The Impact of Obesity on Respiratory Muscle Strength in Adults

Shinde B. V.[1], Phatale S. R.[2], Shinde P. U.[3], Waghmare S. N.[1]

ABSTRACT

Introduction: Overweight or obesity can cause dangerous health problems and impair quality of life. Due to change in life style and lack of physical activity the problem of obesity is increasing by fast rate in 21st century. Obesity is important risk factor for diabetes, hypertension, atherosclerosis, cancer etc. It also causes disturbances in the respiratory functions.

Material and Methods: The study included 100 adult male Medical students, 50 obese and 50 non obese in age group of 18 to 22. We have fulfilled inclusion and exclusion criteria and taken consent to enrol in the study. Obese subjects were taken as Case group in a study and Non- obese were taken as control. Height and weight were measured to find out BMI (Body mass index). WC (waist circumference), HC (Hip circumference) and W/H (waist hip ratio) was measured to see the adiposity. Respiratory muscle strength was assessed by respiratory pressure apparatus manufactured by Vacumed, California, USA.

Results: It was observed that the respiratory parameters, mean maximum expiratory pressure (MEP) was 102.48 cmH_2O (± 8.21) in obese group and 82.84 cmH_2O (± 6.84) in non obese group while mean maximum inspiratory pressure (MIP) was 88.82 cmH_2O (± 6.46) in obese group and 68.92 cmH_2O (± 5.96) in non obese group. Pearson correlation analysis shown that MEP and MIP of the groups were associated weak positive to moderate positive with WC, HC and W/H ratio, but it was not statistically significant.

Conclusion: The alterations in respiratory muscle strength by obesity were evidenced in the parameters MEP and MIP, suggests that obesity affects to the respiratory mechanics. Overload of fat on respiratory muscles and chest region require more pressure during respiration. It may be prevented if active measures are taken to reduce weight by change in lifestyle & food habits.

Keywords: BMI, Respiratory Muscle Strength, MEP, MIP.

INTRODUCTION

Obesity is a fast growing global health, social and economical problem. It is also called as disease of 21st century.[1] It develops due to imbalance of energy intake and energy expenditure. Obesity is defined by WHO as "A Medical condition in which excess body fat has accumulated to the extent that it may have adverse effects on health consequences". The BMI is an attempt to quantify the amount of fatty mass in an individual, and then categorize as underweight, normal weight, overweight, or obese, based on BMI value[2], given in table No.1. People of Asian region have different associations between BMI, percentage of body fat, and health risks than those of European region. It has a higher risk of type 2 diabetes and cardiovascular disease at lower BMI than the WHO cut-off point. Though the BMI cut off for observed risk are different in different countries among Asian populations.[3]

World health organisation in 2005 have estimated total numbers of overweight were 937 million (922– 951 million) and obese adults were 396 million (388–405 million). By 2030, the number of overweight predicted to be 1.35 billion and obese adults 573 million individuals without adjusting for secular trends. If recent secular trends continue, the numbers were projected to total 2.16 billion overweight and 1.12 billion obese individuals.[4] The lifestyle of society is changing from agricultural life to industrial life, where sedentary activities are increased. Eating habits, frequency & fat content of food has increased. It increases the prevalence of obesity. Surprisingly obesity is often neglected although it is associated with serious health consequences like type 2 diabetes, heart & vascular diseases, cancer and respiratory dysfunction[5] etc. Various complications of obesity on respiratory functions were studied by many researchers. Few studies are conducted in India on obesity and respiratory muscle strength, and also obtained controversial findings. Respiratory muscle strength (RMS) is responsible for respiratory mechanics. Expansion during inspiration & recoiling during expiration is totally depends on the respiratory muscle strength. The RMS was measured as MEP (Maximum expiratory pressure in cm H_2O) from Forced vital capacity & MIP (Maximum inspiratory pressure in cmH_2O) from residual volume, which are the pressure values produced during forced expiration & deep inspiration respectively.[6] Respiratory muscles generate the pressure differences that drive ventilation.[7] MEP & MIP are similar like Valsalva's & Muller's respiratory manuvers respectively & its unit is cmH_2O. Some researchers have shown increment in MEP & MIP due to obesity. While others shown decrement in MEP & MIP. Some studies shows no change in MEP & MIP due to obesity. So we aimed to study the effects of obesity on respiratory muscle strength for possible findings.

MATERIAL AND METHODS

The study was carried out among students of MGM Medical College, Aurangabad on male subjects of age group 18 to 22 years in the period of December 2015 to November 2016.

[1]Assistant Professor, MVP'S Dr. V. P. Medical College, Nashik, [2]Professor, [3]Professor and Head, MGM Medical College, Aurangabad, India

Corresponding author: Shinde B. V., Department of Physiology, MVP'S Dr. V. P. Medical College, Adgaon, Nashik-422003, India

How to cite this article: Shinde B. V., Phatale S. R., Shinde P. U., Waghmare S. N. The impact of obesity on respiratory muscle strength in adults. International Journal of Contemporary Medical Research 2017;4 (9):1879-1882.

Subjects were selected and screened from mix group for participation in the study. Written consent was taken from each subject

Anthropometric data collection –

Weight and height of participants were measured without wearing shoes and heavy cloths. These parameters were used to calculate the BMI, using formula,

BMI = Wt. In Kg/Ht. in m^2

1. Adults with BMI more than 25 kg/ m^2 – Obese.
2. Adults with BMI in between 18.5 kg/m^2 to 24.9 kg/m^2 - Non obese.
3. Adults with BMI less than 18.5 kg/ m^2 were excluded from the project.

The cut off value of BMI kept 25 kg/ m^2 as it is recommended for Asian population.The 50 subjects were included in the case group whose BMI were was more than 25 kg/ m^2. The 50 subjects were included in the control group whose BMI was in between 18.5 kg/ m^2 to 24.9 kg/ m^2. Waist circumference and hip circumference were measured. W/H (waist hip ratio) was calculated to clear the adiposity in obesity. A brief personal history was taken. General examinations, vitals and systemic examinations were completed. Blood pressure was measured in sitting position to screen hypertension.

Respiratory muscle strength (RMS) was measured by mouth pressure apparatus manufactured by VACUMED, California, USA. It measures MEP & MIP at mouth during forced expiration and deep inspiration, by holding mouth piece in mouth with tightly closed lips and with applied nose clip.

Inclusion criteria – Clinically healthy willing in study, male Medical students between age group of 18 – 22 years. Subjects who were obese to their respective age were specifically selected. Normotensive subjects with Systolic BP – 110 to 140 mmHg and Diastolic BP -70 to 90 mmHg in sitting position were included in the study. About 50 subjects were selected as obese according to their BMI as case group and bout 50 non obese subjects as control group.

Exclusion criteria – Subjects who were suffering from any medical illness, anxious, apprehensive and non cooperative students and any previous history of disease or hereditary aspect of disease were excluded from the study. Subjects having respiratory infections, any other respiratory disease, hypertensive, & having any musculoskeletal deformities were also excluded.

Parameters	WHO criteria (BMI kg/ m^2)	Asian criteria (BMI kg/ m^2)
Underweight	Below 18.5	Below 18.5
Normal weight	18.5 – 24.9	18.5 - 22.9
Overweight	25 – 29.9	23.0 – 24.9
Obese	≥ 30	≥ 25

Table-1: Classification of obesity based on BMI

STATISTICAL ANALYSIS

The collected data was tabulated and analysed by SPSS statistical software. Paired students ' t' test, and Pearson analysis was used for results.

RESULTS

Subjects were screened for obesity having BMI more than 25 kg/m^2 & included in case group. Subjects having BMI 18.50 to 24.9 kg/m^2 are included in control group. 50-50 subjects included in both groups. Needed data collected from both groups. Further statistical analysis was done of collected data of both groups.

In the anthropometric parameters data in relation with height shows no statistical significant difference. But weight and BMI values were statistically significant with *P* value < 0.001. BMI mean value of case group was 28.24 with standard deviation of 2.03 and of control group mean BMI was 21.46 with standard deviation of 1.62. The t value of BMI was 18.446. In the WC, HC and W/H ratio also values were statistically significant in both groups with *P* value < 0.001 (table-2).

In the respiratory muscle strength parameters mean MEP in case group was 102.48 with standard deviation of 8.21. & in control group MEP was 82.84 with standard deviation of 6.84. The difference was statistical significant with *P* value < 0.001 in case and control group. The t value of MEP was 13.001. In MIP, the mean value of case group was 88.84 with standard deviation of 6.46 and in control group mean was 68.92 with standard deviation of 5.96. Statistically significant difference was observed with *P* value of < 0.001. The t value of MIP was 16.01 (table-3) (figure 1,2).

In results of Pearson correlation analysis of respiratory

Variable	Group	Mean	Std. Deviation	t	Sig. (2-tailed)
Ht (cm)	Case	172.20	6.49	0.302	0.764
	Control	171.80	6.77		
Wt (Kg)	Case	83.24	5.95	13.897	*P* <0.001
	Control	64.44	7.49		
BMI (kg/sq.m)	Case	28.24	2.03	18.446	*P* <0.001
	Control	21.46	1.62		
WC (cm)	Case	37.74	3.53	12.232	*P* <0.001
	Control	30.66	2.08		
HC (cm)	Case	42.76	3.35	11.193	*P* <0.001
	Control	36.74	1.80		
WC/HC	Case	0.88	0.04	5.951	*P* <0.001

Table-2: Anthropometric data analysis

muscle strength parameters (MEP & MIP) with WC, HC & W/H ratio shows weak to moderate positive correlation in the case and control group (table-4).

DISCUSSION

In the present study we found significant difference in the BMI. In the result the BMI of case group mean was 28.03 with deviation of ±2.03. This was the obese group according to the BMI cut-off for Asian & Indian population as given in literature of WHO.[2] It was compared with control group having mean BMI of 21.46 with standard deviation of ±1.62. Correlation of BMI and respiratory parameters were strongly present in our study. For further understanding of adiposity in the obese group we have also measured and compared the waist circumference, hip circumference & Waist hip ratio (W/H). Anthropometrically it was significant. But statistically when relate to study parameters, correlations existing were weak to moderate.

In our study the MEP and MIP were measured by respiratory pressure apparatus. Values were showing significant positive correlation with BMI as like previous study of E. M. Pazzinoto.[8] Increment in MIP was probably due to deposition of fat around the chest. This makes chest region stiff. Deposition of fat on the diaphragm increases load on it. This leads to reduction in Functional residual capacity (FRC). It requires high ventilation, which increases the respiratory force and pressure during ventilation. In this study it was also demonstrated that Morbidly obese and normal-weight women appear to show similarities in expiratory muscle strength (MEP) behaviour. Study of Wilaiwan Khrisanapant[9] shown that continuous high efforts of respiratory muscle leads to adaptation of respiratory muscle to work with more force. More pressure and efforts are required to expand the chest against stiffness to fulfil the need. This mainly increases the MEP & MIP. Study done in obese women by TR Costa et al[10] has reported higher respiratory muscle strength. The

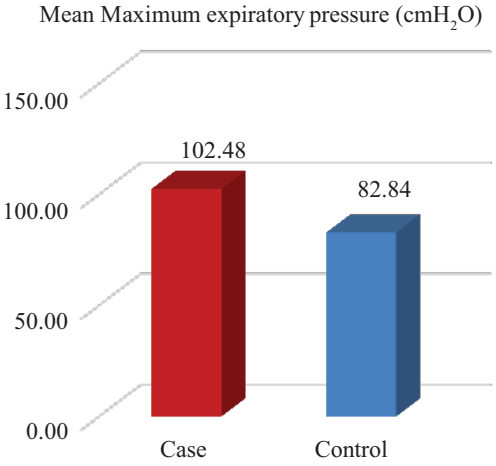

Figure-1: Correlation MEP of both groups

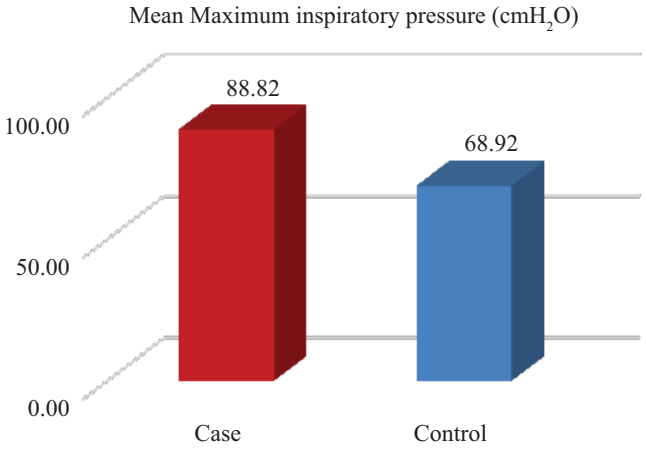

Figure-2: Correlation MIP of both groups

Variable	Group	Mean	Std. Deviation	t	Sig. (2-tailed)
MEP (cmH2O)	Case	102.48	8.21	13.001	*P*<0.001
	Control	82.84	6.84		
MIP (cmH2O)	Case	88.82	6.46	16.01	*P*<0.001
	Control	68.92	5.96		

Table-3: Respiratory muscle strength parameters data analysis (Groups based on values of BMI)

Respiratory Parameter		WC (cm)	Inference
MEP (cmH2O)	Pearson Correlation	0.106	weak positive correlation
	Sig. (2-tailed)	0.464	
MIP (cmH2O)	Pearson Correlation	0.345	Moderate Positive Correlation
	Sig. (2-tailed)	0.014	
Respiratory Parameter		HC (cm)	Inference
MEP (cmH2O)	Pearson Correlation	0.083	weak positive correlation
	Sig. (2-tailed)	0.567	
MIP (cmH2O)	Pearson Correlation	0.274	Intermediate Positive Correlation
	Sig. (2-tailed)	0.054	
Respiratory Parameter		WC/HC	Inference
MEP (cmH2O)	Pearson Correlation	0.074	weak positive correlation
	Sig. (2-tailed)	0.607	
MIP (cmH2O)	Pearson Correlation	0.25	Intermediate Positive Correlation
	Sig. (2-tailed)	0.08	

Table-4: Pearson Correlation Analysis of WC, HC and W/H ratio with respiratory muscle strength Parameters (N – 50)

obesity was assessed by bioelectric impedance & W/H ratio. They suggested that greater fat free muscle mass may pay compensation for the increased work of breathing, forced by obesity and hence removing of impairing muscle strength. Despite, not interfering with respiratory muscle strength, waist circumference should be always assessed in the women, since there might be strong association of this measurement with obesity-related diseases, increasing even further the risk factors for cardiovascular and metabolic diseases.

Negative correlation were reported in BMI & respiratory muscle strength in previous some studies. Paltiel Weiner[11] reported respiratory muscle strength by denoting as PEmax & PImax. After gastroplasty surgery there was improvement in PEmax & PEmax. Significant weight loss followed by gastroplasty in obese individuals improved the lung parameters and muscle strength. In the study of George Jung et al[12] reported decrement in the MEP and MIP due to increment in BMI. According to their studies decreased respiratory muscle functions might be due to increased elastic load by fat deposition around the chest region. It was reported in the study of Srila Ghosh Chowdhury,[13] the adiposity in relation with BMI or hip circumference and waist circumference or waist hip ratio leads to decrement in respiratory parameters. In our result by Pearson analysis weak positive relation between WC, HC, and W/H with MEP was existing. And moderate to intermediate positive relation of MIP with these anthropometric parameters. In one study Noppawan C et al[14] it provides information about the pulmonary function and respiratory muscle strength in Thai obese children. FVC, FEV1 & VC was more in obese group than non obese group. Obese group was having more airway obstruction. Moreover RMS and physical activity in both groups were same. Magnani KL et al[15] in their study shown no change in PEmax & PImax with BMI. In the obese population studied, the excess weight did not result in impairment of respiratory muscle strength. Measurement of maximum inspiratory and expiratory pressures would help in identifying which obese individuals have respiratory impairment.

CONCLUSION

Obesity affects the respiratory muscle strength. Obesity enhances the strength of respiratory muscle. This might be due to fat deposition require more force for ventilation mechanics. This continuous overburden adapts the respiratory muscles and generates more pressure during respiration. These things may change due to type of obesity, duration of obesity and physical activities of the individuals. Further studies with more subjects & with different age group are required to verify the results.

REFERENCES

1. David Haslem, Naveed Sattar, Mike Lean. ABC of obesity. Obesity – time to weak up. BMJ 2006; 333: 640-42.
2. WHO, Global database of BMI classification
3. Appropriate body-mass index for Asian population and its implications for policy and intervention strategies, Lancet. 2004;363:902
4. T Kelly, W Yang, C-S Chen, K Reynolds, J He. Global burden of obesity in 2005 and its projection to 2030. Ij of Obe. 2008;32:1431-1437.
5. SDH Malnick, H. Knobler. The medical complications of obesity.Q J Med 2006; 99:565-579.
6. T. Troosters, R. Gosselink, M. Decramer. Respiratory muscle assessment. Eur Respir Mon 2005; 31: 57–71.
7. Pedro Caruso, André Luis Pereira de Albuquerque, Pauliane Vieira Santana, Leticia Zumpano Cardenas, Jeferson George Ferreira, Elena Prina, et. al. Diagnostic methods to assess inspiratory and expiratory muscle strength. J Bras Pneumol. 2015; 41:110-123
8. E. M. Pazzinoto F, F. S. Peixoto S, C. Picono M, I. Rasera J, M. Barbalho M. Behaviour of respiratory muscle strength in morbidly obese women by using different predictive equations. Rev Bras Fisioter, São Carlos 2012;16:479-86.
9. Wilaiwan Khrisanapant, Jaruwan Plaengde, Watchara Boonsawat, Orapin Pasurivong. Obesity and Respiratory Muscle Strength in Thai women, JPBS; Vol. 24, No. 1 (Suppl), 2011
10. Thais Ribeiro Costa, Tiago Pessoa Lima, Patrícia Lúcia Gontijo, Harley Alves de Carvalho, Flávia Perassa de Faria Cardoso, Orlando Pereira Faria, lorêncio Figueiredo Cavalcanti Neto. Correlation of respiratory muscle strength with anthropometric variables of normal-weight and obese women. Rev Assoc Med Bras 2010; 56: 403-8.
11. Paltiel Weiner, Joseph Waizman, Margalit Weiner, Marinella Rabner, Rasmi Magadle, Doron Zamir. Influence of excessive weight loss after gastroplasty for morbid obesity on respiratory muscle performance, Thorax 1998;53:39–42.
12. George Jung da Rosa, Camila Isbabel S.Schivinski. Assessment of respiratory muscle strength in children according to the classification of body mass index. Rev Paul Pediatr 2014;32:250-55.
13. Srila Ghosh Chowdhury, Oona Mandal, Arunima Datta, Debjani Chakraborti, Effect of Central Adiposity on Lung Function Tests in Young Adults, IOSR Journal of Dental and Medical Sciences (IOSR-JDMS), 2015;14:24-28.
14. Noppawan C., Suwannnee J., Pipop J. Saipin P.,; Pulmonary functions & respiratory muscle strength in Thai obese children.; Sairaj Med. J 2007;59:125-130.
15. Magnani KL, Cataneo AJ. Respiratory muscle strength in obese individuals and infl uence of upper-body fat distribution. Sao Paulo Med J 2007;125: 215.

Source of Support: Nil; **Conflict of Interest:** None

Submitted: 19-08-2017; **Accepted:** 17-09-2017; **Published:** 28-09-2017