Original Article

Influence of Body Mass Index (BMI) on Pulmonary Function Test Values Among Employees & Young People of Shaqra University

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ABSTRACT

Objective: To assess the influence of BMI on the pulmonary functions of the employees and young people of Shaqra University, Shaqra.

Study Design: cross-sectional survey study

Place and Duration of Study: This study was conducted at the Department of Medicine, Colleges of Medicine, Shaqra University (SU), in Riyadh, Saudi Arabia, from September 2022 to February 2023.

Materials and Methods: A specified questionnaire assessed the medical history of the participants followed by spirometry according to the American Thoracic Society. ANOVA with Tukey's post hoc test was used to assess any difference in BMI and lung metrics between various groups, and Spearman's correlation coefficient was used to determine any relationship between BMI and lung metrics. A p-value of 0.05 was considered significant.

Results: Two hundred and twenty-nine (77.0%), 35 (12.0%), and 33 (11.0%) of the 297 participants were Saudis, South Asians, and Africans, respectively. Their mean age was 31.3± 10.2 years. Analyzing the effect of BMI on spirometry values showed that there is a significant negative correlation between BMI categories and the lung function parameters (FEV1, FVC, FEV6, FEF25-75%) except for FEV1/FVC and FEF25-75%/FVC.

Conclusion: The BMI is inversely related to lung function parameters and it entails to curtail the curse of obesity in our populations.

Key Words: Body mass index, lung function parameters, spirometry, obesity, healthy adults.

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INTRODUCTION

Obesity is a major public health concern its prevalence, measured by body mass index (BMI) has increased in the past four decades[1]. The situation is very alarming In Saudi Arabia where almost 60% population is affected (20.2 % & 38.2% of people are classed as obese (BMI > 30) and overweight (BMI over 25), respectively) [2]. High BMI is associated with the risk of developing a broad set of comorbidities, termed obesity-related complications (ORCs), which can affect all organ systems[3].

ORCs include cardiovascular disease (CVD); respiratory conditions, including asthma and obstructive sleep apnoea; and disorders affecting mobility, such as osteoarthritis and pain[3]. Increasing BMI class is closely linked to both the risks of experiencing particular ORCs and the costs associated with treating these conditions[4]. Excessive weight gain has various adverse effects on the body, including reducing compliance in the respiratory system, with the lungs being the most affected anatomical structures[5]. This is largely due to a decrease in lung volumes that mainly results in a restrictive type of ventilatory defect. It is important to note that the compression of the thoracic cage by excessive fat and increased pooling of blood in the pulmonary vasculature both contribute to a decrease in respiratory compliance[6]. Previous research has shown a link between BMI and lung function, with higher BMI being associated with lower dynamic lung volumes like forced vital capacity (FVC) and forced expiratory volume in the first second (FEV1)[7]. The effects of obesity on pulmonary function tests (PFT) among healthy adults working in the office environment in Saudi Arabia have not been adequately addressed. As obesity is a growing concern in Saudi Arabia, it is crucial to understand how it affects spirometry tests, which are considered the initial screening tool for pulmonary diseases. Therefore, research into the relationship between obesity and lung function is needed for understanding how excessive weight gain affects the respiratory system[8]. These studies provide

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insightful information on how to prevent respiratory complications related to obesity and improve the quality of life of those affected. This knowledge can be used to develop new treatment guidelines, screening tools, and novel interventions to combat the respiratory problems associated with obesity.

Our study, which is limited to spirometry testing, aims to investigate the relationship of BMI with pulmonary functions to ascertain the impact of obesity on the respiratory system among office workers and students in the university environment, where the general lifestyle is sedentary.

MATERIALS AND METHODS

This study was conducted from September 2022 to February 2023, using a cross-sectional design with a random convenient sampling technique. The study population included workers, residents, and students from various departments at Shaqra University, Shaqra. Exclusion criteria were patients with respiratory symptoms in the last 4 weeks before testing, patients with acute or chronic cough/wheezing, cardiac disease, abdominal or nasal surgery, and patients who were unable to perform spirometric tests. The minimum sample size required for this study was 195, calculated using a universally accepted sample size calculator RAOSOFT, with a confidence interval of 95%, a margin of error of 5%, and a guesstimate of 15% of abnormal pulmonary function tests in the population. (Size Calculator 2020 [Http://Www.Raosoft.Com/ Samplesize.Html]).

Participants were contacted at their workplaces, and verbal consent was obtained after explaining the procedure to be performed. The study team interviewed the participants using a standard questionnaire modified from previous studies to obtain a medical history[9]. The spirometric test was performed by instructing the participants to take a full breath in, close the lips around the mouthpiece, and blow out as hard and fast as possible without any pause until the completion of expiration. The data not matching the acceptability and reproducibility criteria of the American Thoracic Society (ATS) guidelines were excluded. All measurements were taken by the same team with a ndd "Easy on-PC®" (ndd Medical Technologies Inc., Andover, MA) using disposable mouthpieces. The participants were categorized on the basis of body mass index (BMI) into 6 categories (as by WHO) namely, under-weight (< 18), normal (18 – 25), over-weight (25.01 – 30), grade 1 obese (30.01 – 35), grade 2 obese (35.01 – 40) and grade 3 obese (> 40) to see its association with the lung function parameters.

The data were extracted from the ndd software into the Microsoft Excel program for Windows 11 and were double-checked to discard any inaccuracies. SPSS version 27.0 for Windows (SPSS, Inc., Chicago, IL, USA) was used for analyzing the data. Before analysis, a Shapiro-Wilk test was conducted to determine normality. ANOVA with Tukey's post hoc test was used to assess any difference in BMI and lung metrics between various groups, and Spearman's correlation coefficient was used to determine any relationship between BMI and lung metrics. The significance level was set at a p-value of <0.05.

The research protocol underwent a thorough review by the Local Committee on Bioethics at Shaqra University, ensuring that all ethical issues and concerns were taken into consideration. The committee granted approval as indicated by the reference number ERC_SU_20230028, on 16 May 2023. The researchers adhered strictly to both local and international guidelines on research ethics and respected the rights and welfare of the participants.

RESULTS

Two hundred and seventy-seven (277) participants from three different ethnicities were included in this study, namely 209 Asian (Saudi-75.2%), 35 South Asian (Pakistani, Indian, Bangladeshi-12.6%) and 33 African (Sudani, Egyptian-11.9%). The age range was 17-60 years with a mean of 31.7±10.17 years. The distribution of the participants according to BMI categories in shown in Table No. 1. While comparing these ethnic groups according to BMI, there was no significant difference among them on the pairwise comparison (Post hoc Tukey's test) that can cause bias (Table No. 2). Analyzing the effect of BMI on spirometry values showed that there is a significant negative correlation between BMI categories and the lung function parameters (FEV1, FVC, FEV6, FEF25-75%) except for FEV1/FVC and FEF25-75%/FVC (Table No. 3).

Table No. 1: BMI Distribution

BMI	Frequency	Percentage	Mean	Standard Deviation
< 18	16	5.8	16.7250	.93559
18 – 25	102	36.8	22.3245	2.09783
25.01 – 30	94	33.9	27.4223	1.36067
30.01 – 35	43	15.5	32.2070	1.38708
35.01 – 40	13	4.7	36.9615	1.47679
> 40	9	3.2	46.2778	5.13512
Total	277	100	26.7303	6.21588

Table No. 2: Pairwise Comparison of BMI in Different Ethnic Groups

(I) Ethnicity		Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval for Difference	
					Lower Bound	Upper Bound
African	Saudis	1.291	1.161	.267	-.995	3.577
	S. Asian	-.564	1.504	.708	-3.525	2.397
Saudis	African	-1.291	1.161	.267	-3.577	.995
	S. Asian	-1.855	1.132	.102	-4.084	.374
S. Asian	African	.564	1.504	.708	-2.397	3.525
	Saudis	1.855	1.132	.102	-.374	4.084

Table No. 3: Mean Spirometry Values According to BMI

BMI Values	**< 18**	**18–25**	**25.01–30**	**30.01–35**	**35.01–40**	**> 40**	**R Value**	**P. value**
FEV1 Mean (SD)	2.87 (.902)	2.8 (.889)	2.51 (.810)	2.45 (.905)	2.33 (.725)	2.8 (.982)	-.135	.025
FVC Mean (SD)	3.75 (.952)	3.66 (.823)	3.37 (.882)	3.24 (1.00)	3.24 (.643)	3.48 (.819)	-.160	.008
FEV1/FVC Mean (SD)	.78 (.199)	.77 (.196)	.76 (.222)	.76 (.161)	.72 (.155)	.79 (.155)	-.031	.608
FEV6 Mean (SD)	3.68 (.98)	3.61 (.814)	3.35 (.933)	3.22 (1.01)	3.16 (.674)	3.46 (.822)	-.162	.007
FEF25-75 Mean (SD)	3.10 (1.46)	2.84 (1.35)	2.54 (1.11)	2.39 (1.22)	1.95 (.769)	3.02 (1.39)	-.138	.021
FEF25-75/FVC Mean (SD)	.863 (.472)	.783 (.331)	.787 (.348)	.789 (.418)	.594 (.196)	.836 (.313)	-.053	.385

DISCUSSION

Our study has engaged a population that has been untouched previously in Saudi Arabia. The correlation of BMI with lung function parameters has not been reported in Saudi Arabia except in one study by Al-Ghobain, many years ago[10]. But that study was limited to Riyadh city and included a mix of population from the city and hospital. Our study, on the other hand, is geographically in a rural area and has focused on the same type of profession i.e., university employees who have similar work habits. Quite interestingly, Al-Ghobain did not find any significant difference in spirometric values between the obese and the non-obese subjects. On the contrary, our study has shown a clear-cut significant difference in many spirometric parameters between various degrees of obesity.

During the same time period, Sohail et al. studied the dynamic lung function parameters in relation to BMI in the office workers of various Pakistani departments[11]. He also reported, like in our study, a significant negative linear association of lung function parameters with overweight and obese participants. Bhatti et al. from Pakistan evaluated the lung function parameters, in a rural population like ours, involving all weight ranges from underweight to normal and obese[12]. He also reported that increasing BMI has a significant detrimental effect on spirometric values. Our population and results are quite in line with the above study.

A relatively large study from China, involving 770 participants also tried to explore the relation of BMI with the lung function parameter[13]. Their results are also in conformity with our results. They also concluded that BMI has a significant effect on lung function parameters but not all. A study conducted in Switzerland that involved over 2000 participants also tried to find a relation between age, BMI and spirometry values[14]. Their conclusion was the same as ours that spirometry values change significantly with these variables. An Italian study involving over 2000 participants came to the same conclusion as ours that an elevated BMI increases lung volumes but reduces airflow[15]. A large cross-sectional study was done to assess the association between underweight healthy adults (low BMI) and pulmonary functions in the Korean population where they involved 282,135 participants[16]. They demonstrated that there does exist a proportional relationship between pulmonary function values and the degree of BMI. These results also favor our study. Another large study involving 16,186 participants was carried out in the Guangzhou Biobank region of China where they assessed the pulmonary functions in people whose mean age was 61.4 ± 7.2 years[17]. They tried to see the association of BMI, waist circumference, waist-hip ratio, waist-height ratio and body fat percentage with the pulmonary function values. Their conclusion with this large study was that there is a significant inverse association between BMI and pulmonary function values. Another large study from a rural area of China on 8284 adults with an age

range of 20-80 years described that obesity has a close relationship with lung function parameters[18].

In a recent study from Shanghai that recruited 407 patients, it was found that obesity is likely to lead to the impairment of pulmonary function[19]. Another recent study from Saga university hospital reported that obesity leads to reduced pulmonary functions including FVC and FEV1[20].

Our study has certain limitations like the sample size of the study being limited, and the study was conducted only in one specific location/profession. The study focused only on BMI as a factor, without examining other potential factors that can affect pulmonary functions. Additionally, the study did not control for other variables such as smoking habits, physical exercise, dietary habits or lifestyle choices that could have influenced pulmonary function test values.

CONCLUSION

Our study indicates that there is a significant correlation between BMI and pulmonary function test values among employees and young people at Shaqra University. Higher BMI values were found to be associated with decreased lung function, particularly FEV1, FVC, FEV6 and FEF25-75%. These findings suggest that efforts to reduce obesity rates may lead to improvements in the respiratory health of our citizens. Further research may confirm these findings and identify potential mechanisms underlying the observed relationship between BMI and pulmonary function test values. Yet, this data is a useful point to start for future investigators.

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Author's Contribution:

Concept & Design of Study:	Ghulam Mustafa
Drafting:	Himayat Ullah
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Conflict of Interest: The study has no conflict of interest to declare by any author.

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