Comparison of Pulmonary Functions, Physical Activity Level and Quality of Life in Obese and Pre-Obese Individuals

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Abstract

Objective: There are studies regarding pulmonary functions of obese individuals in literature; however, there is insufficient data regarding pre-obese individuals. This study aimed to compare the pulmonary functions, physical activity levels, and health-related quality of life (HRQOL) of obese and pre-obese individuals.

Methods: The characteristics of 62 subjects participating in the study were recorded All subjects were evaluated using pulmonary function tests (PFT), short form-36 health survey (SF-36), obesity and weight loss quality of life measure (OWLQOL), international physical activity questionnaires (IPAQ), and modified medical research council (mMRC) scale.

Results: The severity of perceived dyspnea in obese subjects was significantly higher than that in pre-obese subjects. The PFT parameters (FVC, FEV_1, PEF, FEF_{25-75}, FEF_{25-75}%, MVV, and MVV%) were significantly lower in obese subjects. Although individuals in both groups were inactive, the inactivity levels in obese subjects were significantly higher. HRQOL scores were significantly lower in obese individuals. The body mass index (BMI) was significantly correlated with dyspnea severity, SF-36 subscores, OWLQOL scores, and PFT parameters.

Conclusion: While an increasing BMI has an adverse effect on the pulmonary functions of pre-obese individuals, increased BMI coupled with reduced pulmonary functions causes a decrease in the physical activity levels and reduces HRQOL of obese individuals.

Keywords: Lung function, obesity, physical activity, pulmonary function test, quality of life

INTRODUCTION

The prevalence of obesity continues to increase worldwide. Obesity is defined as abnormal and excessive accumulation of fat molecules within adipose tissues, which could cause adverse health effects (1, 2). Obesity is a health problem characterized by restrictive pulmonary functions. Studies have proven that an increased body mass index (BMI) decreases the forced expiratory volume in 1 second (FEV_1) in pulmonary function tests (3), indicating that obesity is also correlated to an impaired pulmonary function (4). Pulmonary functions disturbed by obesity, particularly the decrease of FEV_1, increase the mortality and morbidity rates (4-6).

Pre-obese and obese individuals are more likely to show pulmonary symptoms compared to non-obese individuals (3). The impairment of pulmonary functions in obese individuals increases their exercise intolerance (1). Because of limited exercise, the physical activity levels decline, leading to a more inactive lifestyle of obese individuals. The decreasing anaerobic threshold increases lactic acid accumulation. Increased lactic acid accumulation in obese individuals leads to increased fatigue and deterioration of the pulmonary system (7).

Banerjee et al. (8) found that there was a significantly negative correlation between FEV_1, FEV_1/forced vital capacity (FVC) ratio, and forced mid-expiratory flow (FEF_{25-75}) percentage values and BMI in obese individuals. However, the effects of obesity on pulmonary functions are still a subject of research (6,

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9). While there are studies regarding pulmonary functions of obese individuals in literature, data are insufficient regarding pre-obese (BMI=25–29.99 kg/m^2) individuals.

This study aimed to compare the pulmonary functions, physical activity levels, and health-related quality of life (HRQOL) of obese and pre-obese individuals and to interpret the differences within these parameters among the groups according to BMI.

METHODS

Study Population

Booths were set up in shopping centers in Turkey's Izmir province to raise awareness regarding the fight against obesity. Overall, 62 individuals who visited the booths volunteered to participate in the study. The flow up of study population throughout the study is shown in Figure 1. The inclusion criteria of our study were determined to be as follows: BMI ≥25 kg/m^2, mentally competent, voluntary participation and ability to walk independently, no hospitalization with pulmonary problems in the last 6 months, and no usage of steroid-containing drugs. The exclusion criteria were as follows: diagnosed with cardiopulmonary conditions (chronic obstructive pulmonary disease, bronchial asthma, bronchiectasis, hypertension, and chronic heart failure), presence of orthopedic pathologies that would prevent performance of physical activities, neurological problems or conditions, and mental and cognitive problems. Participants were classified according to the BMI as pre-obese, BMI=25.00–29.99 kg/m^2, and obese, BMI ≥30 kg/m^2 (10).

Measurements

The height and weight of the participants were measured and BMI was calculated (kg/m^2). FVC, FEV_1, FEV_1/FVC ratio, peak expiratory flow (PEF), and forced mid-expiratory flow rate (FEF_{25-75}) were calculated in accordance with the American Thorax Society criteria using MIR miniSpir® (Medical International Research Co., Roma, Italy). Maximum voluntary ventilation (MVV) was determined as the maximal volume expelled in 12 seconds of forced breathing. All pulmonary test parameters were recorded as the value and percentage of the predicted value. The measurements were obtained while the participants were in a sitting position and had rested for 15 minutes. Participants' noses were constrained using a nose clip. A mouthpiece was placed between the teeth and the lips, and the participants were instructed to breathe through the mouthpiece without creating air leakage. The subjects were instructed to perform a deep inspiration at first, followed by a fast strong expiration, and finally another inspiration to conclude the spirometric test. This test was repeated three times, and the best performance was recorded. For all of these procedures, an information form was completed, and consent was received from the participants (11).

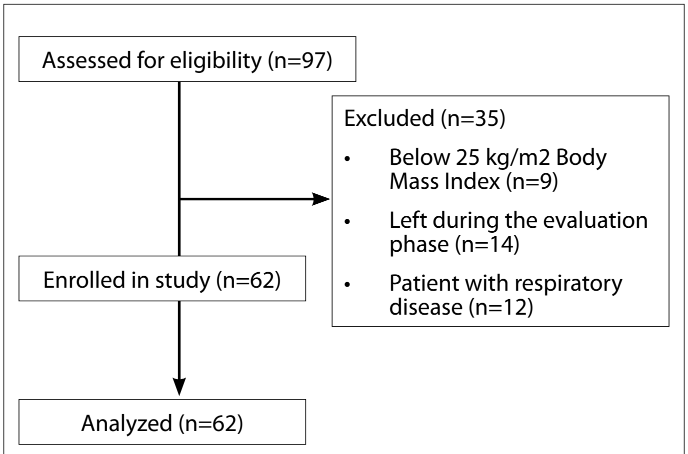

Figure 1. Flow diagram of the study

Dyspnea was evaluated using the modified Medical Research Council (mMRC) Dyspnea Scale, which is a five-item scale based on a variety of physical activities that cause a feeling of dyspnea. The participants read and chose the most appropriate scale option between 0 and 4 that best describes the degree of their pulmonary distress (12).

Short form-international physical activity questionnaire (IPAQ) was used for physical activity evaluation. It determines the physical activity level of a person based on the time spent in the last 7 days during day-to-day physical activities of the person and calculates the metabolic equivalent of task values of each physical activity (13, 14).

HRQOL was evaluated using short form-36 health survey (SF-36). This 36-item survey enables the measurement of eight sections: physical functioning (10 items), social role functioning (2 items), physical role functioning (4 items), emotional role functioning (3 items), mental health (5 items), vitality (4 items), bodily pain (2 items), and general health perceptions (5 items). The subscales measure health between 0 and 100, wherein 0 represents bad health and 100 represents good health (15).

Obesity and weight loss quality of life measure (OWLQOL) developed by Patrick et al. (16) was used to determine the quality of life specific to obesity. The validity and reliability of the scale in Turkish was ensured by Gündüzoğlu et al. (17). OWLQOL is a 17-item Likert-type scale. The questions are answered as 0 - not at all, 1 - hardly, 2 - somewhat, 3 - moderately, 4 - a good deal, 5 - a great deal, or 6 - a very great deal. The scale is a single factor and does not have subfields. The sum of all items within the OWLQOL gives a single quality of life score. As the total score from the scale approaches 0, the quality of life decreases, and as it approaches 100, the quality of life increases. The Cronbach's alpha reliability coefficient of the scale is 0.90 (16, 18).

The participants provided consent for all the procedures. This study was approved by the ethics committee of our institute.

Statistical Analysis

We performed statistical analyzes using the IBM Statistical Package for Social Sciences (SPSS Inc.; Chicago, IL, USA) software for Windows version 20.0.. Descriptive statistical methods (mean, standard deviation, frequency, percentage, and range) were used for evaluating data. Student's t test was used for comparing normally distributed parameters between the two groups, and Mann–Whitney U test was used for comparing the parameters that were not normally distributed. The relation of physical activity levels with other parameters was evaluated using the Pearson correlation analysis. The significance level was determined at 95% confidence interval when p≤0.05.

RESULTS

A total of 62 patients including 24 females and 38 males participated in the study. The individuals were categorized into two groups in accordance with the World Health Organization BMI classification as pre-obese (n=33) and obese (n=29). The pre-obese group consisted of 10 (30.3%) female and 23 (69.7%) male subjects; the obese group consisted of 14 (48.3%) female and 15 (51.7%) male subjects. There was no statistically significant difference among groups in terms of gender (p=0.15) and age (p=0.26). The general characteristics of the groups are given in Table 1.

Comparing the pre-obese group with the obese group, the mean FVC, FEV_1, PEF, FEF_{25-75}, FEF_{25-75}%, MVV, and MVV% values in the obese group showed lower statistical significance ($p<0.05$; Table 2).

The physical activity levels and HRQOL of the groups were compared; the IPAQ, OWLQOL, and SF-36 subscale (physical function, physical role functioning, general health, vitality, social role functioning, and emotional role functioning) scores of the individuals in the obese group showed a lower statistical significance ($p< 0.05$; Table 3).

BMI and mMRC values in the pre-obese group were statistically and positively correlated (r=0.37; p=0.04).

Table 1. Demographic characteristics of the groups

	Pre-obese (n=33) Mean±SD	Obese (n=29) Mean±SD	p
Age, years	51.46±9.40	54.28±9.92	0.26
Height, m	1.70±0.09	1.67±0.11	0.27
Weight, kg	80.24±9.39	91.07±13.54	<0.001
BMI, kg/m^2	27.85±0.99	32.61±1.99	<0.001
mMRC	0.88±0.33	1.41±0.78	<0.001
Cigarette consumption, package.year	26.97±8.38	28.60±10.78	0.73

BMI: Body mass index; mMRC: modified medical research council; SD: standard deviation

A p value <0.05 was considered significant

Table 2. Comparison of pulmonary function test parameters of the groups

	Pre-obese (n=33) Mean±SD	Obese (n=29) Mean±SD	p
FVC, L	3.58±0.95	2.70±0.76	<0.001
FVC, %	92.91±15.07	87.79±11.17	0.13
FEV_1, L	2.91±0.78	2.23±0.51	<0.001
FEV_1, %	92.82±16.81	87.17±16.33	0.18
FEV_1/FVC, %	104.61±9.85	100.86±6.89	0.09
PEF, L/min	5.88±2.07	4.15±1.22	<0.001
PEF, %	74.88±19.65	67.69±17.09	0.13
FEF_{25-75}, L	3.19±1.01	2.43±0.79	<0.001
FEF_{25-75}, %	87.52±24.18	76.17±18.72	0.041
MVV, L/min	102.03±27.33	74.57±21.53	<0.001
MVV, %	86.03±14.84	77.79±15.71	0.042

FEV_1: Forced expiratory volume in 1 second; FEF_{25-75}: forced mid-expiratory flow rate; FVC: forced vital capacity; MVV: maximum voluntary ventilation; PEF: peak expiratory flow; SD: standard deviation

A p value of <0.05 was considered significant

DISCUSSION

Obesity can be defined as the abnormal increase of adipose tissue in the body. For this reason, an overall body weight gain is not similar to obesity. If the increased fat accumulation threatens the health and is at an abnormal level, it can be regarded as obesity (19). In our study that compared the pulmonary functions, physical activity levels, and HRQOL of obese and pre-obese individuals, the similarity of the demographic and clinical characteristics of both groups rendered easy comparison and interpretation of the data from the two groups. Pulmonary symptoms observed in obesity are correlated to an increased risk of morbidity and mortality (5, 6). Studies have shown that pre-obese and obese individuals experience more pulmonary symptoms than do average individuals. Pulmonary functions are determined by the interaction between the lung, chest wall, and diaphragm. Although their lungs are healthy-normal, pulmonary functions are impaired in obese individuals due to the effect of obesity on the thorax and diaphragm (1, 10). In pulmonary functions, particularly, the decrease of FEV_1 is associated with increased morbidity and mortality rates (4). Sarsan et al. (1) found that FEV_1, FVC, FEV_1/FVC ratio, and FEF_{25-75} values were lower in obese women than in non-obese women and that the weight loss coupled with the decrease in adipose tissue causes an increase in FEF_{25-75} value and a decrease in breathing difficulty in both males and females. FEV_1 and PEF are important parameters among the pulmonary functions, as they reflect the diameter of the central airways and the power of expiratory muscles. FEF_{25-75} shows the resistance of small airways. The flow to large airways depends on the elastic recoil of lungs and the resistance of small airways (20). MVV is an important PFT parameter as it defines the muscle strength and endurance. Pulmonary muscles are influenced by the compliance of the lung–thorax system, pulmonary control, and airway and tissue resistance (21). MVV is also reduced in restrictive diseases as well as in moderate to severe airway obstruction and pulmonary muscle dysfunction (22). In our study, pulmonary function values of obese individuals were found to be significantly reduced compared

Table 3. Comparison of values of physical activity level and HRQOL between the two groups

	Pre-obese (n=33) Mean±SD	Obese (n=29) Mean±SD	p
IPAQ	305.61±73.43	177.71±18.50	0.011
OWLQOL	69.15±11.86	35.04±12.33	<0.001
SF-36			
Physical functioning	65.61±20.45	55.66±14.76	0.021
Physical role limitations	48.49±47.16	6.90±1.62	<0.001
Bodily pain	84.64±15.80	79.35±19.23	0.24
General health perceptions	59.18±11.21	53.07±13.28	0.042
Vitality	69.24±10.24	60.52±16.22	0.012
Social role limitations	78.41±12.21	62.85±16.59	<0.001
Emotional role limitations	46.46±47.83	18.38±3.84	0.012
Mental health	66.06±7.95	61.66±12.94	0.11

HRQOL: Health-related quality of life; IPAQ: international physical activity questionnaires; OWLQOL: obesity and weight loss quality of life; SD: standard deviation; SF-36: short-form 36 health status questionnaire

A p value of <0.05 was considered significant to pre-obese individuals. According to our findings, as the BMI increases, the pulmonary muscle strength decreases.

Due to decreased pulmonary muscle strength in obese individuals, the lungs cannot cope with the increased oxygen need in the future thus increasing the severity of perceived dyspnea and thereby contributing to exercise intolerance due to dyspnea in individuals. Increased dyspnea as well as increased BMI and the accompanying musculoskeletal problems cause individuals to lead an inactive lifestyle. For these reasons, it is obvious that pre-obese individuals and particularly obese individuals would have pulmonary problems in the near future. In our study, considering particularly those individuals without a pulmonary problem or a diagnosed lung disease enabled us to clearly interpret the effects of increasing BMI and decreasing physical activity levels on the pulmonary functions of subjects that are assumed healthy.

Sevimli et al. (23) proved that BMI values in individuals with high levels of physical activity were lower than those with a sedentary lifestyle. According to the IPAQ scores in our study, both groups were inactive. In addition, the fact that physical activity level decreases as the BMI increases shows that not only obese individuals but also pre-obese individuals lead inactive lives due to increased BMI. Ultimately, the positive effect of regular physical activity on the BMI of individuals can be seen clearly. Hence, we support the idea that individuals of all ages should lead an active life because of the risk of obesity.

The severity of perceived dyspnea in obese subjects was shown to be significantly higher than that in non-obese individuals, and the severity of dyspnea increased with the level of obesity (24). Also, in our study, the severity of perceived dyspnea in obese subjects showed a higher statistical significance compared to pre-obese individuals. The increase in the severity of dyspnea with increasing BMI in both groups proves that the oxygen requirement cannot be met in proportion to the increased body fat ratio in these individuals (Table 4).

Studies have proven that increasing BMI reduces FEV_1 and FVC in PFT (3). Torun et al. (25) investigated the effect of obesity on pulmonary functions and found that PEF and FEF_{25-75} values of pre-obese individuals were statistically lower than those of normal individuals. Wannamethee et al. (4) proved that in individuals with BMI ≥30 kg/m^2, as BMI increases, FEV_1 and FVC decrease. In our study, the strong negative correlations found between the parameters proves that as BMI increases in obese individuals, FEV_1 and PEF values decrease (Table 4).

Due to the low levels of physical activity in obese individuals, the amount of energy consumed decreases. Lower energy expenditure significantly reduces resting metabolic rate and total energy consumption in obese individuals. It is safe to say that the BMI increases when the energy intake exceeds the amount of energy consumed (26). It is found that physical activity levels of obese individuals are lower than those of normal individuals (27). In obesity etiology, it was demonstrated that obesity formation is caused by physical inactivity, and obese individuals lead inactive lives (28). Hernandez et al. (26) found that the frequency of obesity is increased by physical inactivity. In our study, IPAQ was used to determine how physically active the participants are in their day-to-day lives. Both groups were found to be physically inactive, and the physical activity levels of obese individuals showed a lower statistical significance compared to pre-obese individuals. Another finding was that as BMI increases in obese individuals, the level of physical activity decreases.

Our study shows that as the dyspnea severity and impairment of pulmonary functions increases in obese and pre-obese individuals, the physical activity level decreases. It is a striking fact that pre-obese individuals lead inactive lives similar to the obese individuals. Hence, efforts to fight against obesity should be implemented with a multidisciplinary team; approaches that aim to increase the physical activity levels of individuals should have the top priority. Along with healthy individuals, ensuring that all individuals with a BMI above the normal limits determined by the WHO criteria adopt an active lifestyle would increase the HRQOL of such individuals. Providing the right lifestyle suggestions along with personalized exercise programs will ensure a healthier society.

Obesity has a vitally negative impact on the HRQOL. Kortt et al. (29) proved the negative association between BMI and HRQOL. Jia et al. (30) found that there was a significant difference in HRQOL between normal and obese subjects, and health-related quality of life decreased with weight gain. Vieira et al. (31) found that pre-obese individuals had a self-esteem lower than those with normal BMI; and that similar to obese subjects, pre-obese subjects felt that they were under constant pressure to observe community standards with regard to weight and appearance. Kim et al. (32) found a significant association between obesity and subscales of HRQOL . In our study, the OWLQOL and SF-36 subscale (physical function, physical role functioning, general health, vitality, social role functioning, and emotional role functioning) scores of obese individuals showed a statistical significance lower than that of pre-obese individuals. Our study has shown that the increased BMI and decreased physical activity resulted in decreased HRQOL in both groups.

Although not as striking as in obese individuals, pre-obese individuals also have significantly low quality of life scores, particularly in the subscales of physical function. This result suggests that the HRQOL has begun to decline due to increased BMI in pre-obese subjects. The increase in the pulmonary workload with the increase in BMI indicates the necessity of dealing with dyspnea in these individuals.

For obese individuals, we think that pulmonary physiotherapy techniques for reducing pulmonary workload, and respiratory muscle training would help to reduce pulmonary effects. In addition, providing exercise training and appropriate diet programs for these individuals to lose weight in a healthy way will reduce their body fat ratio by reducing the burden on the joints, increasing the metabolism rate, and accelerating the fat breakdown.

As the level of physical activity of these individuals increases, their HRQOL would definitely improve.

The fact that the results are different in studies examining the effect of obesity on pulmonary function suggests that the inclusion criteria for these studies, number of cases received, and the type of obesity is the reason behind these differences. The fact that the number of cases was low in the study has narrowed the study universe. For this reason, we think the exact relation between BMI and some parameters of pulmonary function test could not be determined. Moreover, not including normal or low-weight subjects in the study resulted in a less-than-conclusive demonstration of the effect of BMI on pulmo-

Table 4. Comparison of correlation of BMI and other outcome parameters in pre-obese and obese groups

	BMI			
	Pre-obese (n=33)		Obese (n=29)	
	r	p	r	p
Age, years	-0.05	0.79	0.07	0.71
Height, m	0.23	0.19	0.02	0.90
Weight, kg	**0.51**	**0.00*** **	**0.43**	**0.02***
Cigarette consumption, pack-years	0.11	0.56	-0.14	0.48
mMRC	**0.37**	**0.04***	**0.45**	**0.05***
OWLQOL	-0.11	0.55	**-0.49**	**0.03***
Physical functioning, SF-36	0.16	0.38	0.05	0.78
Physical role limitations, SF-36	-0.07	0.69	0.19	0.32
Bodily pain, SF-36	0.20	0.28	0.00	0.98
General health perceptions, SF-36	**-0.29**	**0.05***	**-0.48**	**0.01****
Vitality, SF-36	**-0.38**	**0.03***	-0.23	0.23
Social role limitations, SF-36	0.00	0.99	**-0.36**	**0.05***
Emotional role limitations, SF-36	0.00	0.98	-0.15	0.45
Mental health, SF-36	**0.25**	0.16	0.13	0.50
FVC, L	0.03	0.85	-0.17	0.39
FVC, %	-0.18	0.32	0.14	0.48
FEV_1, L	-0.03	0.89	**-0.51**	**0.02***
FEV_1, %	-0.23	0.27	0.05	0.82
FEV_1/FVC, %	**-0.37**	0.08	0.24	0.20
PEF, L/min	0.14	0.45	**-0.53**	**0.03***
PEF, %	0.08	0.66	0.03	0.90
FEF_{25-75}, (L)	-0.01	0.94	-0.05	0.79
FEF_{25-75}, %	-0.03	0.85	-0.18	0.93
MVV, L/min	-0.01	0.96	-0.03	0.90
MVV, %	-0.22	0.21	-0.06	0.77

BMI: Body mass index; FEF_{25-75}: forced mid-expiratory flow rate; FEV_1: forced expiratory volume in 1 second; FVC: forced vital capacity; mMRC: modified medical research council; MVV: maximum voluntary ventilation; OWLQOL: obesity and weight-loss quality of life; PEF: peak expiratory flow; SF-36: short-form 36 health status questionnaire

*=0.01<p≤0.05, **=0.001<p≤0.01, ***=p≤0.001

nary functions. The lack of evaluations regarding the etiology and type of obesity is also a limitation of the study. In addition, more objective parameters, such as pulmonary muscle strength, static lung volumes and capacities, and body fat analysis, could not be measured due to a lack of financial support and necessary equipment.

CONCLUSION

As a conclusion, compatible with the literature, our findings show that increased body weight decreases the physical activity level, disrupts pulmonary functions, and increases the perceived dyspnea severity in obese individuals. The impaired pulmonary functions in obese individuals substantially decrease their activity levels and HRQOL; while the increased body weight disrupts pulmonary functions and creates dyspnea in pre-obese individuals, it does not severely affect their activity level and quality of life. The deteriorating pulmonary functions and the emergence of dyspnea are vitally important in pre-obese individuals. Although these factors do not severely affect the HRQOL of pre-obese individuals, they still decrease it, and with increasing BMI, it is clear that these problems will lead to significant health concerns in the future. Thus, it is necessary to raise awareness regarding the fight against obesity in the earliest period particularly in pre-obese individuals.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Dokuz Eylül University, Institute of Health Sciences Ethical Committee, İzmir, Turkey.

Informed Consent: Written informed consent was obtained from patients who participated in this study.

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