EFFECTS OF COMBINED STRENGTH AND ENDURANCE TRAINING ON RESPIRATORY PARAMETERS AND EXERCISE CAPACITY AMONG GRADE I AND GRADE II OBESE INDIVIDUALS

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Abstract

Background: Obesity is currently a worldwide disease that is affecting every 1 out of 3 individuals regardless of their gender or ethnicity. It is also associated with decreased pulmonary functions that hinders an individual to efficiently carry on activities of daily living without being exhausted.

Objective: This study determined the effects of 6-week combined strength and endurance training on forced expiratory volume in one second (FEV1), forced vital capacity (FVC), ratio between FEV1 and FVC and exercise capacity upon Pakistani individuals with grade I and grade II obesity.

Methods: A Quasi experimental study was conducted in which 46 participants diagnosed with either grade I or grade II obesity were given both strength and endurance based training for 6 weeks, five sessions per week, 1 session per day. Parameters that included anthropometric data, respiratory parameters (FVE1, FVC, FVE1/FVC ratio) and exercise capacities were compared between initial and post interventional values.

RESULTS: Combined strength and endurance training induced an increase in six-minute walk duration ($P < 0.05$), forced vital capacity ($P < 0.05$), FVE1/FVC ratio from predicted value ($P < 0.05$). Individuals with grade II obesity had longer six-minute walk than grade I obese individuals. Grade I obese individuals had greater improvements in Forced Vital Capacity and FVE_1/FVC ratios.

CONCLUSION: Combined endurance and strength-based training improves exercise capacity and respiratory parameters in both grade I and II obese individuals. Improvements in exercise capacity is more prominent in grade II individuals while improvements in respiratory parameters are more prominent in grade I individuals.

KEYWORDS: Exercise Tolerance, Obesity, 6 Minute Walk Test, Resistance Training, Endurance Training, Forced Expiratory Volume

Introduction

A prevalence study conducted by global burden of disease in 2015 stated that approximately one out of three individuals worldwide is either considered as overweight (grade I obesity) or obese (grade II obesity).[1] In Pakistan, National Survey of Pakistan (NHSP) revealed prevalence of obesity of 22% in men and 37% in women in urban regions between 1990-1994 that increased to 23% in men and 40% in women in 2013.[2] Another prevalence study for obesity conducted by Nagy K. et al (2017) that included 20 European countries and 34, 814 adults revealed a 53.1% prevalence of grade I obesity.[3]

In Saudi Arabia a review conducted on 14 prevalence studies in different regions regarding grade I and grade II obesity by Saad (2016) concluded a mean prevalence of 31.6% and 24.6% for grade I and grade II obesity respectively. [4] A study conducted by Hales, C.M, et al (2016) in which different demographic data were analyzed to study prevalence of obesity in the past 10 years, from 2007 to 2016 among adolescents and adults. The study revealed an overall increase of obesity prevalence from 16.8% to 18.5% in adolescents while adults had even more overall increase in prevalence of obesity that is; from 33.7% to 39.6%. [5]

Verma (2017) wrote that several epidemiologic studies revealed the parallel escalation of obesity and diabetes along with at least 45 co morbidities and it has a potential to reach pandemic level by 2030. [6] There is also an evidence of correlation of obesity with musculoskeletal disorders as cited by

Onyemaechi, N et al (2016) who stated that 34% of obese patients had osteoarthritis while 22% of patients with obesity had lower back pain.[7] It is estimated that in next 20 years, prevalence of pulmonary hypertension with obesity will further increase (Kotsis V., 2018).[8] For instance, a study that was conducted upon COVID-19 positive patients who were admitted to Intensive Care Unit (ICU) within first 10 days of arrival correlated several risk factors. Surprisingly, patients with either BMI between 25 and 30 or greater than 35 had the highest prevalence of ICU admissions. [9]

On the other hand, multiple studies have revealed that obesity has a significant relationship with pulmonary function as well. The study concluded a negative association of obesity with logarithm of forced vital capacity (FVC) and logarithm of forced expiratory volume (FEV). [10,11,12]

A retrospective study that was conducted in 2017 by Littleton SW. et al looked at several records of pulmonary function tests of 118 patients and correlated these records with their BMI (body mass index). Comparatively, they found that FEV_1 was lower in both obese individuals associated with at least one comorbidity and those with no comorbidities. They also found a higher ratio of FVE_1/FVC among these individuals. [13] TabarésSeisdedos, R., (2017) revealed that 60% of death in over 195 countries within 25 years had association with obesity. [14]

Interventional approaches towards managing obesity and its associated conditions include surgical intervention, medicinal approach and exercise therapy. According to Nudel, J. and Sanchez, V.M., (2019) they stated that the most effective measure to reduce obesity specially that which is associated with type II diabetes is weight loss surgery. [15] However, operative choices are suspected to risk imposed on associated co morbidities and must be evaluated before selecting one. As far as medicinal approach is concerned, Tronieri JS et al (2016) included a study in which over 3200 overweight/obese patients with glucose tolerance impairment had participated. A randomized control trial between placebo (control) and metformin (intervention) medication concluded that metformin administration to obese patients with diabetes induced a significant weight loss compared to placebo. [16]

As far as studies that correlated variable complications in overweight or obese individuals with exercise interventional approaches, there is a study that was conducted by Ercin et al among 72 obese and overweight individuals with chronic obstructive pulmonary disease (COPD). This study compared effects of interval aerobic training against continuous aerobic training among these patients upon their respiratory parameters and exercise capacities. Eventually, both interventions increased performance of participants in pulmonary function test (PFT) and 6-minute walk test (6MWT). [17]

Obesity is a global disease that has kept on growing worldwide regardless of gender, age or demography. There are many conditions and other diseases that are associated with obesity. Hence the current study was effects of combined strength and endurance training on respiratory parameters and exercise capacity among grade I and grade II obese individuals.

Materials and methods

Target Population

Grade I and II obese patients.

Study Setting

The study was conducted into tertiary care hospitals of Karachi.

Sample Size

Forty six patients.

Study Design

Quasi experimental study

Selection Criteria

Grade I (BMI between 25 and 30) or grade II (BMI beyond 30) obesity. Out of these participants, any individual with a previous history of type I or II diabetes, heart disease or any previous cerebrovascular accident episode were excluded from our final selection criteria

Intervention

Forty six participants were initially screened for their additional anthropometric data that included their waist and hip circumference in inches. Their exercise capacities were measured through six-minute walk test (6MWT). Their respiratory parameters that included forced vital capacity (FVC) and forced expiratory volume in one second (FEV1) were also measured through pulmonary function test by using Spiro Lab. After initial screening of their aforementioned parameters, these participants underwent 6 weeks of a blended training that included both strength and endurance exercises. The training included 5 sessions per week (Monday to Friday), one session per day. These days were divided alternatively among strength training and endurance training sessions. For instance, endurance training was performed on Mondays, Wednesdays and Fridays and strength-based training were performed on Tuesdays and Thursdays. A total of 30 sessions in 6 weeks comprising of 18 sessions of endurance and 12 sessions of strength training were given to the participants. Exercise trainings were performed under the supervision of a qualified physical therapist within the physical therapy department of Ziauddin Hospital, North Nazimabad. All participants performed both aerobic (endurance) and anaerobic (strength) exercises as per ACSM guidelines following FITT's protocol (frequency, intensity, time and type). For instance, Aerobic/endurance trainings were initiated once maximum heart rates of the participants were determined. This included walking for 20 to 60 minutes on treadmill with intensity of 60-80% peak work rate followed by a 5-minute cool down. Once training session was over, they were allowed to sit on a chair for 5 minutes before leaving the training area. All other days that included aerobic training was similarly followed. As far as anaerobic training was concerned, the training was initiated once one-repetition-maximum (1RM) load of each participant was determined. This included resistance training using free weights (dumbbells) weighing 60 to 80% of their 1 RM (One Repetition Maximum). Once 10 to 15 repetitions were performed by the participant, they were asked to take rest for 15-30 seconds to constitute a set. Eventually, each participant performed 1- 4 sets in each session. After 6 weeks of combined training, these participants were reassessed for anthropometric data, respiratory parameters and exercise capacities once again.

Outcome Measures

Anthropometric measurements

Body measurements were taken during morning while participants wore light clothing. Weight was measured nearest to 0.1kg while height was measured nearest to 0.1cm. Waist circumferences and hip circumferences were measured nearest to 0.1 inches. Body Mass Index (BMI) was calculated using Quetlet's index (body weight in kg/height in meters). A BMI score range between 25 and 30 was considered as grade I obesity while BMI score range between 30 and 40 was considered as grade II obesity.

Measurement of Respiratory Parameters

Forced vital capacity (FVC) and FEV1/FVC ratio were assessed by pulmonary function test (PFT) with the help of Spirolab instrument. This instrument consists of a flexible air pipe attached to a turbine which rotates as fast as the air passes through it. All readings were recorded and a printout of recording of each individual was taken.

Measurement of Exercise Capacity

Exercise capacity of each individual was assessed by a 6-minute walk test (6MWT)[18]. During this test, all participants' vitals such as heart rate, breathing rate and saturation of oxygen in blood (SPO2) were taken. Once participants' vitals were assured being normal, they were asked to walk at their natural pace around a 10 meters' hallway back and forth for 6-minutes. Nevertheless, distance travelled in meters in six minutes was recorded for each individual participant.

Statistical Analysis

SPSS 20.0 for windows (SPSS Inc., Madison, WI, USA) was used to record and analyze collected data statistically. Demographic data were expressed in frequencies. Data was then analyzed for distribution pattern. The pattern of our data was normally distributed. Hence, a paired t-test was applied to check for significant mean difference between pre and post data of each parameter.

Results

Demographic Characteristics

Forty-six participants were recruited comprises 54.3% (n=25) males and 45.7% (n=21) females. Out of these, 52.17% (n=24) were overweight or grade I obese while 47.82% (n=22) were grade II obese. The mean age of participants was 41.59±10.15 years. Females were predominant (58.3%) over males in grade I obesity while males were predominant (68.2%) over females in grade II obesity. The mean waist to hip ratio and mean waist to height ratio among grade I obese participants were found to be 0.93 (±0.057).and 0.58(±0.03) respectively while for grade II obese participants, mean waist to hip ratio and mean waist to height ratio were found to be 1.01(±0.05) and 0.65(±0.04) respectively as depicted in table 1.

Table 1 Demographic and anthropometric data of participants between grade I and grade II Obesity		
Participants Characteristics	**Obesity**	
	Grade I (BMI>25kg/m^2) n=24	**Grade II (BMI>30kg/m^2) n=22**
Mean Age in years ± SD	40.87±10.33	42.36±10.12
Males	41.7	68.2
Females	58.3	31.8
Mean Weight in Kg ± SD	73.7 ± 7.37	79.03 ± 7.19
Height in cm ± SD	165 ± 7.45	157.9 ± 6.44
Mean Waist Circumference Inches ± SD	38.06 ± 1.69	40.37 ± 1.57
Mean Hip Circumference in Inches ± SD	40.87 ± 1.23	40.04 ± 1.23
Mean Waist Hip ratio ± SD	0.93 ± 0.05	1.009 ± 0.04

Within group analysis of 6MWD, FVC, FEV1, FVE1/FVC

On the first day, participants had undergone initial screening for parameters to be assessed, i.e. six-minute walk distance (6MWD), Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FVE1) and FVE1/FVC ratio. Mean six-minute walk distance for participants was found out to be 583.7(±69.43) meters, mean Forced Vital Capacity (FVC) was 3.877(±0.73) liters (98.1±10.36% of predicted value), mean Forced Expiratory Volume in one second (FVE1) was 3.26(±0.61) liters/second (99.42±10.27% of predicted value) and FVE1/FVC ratio was found out to be 80.91(±5.03) percent (101.47±5.26% of predicted value)

After 8 weeks of intervention, same parameters were reassessed for any significant differences. Mean Six-minute walk distance of participants was 595.53±73.027 meters, mean Forced Vital Capacity (FVC) was 3.93(±0.74) liters, mean Forced Expiratory Volume in one second (FVE1) was 3.03 (±0.614) liters/second and mean FVE1/FVC ratio was 85.69 (±9.83) percent. Test for normality was done before applying test for statistical significance between pre- and post-results. The data was found to be normally distributed. Afterwards, a paired t-test was applied between means of pre interventional and post interventional data. Table 2 summarizes pre and post exercise comparison between these parameters.

Table 2: Comparison of parameters between pre-post interventional data			
Parameter	**Pre Exercise**	**Post Exercise**	**p-value**
6MWD in meters	583.7	595.53	0.05
FVC liters	3.87	3.93	0.05
FEV1 (Liters/Second)	3.26 ±0.61	3.03 ±0.61	0.05
FVE1/FVC (%)	80.91 ± 5.03	85.69 ± 9.83	0.05

The comparison of post interventional results based on grade I and II obesity revealed significant improvement in all variables with p value 0.05. However, the results were more significant for 6MWD, FVCL, and FEVI1/FVC in grade I obese as compared to grade II obese patients as depicted in table 3.

Table 3: Comparison of post interventional results based on grade I and grade II obesity								
Obesity	6MWD	p-value	FVC L	p-value	FEV1 (L/S)	p-value	FEVI1/FVC (%)	p-value
Grade I	10.33 ± 2.63	0.05	0.08 ± 0.11	0.05	0.22 ± 0.02	0.05	5.24 ± 6.42	0.05
Grade II	13.45±21.29	0.05	0.033±0.08	0.05	0.22±0.21	0.05	4.26±9.54	0.05

Results on all variables were analyzed based on the gender difference that revealed although all variables significantly improved among both the gender, the improvements in males were more significant than females as depicted in table 4

Table 4: Comparison of post interventional results based on gender

Obesity	6MWD	p-value	FVC L	p-value	FEV1 (L/S)	p-value	FEVI1/FVC (%)	p-value
Male	14.76± 22.4	0.05	0.05 ± 0.1	0.05	0.22 ± 0.02	0.05	5.86 ± 8.87	0.05
Female	8.33±25.57	0.05	0.07±0.09	0.05	0.22±0.21	0.05	3.48±6.78	0.05

Discussion

Our study determined the effects of 6-week combined strength and endurance training on forced expiratory volume in one second (FEV1), forced vital capacity (FVC), ratio between FEV1 and FVC and exercise capacity upon Pakistani individuals with grade I and grade II obesity. Hence, our study concluded with similar findings compared to certain researches on the basis of the parameters that we have considered. Our treatment revealed a significant increase in exercise capacity among participants. This result is similar to a study that was conducted in 2020 by AB. Gosavi et al[19] among obese individuals with BMI in grade I range of obesity. Participants performed either free exercises or aerobic training. Their results revealed an increase in six-minute walking distance in both groups. Although increase in 6MWD in our study is far lesser compared to study of Gosavi et al their study took participants with lesser BMI compared to ours. Furthermore, our study consisted of combined intervention of endurance as well as strength training rather than focusing on one type intervention. Overall, both studies revealed an increase in 6MWD among obese individuals.

Similarly, a study that was conducted in 2017 by Prasertsri et al [20] upon sedentary young adults in normal weight and overweight ranges, compared exercise capacities between both weight categories after giving intervention of arm swing exercises (endurance training) for two months. The study revealed an increase in six-minute walk distance among the participants. While comparing results of our study to above study, our intervention had also increased exercise capacity but to a lesser extent than the referenced study, once again mostly due to our combination of endurance training with strength training program rather than intervening either one of them. Another study was conducted by Nichols J. et al in 2017 among post bariatric patients with mean BMI of 32.7 kg/m2. A comparison between usual post-operative cares versus exercise intervention was drawn in the duration of one year. After one year, the results regarding six-minute walk duration found to be increased in exercise group. [21] These results were more significant than our results due to less BMI of the participants. Furthermore, our research had a considerably short duration of intervention compared to this study. As far as Forced Vital Capacity is concerned, the results of our study revealed an increase in Forced Vital Capacity by 0.08 Liters and 0.033 Liters among grade I and grade II obese individuals respectively. These results were similar to results of a study conducted by Kim et al. [22] among stroke patients who were intervened with endurance and muscle (strength) training with an individualized training device. The study concluded with an increase of 1.09 Liters in Forced Vital Capacities of participants after training, a far greater increase in FVC compared to our results. Hence, taking both studies into consideration there is a depiction of a negative association of FVC with BMI. Furthermore, our results revealed a lesser increase in FVE1/FVC ratio among grade II (higher BMI) participants as compared to grade I (lower BMI) ones after giving intervention of endurance and strength training. Moreover, our results showed similarities compared to another study conducted by Chau J et al. [23] which concluded with a negative association of FVE1/FVC ratio with Body Mass Index that was estimated through multivariable regression. Hence, there can be a conclusive depiction that increase in BMI not only has a negative impact on FVE1/FVC ratio but it also limits the effectiveness of exercise intervention upon it.

Conclusion

According to this study findings, it is concluded that the combined endurance and strength-based training programs can improve exercise capacities in grade II obese individuals while improvements in respiratory parameters are significant only in grade I obese individuals.

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