketiminin yağsız kütle ile normalizasyonu daha doğru sonuçların elde edilmesini sağlayabilir. Diğer yandan, yağ kütlesinin artışı yürüme sırasında vücut dengesini korumak için enerji gereksinimini artırmaktadır. Bu nedenle yürüme enerji tüketiminin değerlendirilmesinde brüt yürüme enerji tüketimi göz önünde bulundurulabilir.

Anahtar Kelimeler: Enerji tüketimi; vücut kompozisyonu; obezite

The indirect calorimetry is a method used to measure energy expenditure. This method measures the oxygen (O_2) consumption and carbon dioxide (CO_2) production to determine the resting energy expenditure (REE) by the Weir equation.[1] In order to determine the energy consumption to provide adequate nutrition especially for obese subjects, it is substantial to measure both the REE and the walking energy expenditure.[2] The metabolic rates have to be standardized in order to compare the energy expenditure of subjects with different body weight.[3,4] The body weight, height, body surface area, fat mass and fat free mass (FFM) were frequently used to normalize the energy expenditure.[5]

The normal walking can be defined as subsequent series of rhythmic and various movements that require at least one foot contacts with ground to move the body forward in a full walking cycle.[6] The preferred walking speed (PWS) is determined by the central nervous system and known to be a speed in which subjects walk in a "natural" or "comfortable" way, and the walking energy expenditure is minimum.[7] Previous studies have indicated that obese individuals had lower walking speed than the normal weight counterparts.[8,9] It was also reported that the obese subjects require relatively more aerobic exertion during walking on their PWS than the normal weight individuals.[8] It was emphasized that the walking speed affects the energy expenditure in addition to the body weight.[10] The oxygen cost is the volume of oxygen uptake per distance and indicate the walking efficiency.[4,11] It associates with the level of physical effort and evaluates the amount of energy required during walking.[11]

The walking is the simplest method to increase daily physical activity level for most people.[10] The low physical activity level may cause obesity. It is important to determine the energy expenditure during the activities like walking and running to develop appropriate exercise prescriptions and to manage a healthy body weight.[12]

In former studies, the REE and walking energy expenditure have been studied between the overweight/obese and normal individuals, and evaluated by using the different normalization methods.[13-15] However; we could not find any study in which the normalization data was used to compare the REE and walking energy expenditure of individuals at PWS and higher speeds with different body mass index (BMI) like underweight, normal, overweight and obese groups. Therefore, we aimed to evaluate the REE and walking energy expenditure at PWS and higher walking speeds of individuals with different BMI and to determine the effect of normalization techniques to these data.

▌ MATERIAL AND METHODS

This study consisted of 4 groups as underweight (BMI <18,5 kg/m²), normal (BMI=18,5-24,9 kg/m²), overweight (BMI=25-29,9 kg/m²), and obese (BMI ≥30 kg/m²). The healthy eight woman and eight man with no known gait disabilities were assigned to each groups (total 64 subjects) aged between 18-30 years. All participants were asked to fill out a physical fitness readiness questionnaire.[16] All participants signed the written informed consent. This study was approved by Mersin University Clinical Research Ethics Committee (Date: 18/10/2012, Number: 2012/342) and performed according to the principles of the Declaration of Helsinki Approval.

All participants' height was measured barefoot by a stadiometer and the body composition was estimated via the bioelectric impedance analysis method (TANITA BC-418 MA, Tanita Corporation, Tokio, JAPAN). The BMI of participants was calculated as the body weight in kilograms divided by the height in meters squared (kg/m²).

DETERMINATION OF THE PREFERRED WALKING SPEED

The PWS of each participant was determined by walking in 14 m walkway with infrared sensors (Sport Expert Professional Sport Technologies, Sport Expert Professional Sport Technologies, Ankara, Turkey) placed in 2nd and 12th meters. All participants were instructed to walk at a speed that is most "natural" or "comfortable" along the walkway. This protocol was repeated three times and the calculated average duration was used to evaluate the PWS.[17]

THE ENERGY EXPENDITURE MEASUREMENTS

The exclusion criteria were any gait abnormalities, extremity injuries, or taking medications that may

change their energy metabolism. Subjects were asked to fast and not to attend any physical exercise for 12 h before the test day.[18] All female participants attended the test protocol at their follicular phase of the menstrual cycle.[15] The energy expenditure of individuals was assessed by the indirect calorimeter method (Vmax Spectra 29c, California, USA). Two different standard gas mixtures (%4 CO_2, %16 O_2, balance N_2 and %26 O_2, balance N_2 gas mixtures) were used to calibrate the gas analyzer, and the flow sensor was calibrated using a 3-L syringe before the each testing trials. The inspired and expired gas samples were analyzed as breath-by-breath via a face mask (Hans Rudolph, Kansas, USA). The measurement of REE was performed in a termoneutral environment, and the participants were kept awake in a supine position during 30 min. The last 5 min data was used to determine the REE.

Before the walking energy expenditure measurement, all participants walked for 10 min on the treadmill for familiarization to the treadmill.[19] The walking energy expenditures of subjects were measured during the walking at their PWS and 30% more of PWS (PWS 30%) on the treadmill (Viasys Health Care, California, USA) for 7 min.[20] The energy expenditure measurements were calculated by using the abbreviated Weir equation.[1] The last 2 min data of the walking energy expenditure trial were averaged at 10 s intervals to determine the walking energy expenditure.[17] The respiratory exchange ratio (RER) is the ratio of CO_2 output to O_2 consumption and it was used to evaluate the exercise intensity during walking.[10]

STATISTICAL ANALYSIS

The descriptive statistics were reported as mean±standard deviation. ANOVA was used to calculate the differences between the four study groups. The post hoc TUKEY and LSD tests were used to locate the statistical significance between the groups. The descriptive statistics for the non-parametric data was presented as the median. Kruskal-Wallis test was used to compare medians. Regression analysis was used to describe the association between the variables of the obese and normal groups and to evaluate the model-predicted for the obese and normal groups. The significance was set to p≤0.05 for all statistical tests.

RESULTS

The demographic and anthropometric characteristics of groups are shown in Table 1 and Table 2.

The means of REE values and the means of normalized REE by body mass and FFM variables in the groups are shown in Figure 1 and Figure 2.

There was no significant difference between the groups in terms of the means of the PWS (p>0.05). The means of the PWS were 4.13±0.57 kph in the underweight, 4.48±0.46 kph in the normal, 4.18±0.57 kph in the overweight and 4.09±0.53 kph in the obese groups. The means of the PWS 30% were 5.35±0.71 kph in the underweight, 5.83±0.61 kph in the normal, 5.38±0.74 kph in the overweight, and 5.31±0.67 kph in the obese groups.

The medians of walking energy expenditure both at PWS and PWS30%, the means of normalized walking energy expenditure at PWS and at PWS 30% by the body mass and the medians of walking energy expenditure at PWS and PWS 30% by the FFM are shown respectively in Figure 3, Figure 4, Figure 5.

The means of RER values of all groups were under 1.00 during all metabolic measurements. It means that the aerobic metabolism was dominant in the individuals during all procedures.[10]

The medians of the oxygen cost 2 were statistically higher in the underweight and normal groups than the other groups (p<0.0001) (Table 3). The means of oxygen cost 4 were statistically higher in the underweight and normal groups than overweight group (p<0.05) (Table 4).

REGRESSION ANALYSIS

The R^2 between the walking energy expenditure and weight was significant in the normal and obese groups (p<0.05) (Table 5). The weight explained 70.5% of the walking energy expenditure at PWS in the normal group, but 57.9% and in the obese group. The FFM explained 64.1% of the walking energy expenditure in the normal group at PWS.

The R^2 between the gross REE and FFM was significant in both groups (p<0.05). As expected, the FFM explained 83.5% of the REE in the normal group and 26.8% in the obese group (Table 6).

TABLE 1: Means and standard deviations of the demographic and anthropometric variables in the groups.				
	Underweight	Normal	Overweight	Obese	
Variables	Mean±S.D	Mean±S.D	Mean±S.D	Mean±S.D	p
Age (years)	20.94±161	24.13*±2.94	22.63±3.46	22.13±2.42	0.014
Height (cm)	170.74±6.36	166.29±9.95	170.14±9.67	172.27±10.69	0.319
Body Fat (%)	13.38±6.49	19.7±6.15	29.98*,†±8.65	37.26*,†,‡±8.57	<0.0001
Fat Mass (kg)	6.77±3.52	11.20±3.16	23.64*,†,§±6.49	38.68*,†,‡±10.35	<0.0001

*: Compared to underweight; †: Compared to normal; ‡: Compared to overweight; §: Compared to obese; S.D: Standard deviation.

TABLE 2: Medians and minimum-maximum values of the demographic and anthropometric variables in the groups.								
	Underweight		Normal		Overweight		Obese		
Variables	Min-Max	Median	Min-Max	Median	Min-Max	Median	Min-Max	Median	p
Weight (kg) ‡	42.90-56.10	50.25	46.30-75.30	61.10	66.30-97.30	81.55	84.80-152.10	101.65	<0.0001
BMI (kg/m²) ‡	15.80-18.40	17.35	19.30-24.60	21.60	25.30-29.90	27.70	30.30-42.10	34.45	<0.0001
FFM (kg)	32.6-52.30	42.45	31.60-71.40	48.60	42.60-71.40	55.6*	50.90-98.70	61.55*,†	<0.0001
Abdominal Fat (kg) ‡	0.8-8.60	3.1	3.40-10.10	5	8.10-22	12.45	11.60-26.60	20.10	<0.0001

BMI: Body mass index; FFM: Fat free mass.

*: compared to underweight; †: compared to normal; ‡:There was a significant difference between all groups for the medians of the weight, BMI and abdominal fat.

DISCUSSION

THE RESTING ENERGY EXPENDITURE

The REE is defined as the sum of the metabolic rates of all tissues and organs in the body and depends on the body composition.[21,22] Between-individual variability in REE is related to various personal factors (the body size, body composition, age, gender, etc.).[23] Several normalization methods were developed to compare the physiological variables between people with different body size.[24,25] One of these methods is the normalization of the energy expenditure by the body weight. The relationship between the REE and body size was studied in previous studies.[22,26] As it is expected, the gross REE was significantly higher in obese individuals than the underweight and normal individuals in the current study. However, there was no significant difference between the overweight and obese individuals in terms of the gross REE, since the FFM was not significantly different between the overweight and obese individuals.

Gallagher et al. have reported that there is a significant relationship between the oxidative metabolism and body composition.[27] The individuals with lower body size tend to have higher REEs per
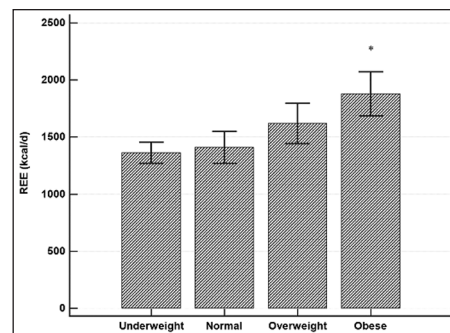

FIGURE 1: The means of resting energy expenditure (REE) values in the groups. *REE in obese group significantly higher than the underweight and normal groups (p<0.0001).

kilogram of body cell mass and FFM than the individuals with higher body size. The main reason for this situation is that the obese and overweight subjects have more FFM than the other groups and it is well known that the FFM has the highest contribution to the REE.[3,28,29] In accordance with our results, it has been concluded that the FFM and the fat mass account for together 70% of the REE and the fat mass account for 4% of the REE.[30] Based on the findings of the current study, the normalization of the gross REE by the body weight lead to lower REE results in obese subjects. The normalization of REE by the
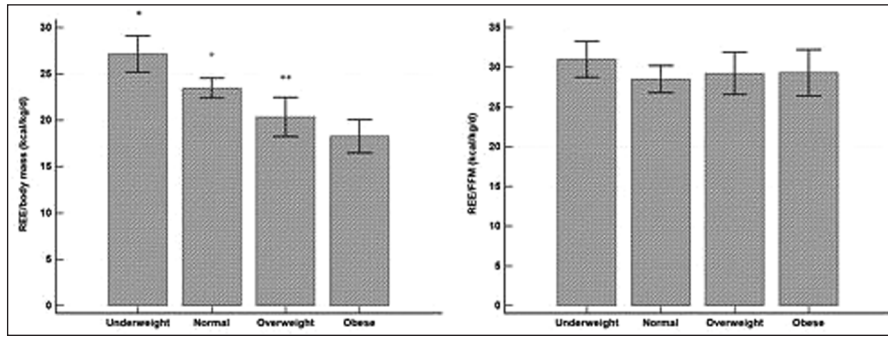
FIGURE 2: The means of normalized resting energy expenditure (REE) by body mass and fat free mass (FFM) variables in the groups.

*REE/body mass is higher in the underweight and normal than the other groups. **REE/body mass is higher in the overweight than the obese (p<0.0001). There was no a significant difference between groups in terms of REE/FFM (p= 0.464).
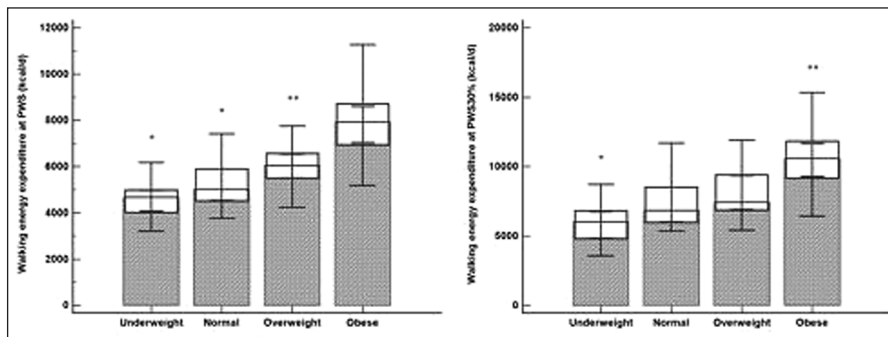

FIGURE 3: The walking energy expenditure both at preferred walking speed (PWS) and PWS30% (kcal/d).

*Walking energy expenditure at PWS is significantly lower in the underweight and normal than the other groups. **Walking energy expenditure at PWS in overweight is significantly lower than the obese group (p<0.0001). *There was a significant difference between the underweight and the other groups in terms of the median of the walking energy expenditure at PWS30%. **The walking energy expenditure at PWS30% was significantly higher in obese than the normal and overweight groups (p<0.0001).
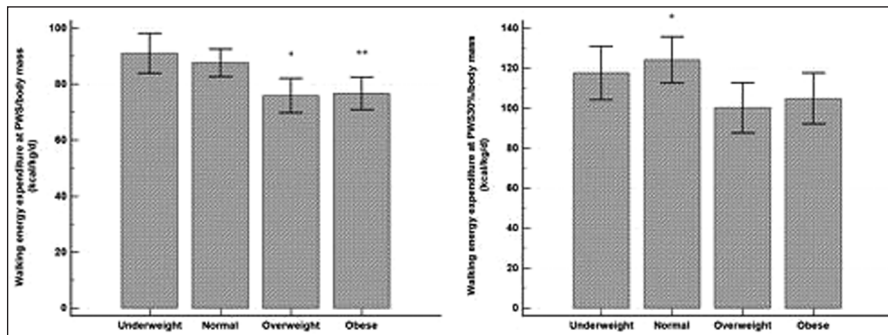

FIGURE 4: The walking energy expenditure at PWS /the body mass, and the walking energy expenditure at PWS30%/the body mass in the groups.

*The walking energy expenditure at preferred walking speed (PWS) normalized by the body mass was statistically lower in the overweight group than underweight and normal groups. **It was also significantly lower in obese than the underweight and normal groups (p<0.05). *There was also a significant difference between the normal and overweight groups in terms of the means of the normalized walking energy expenditure at PWS30% (p<0.05).

body weight also leads to an evaluation of all the part of the body composition (inactive FM) as an active tissue. The lower REE results also cause an improper diet programming because of inaccurate calorie estimation for obese subjects. Therefore, the determination of the body composition is essential for the interpretation of between-individual differences in REE.[25]

The specific metabolic rate (energy expenditure per unit body mass) is lower in the obese individu-
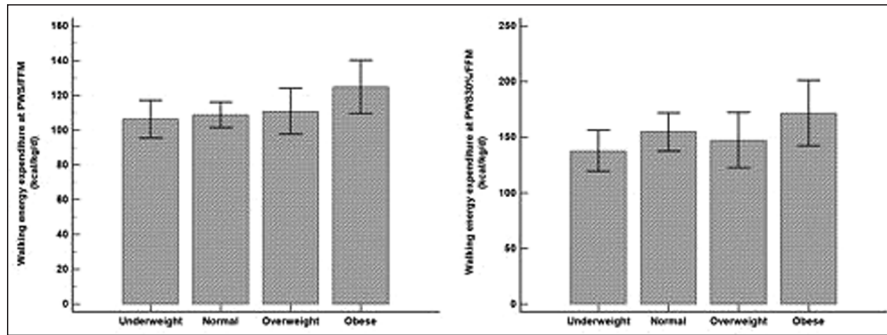
FIGURE 5: The medians of the walking energy expenditure at preferred walking speed (PWS)/the fat free mass (FFM), and the walking energy expenditure at PWS30%/the FFM in the groups. There was no significant difference among the all groups in terms of the medians of the walking energy expenditure both at PWS and PWS30% per kg of the FFM (p>0.05).

TABLE 3: The medians of the oxygen cost in the groups.									
	Underweight		**Normal**		**Overweight**		**Obese**		
Variables	Min-Max	Median	Min-Max	Median	Min-Max	Median	Min-Max	Median	p
Oxygen Cost 1 (ml/kg/m)	0.09-0.17	0.12	0.11-0.16	0.12	0.10-0.14	0.11	0.10-0.15	0.12	0.44
Oxygen Cost 2 (ml/kg/m)	0.09-0.17	0.11	0.10-0.15	0.11	0.08-0.12	0.09	0.06-0.13	0.10	<0.0001

Oxygen Cost 1 was calculated by dividing net energy expenditure [subtracting normalized VO_2 by body mass during resting energy expenditure (REE) from consumed VO_2 during walking energy expenditure at preferred walking speed (PWS)] to PWS.

Oxygen Cost 2 was calculated by dividing net energy expenditure (subtracting normalized VO_2 by FFM during REE from consumed VO_2 during walking energy expenditure at PWS) to PWS.

TABLE 4: The means of oxygen cost in groups.				
	Underweight	**Normal**	**Overweight**	**Obese**
Variables	Mean±S.D	Mean±S.D	Mean±S.D	Mean±S.D	p
Oxygen Cost 3 (ml/kg/m)	0.14±0.03	0.15±0.02	0.13±0.02	0.14±0.02	0.078
Oxygen Cost 4 (ml/kg/m)	0.14±0.03	0.14±0.02	0.11±0.02	0.12±0.02	0.002

S.D: Standard deviation.

Oxygen Cost 3 was calculated by dividing the net energy expenditure [subtracting normalized VO_2 by the body mass during resting from the consumed VO_2 during walking at preferred walking speed (PWS)30%] to PWS30%.

Oxygen Cost 4 was calculated by dividing the net energy expenditure (subtracting normalized VO_2 by the FFM during resting from the consumed VO_2 during walking at PWS30%) to PWS30%.

TABLE 5: The correlation between the walking energy expenditure at PWS and age, height, weight, FFM, fat mass and walking speed in the normal and obese groups.				
Walking energy expenditure at PWS (kcal/d)		R^2		
Variables	Normal	p	Obese	p
Age (years)	0.010	0.707	0.030	0.521
Height (cm)	0.599	<0.0001	0.132	0.091
Weight (kg)	0.705	<0.0001	0.579	0.001
FFM (kg)	0.641	<0.0001	0.210	0.074
Fat mass (kg)	0.002	0.883	0.338	0.018
PWS (m/min)	0.519	0.002	0.546	0.001

PWS: Preferred walking speed, FFM: Fat free mass.

TABLE 6: The correlation between the gross REE and age, height, weight, FFM and fat mass in the normal and obese groups.

REE (kcal/d)	R^2			
Variables	Normal	p	Obese	p
Age (years)	0.006	0.782	0.172	0.110
Height (cm)	0.752	<0.0001	0.126	0.177
Weight (kg)	0.830	<0.0001	0.186	0.095
FFM (kg)	0.835	<0.0001	0.268	0.040
Fat mass (kg)	0.031	0.515	0.000	0.975

REE: Resting energy expenditure, FFM: Fat free mass.

als, since they have higher metabolically inactive fat mass. Therefore, the normalized REE by body weight lead to lower REE than the normalized REE by FFM in obese individuals.

Another method that is frequently used is REE's normalization by the FFM. In the current study, there was no significant difference in terms of the REE per kilogram of the FFM in all groups. Yu et al. have shown that the basal metabolic rate normalized by FFM in obese children was significantly higher than the non-obese counterparts.[28] It was known that the FFM is the main determinant of the REE.[3,28,29] Similarly, the linear regression analysis results of our study have shown that the REE was highly correlated with the FFM in normal and obese groups. Heymsfield et al. supported that the FFM is not energetically homogeneous.[31] The increment in body weight comprises the expansion of both the metabolically active and inactive tissues. The metabolically inactive adipose tissue increases more than skeletal muscle and other metabolically active tissues during the weight gaining. Therefore, the contribution of the FFM to the REE may be lesser in obese adults than normal adults.

The basal metabolic rate is proportional to the FFM, and any significant changes in the body composition, such as a decrease in FFM and/or increase in body fat after the second decade, explains the 2% on men and 3% on women BMR reduction per decade.[10] In this study, the means of age in underweight group was significantly lower than the normal group. Watson et al. found that the contribution of age to the REE was low (2%).[30] According to the linear regression analysis of our study, there is no signifi-

cant correlation between the age and REE. Therefore, it was assumed that the difference of age between the groups did not affect the measurement of energy expenditure in our study.

THE WALKING ENERGY EXPENDITURE

The PWS and the body mass are the important determinants of the energy expenditure during the movement of the body forward.[32] In our study, although the PWS of the obese subjects was lower than the other groups, it was not statistically significant. Browning and Kram postulated that the PWS of the obese subjects were not different from the normal subjects.[33] Moreover, lower PWS were also reported by obese subjects in other studies.[8,9]

Biomechanical loads during walking greatly increased in obese adults. LeCheminant et al. reported that the overweight/obese women had greater walking energy expenditure than the normal weight women.[34] The result of our study implies that the gross walking energy expenditure was significantly higher in overweight and obese individuals than the underweight and normal individuals. Similarly, the gross walking energy expenditure was significantly higher in obese participants than the overweight counterparts. It has been shown that the net metabolic energy during walking was higher in obese individuals than the normal individuals and when the net metabolic rate was normalized by the body mass, the results were 6-13% higher in obese individuals than the normal individuals.[32] Mattsson et al. have reported that obese women have higher metabolic energy during walking than the normal weight women.[8] Ayub and Bar-Or declared that the

high ventilation rate in obese subjects lead to increased walking energy expenditure in faster walking speeds.[35] In our study, there was a significant difference between the underweight and the other groups in terms of the median value of the gross walking energy expenditure, and it was also statistically higher in obese than the normal and overweight groups at PWS30%.

According to our results, the gross walking energy expenditure results that are normalized by body weight were significantly lower in the overweight and obese individuals than the underweight and normal individuals. The gross walking energy expenditure normalized by body weight in overweight group is also significantly lower than the normal group at PWS30%. In accordance with our results, Browning et al. have found that the walking energy expenditure per kg body mass is lower in obese individuals than non-obese counterparts at different speeds and grades and they claimed that the obesity does not impair the walking energy expenditure.[36] In contrast, more aerobic effort while walking at PWS was reported in obese subjects.[33]

The other method for the normalization of the walking energy expenditure is by FFM. Our results indicated that there was no significant difference between groups in terms of the walking energy expenditure normalized by the FFM. Similarly, in a previous study, a significant difference was not found between groups in terms of the walking energy expenditure per kg of the FFM.[32] Ayub and Bar-Or have indicated that the increased oxygen cost can be explained by enhanced total body weight rather than the increased adipose tissue at all walking speeds.[35] Moreover, our regression analysis result shows that the effect of the fat mass is highly increased while walking on the treadmill that may be commented as the fat mass is an important determinant of the increased walking energy expenditure due to altered balance. Katch et al. have also indicated that the obese individuals need more energy to maintain balance at increased walking speeds, and this energy will increase with the body fat gain.[37]

The metabolic energy during walking is required to elevate and accelerate the centre of mass, to support the body, to ensure leg swing and to maintain balance. Obesity causes a postural instability that may be compensated by increased energy expenditure.[37] Therefore, when the walking energy expenditure normalized by the body weight in obese subjects may disregards effect of these processes.[36] According to these results, to use the walking oxygen consumption normalized by the body weight or the FFM to calculate the oxygen cost may lead to inaccurate results. We may speculate that there is no good walking economy in obese subjects walking, the misinterpretation of walking energy expenditure data may lead to that comments about walking energy expenditure in obese subjects.

In present study, it was found that the body mass was the most important determinant of the walking energy expenditure in obese groups. According to a former study, it was reported that the body mass was more correlated with the energy cost than the age, height and fat percentage at the three different walking speeds.[35] Lafortuna et al. have indicated that 82-92% of the alteration observed in metabolic rate can be explained with the body mass at the different walking conditions.[32] Therefore, walking is a difficult task for the obese subjects, and requires a substantial percentage of the aerobic maximal capacity.

CONCLUSION

In conclusion, the energy expenditure is closely associated with the body composition. In obese population, many different normalization methods wherein the body weight, FFM, or fat mass were used to evaluate the energy expenditure. The FFM is highly correlated with the REE. According to our results, the REE normalized by FFM can be used for evaluating REE between obese individuals and others. It is expected that the increased walking energy expenditure in obese group may be related to the negative effect of enhanced body fat on the balance. However, this effect may be underestimated by using the walking energy expenditure normalized either by the body mass or the FFM. Therefore, the gross walking energy expenditure can be used in order to evaluate the walking energy expenditure in obese subjects.

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Uğur Dal;* ***Design:*** *Uğur Dal;* ***Control/Supervision:*** *Uğur Dal, Zeynep Altınkaya;* ***Data Collection and/or Processing:*** *Zeynep Altınkaya, Figen Dağ;* ***Analysis and/or Interpretation:*** *Uğur Dal, Zeynep Altınkaya, Merve Türkegün;* ***Literature Review:*** *Uğur Dal, Zeynep Altınkaya;* ***Writing the Article:*** *Zeynep Altınkaya;* ***Critical Review:*** *Uğur Dal, Figen Dağ.*

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