Original Article

Lung Function Parameters of Healthy, Non-Smoking Young People and Employees at Shaqra University, Shaqra

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ABSTRACT

Objective: To determine lung function parameters and their correlation with various anthropometric measurements in a healthy university population.

Study Design: Cross-sectional study

Place and Duration of Study: This study was conducted at the Department of Medicine, College of Medicine at Shaqra, Shaqra University, Saudi Arabia, from September 2022 to February 2023.

Materials and Methods: Study was included workers/residents/students of Shaqra University, Shaqra. A convenient sampling approach was used to enroll participants. A specified questionnaire assessed the medical history of the participants followed by spirometry according to the American Thoracic Society guidelines using ndd "Easy on-PC®" spirometer. The data are presented as frequencies and percentages for qualitative and the mean and standard deviation for quantitative data and 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, Southeast Asians, and Africans, respectively. The mean age of the study participants was 31.3± 10.2 years. Significant ($p<0.001$) differences in lung metrics were observed between these ethnicities. Further analysis of the Saudi population revealed FVC ($r= -0.349$; $p<0.001$), FEV1 ($r= -0.248$; $p< 0.001$), FEV6 ($r= -0.33$; $p<0.001$) were all negatively correlated with age, while height was positively correlated.

Conclusion: The lung function parameters of Saudi participants are significantly different from the participants from other geographical regions. The lung parameters are significantly affected by age, height and ethnicity.

Key Words: Lung function parameters, Asthma, FEV1, FVC, COPD, Reference Equations.

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INTRODUCTION

Pulmonary function test is essential for proper interpretation of results to evaluate reference ranges[1]. Respiratory disorders have main concerned to assess the range and management for severity[2]. An appropriate lifespan calculation was encouraged by combined American Thoracic Society (ATS) and European Respiratory Society (ERS) guidelines[3]. A few studies significantly reported in Asian healthy population the pulmonary function test was low as compared to European population[4].

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Also in population of Saudi Arabia some studies were conducted to assess the level of lung function while they have not produce the reference equations[5-6].

The widely used equations were first published in 1983 and adopted by the ERS in 1993 by European Community for Steel and Coal (ECSC), provide a single source of reference ranges for many commonly measured respiratory parameters. These equations have frequently been used in studies of respiratory function including the European Community Respiratory Health Survey (ECRHS)[7]. However, although these equations are presented as a single source, they are composite equations derived from many separate studies conducted in different populations[2]. Although validated at the time of their original publication, more recent data suggests that at least some of these equations, particularly for spirometry, are now out of date even in the European populations[8].

In addition, ECSC reference ranges are not available for newer parameters such as the forced expiratory volume in 6 seconds (FEV6), which is increasingly being used as a substitute for Forced Vital Capacity (FVC) in the detection of airflow obstruction[9]. To address these issues, we planned to obtain a complete set of pulmonary function tests from our population that is free from respiratory disease and symptoms. We also planned to compare these parameters to those predicted earlier by the ECSC/ERS equations and equations for static lung volumes[10]. Lung function parameters help to identify, evaluate, and treat numerous respiratory illnesses. These parameters need to be population specific for better outcomes. Our study is the first in the region that has focused on the suburban or rural population of the Kingdom. The other important feature is that the population is occupation specific i.e., the university employees. This helps to understand and compare the lung function parameters of the population that was not touched before.

MATERIALS AND METHODS

This cross-sectional study with random convenient sampling was started from September 2022 to February 2023. The workers/residents/students from various departments at Shaqra University, Shaqra were included and patients with respiratory symptoms in the last 4 weeks before testing, at the time of examination who had acute or chronic cough/wheezing cardiac disease, abdominal or nasal surgery and patients who were not able to perform spirometric tests were excluded. Using a universally accepted sample size calculator RAOSOFT, keeping a confidence interval of 95% with a margin of error of 5% and a guesstimate of 15% of abnormal pulmonary function tests in the population, a minimum sample size of 195 was required for this study. The study team contacted the participants at their workplace, explained the procedure to be performed and obtained verbal consent. The study team interviewed the participants for medical history according to a standard questionnaire, modified from previous studies.

The participants were instructed to take a full breath in, then close the lips around the mouthpiece and blowout as hard and fast as possible. Inspiration had to be full and unhurried, and expiration had to be continued without pause. The participants were allowed up to 20 efforts until at least two acceptable efforts were obtained. Data that did not match the acceptability and reproducibility criteria of ATS was discarded. The same team conducted all maneuvers with a ndd “Easy on-PC®” (ndd Medical Technologies Inc., Andover, MA) using disposable mouthpieces.

The data was extracted from the ndd software into the Microsoft Excel program for Windows 10. The data were double-checked for any inaccuracies. The data were analyzed with SPSS version 22.0 for Windows (SPSS, Inc., Chicago, IL, USA). Before analysis, we ran a Shapiro-Wilk test for the anthropometric data to determine the normality. Analysis of variance (ANOVA) with Tukey’s post hoc test was used to assess any difference in anthropometric and lung metrics between the three groups. Spearman’s correlation coefficient was used to determine any relationship between anthropometric measurements and lung metrics. The scatter plots were also drawn for visual interpretation of the relationship. A p-value of <0.05 was considered significant.

RESULTS

Of the 297 participants, 229 (77%) 35 (12%), and 33 (11%) were Saudi, South Asian and Africans ethnicity. The mean age was 31.3±10.2 years (median 28 years and range 17-60 years). The mean weight was 77.5±18.7 kilograms and the mean height was 171.0±6.3. The details for all ethnicities are presented in Table No. 1**.**

Table No. 1: Anthropometric measurements of the study population (n=297)

Parameter*	All (297)	Africans (33)	South-east Asians (35)	Saudis (229)
Age (Years)	31.3±10.2	33.6± 10.4	44.3±9.2	29.0±8.6
Median	28.0	31.0	46.0	27.0
Range	17.0-60.0	18.0-60.0	26.0-59.0	17.0-58.0
Height (cms)	171.0±6.3	170.0±7.1	169.0±6.1	171.0± 6.3
Median	170.0	170.0	171.0	170.0
Range	150.0-193.0	155-185	156-180	150-193
Weight (Kgs)	77.5±18.7	79.4±12.9	80.1±16.4	76.8±19.8
Median	76.0	78.0	79.0	75.0
Range	38.0-164.0	55.0-106.0	56.0-164.0	38.0-149.0

***Expressed as mean ± SD**

As the number of female participants was only 20 (all Saudis) so they were excluded from the rest of the analysis. Furthermore, the lung metrics data of two participants (Saudi) was missing so they were also excluded from the analysis. On analysis of variance (ANOVA), the ethnic groups showed significant differences in age (F= 41.45; P<0.05), and height (F= 3.92; P<0.05) as is seen in table-2). In addition, significant (p <0.001) differences in age and height for Saudis vs South Asians and Africans were observed on Tukey’s post hoc test and is shown in Table No. 3.

Table No. 2: Anthropometric measurements of the study population (Males only; n=275)

Parameter	Ethnicity	Number	Mean±SD	F	P-value
Age	South east Asian	35	44.3±9.2	41.456	<0.001*
	Saudis	207	29.3±8.6		
	African	33	33.6± 10.4		
Height	South east Asian	35	169.0±6.1	3.924	0.026*
	Saudis	207	172.0± 5.7		
	African	33	170.0±7.1		
Weight	South east Asian	35	80.1±16.4	0.364	0.696
	Saudis	207	77.8±19.9		
	African	33	79.4±12.9		

***One–Way ANOVA significant**

Table No. 3: Anthropometric measurements of the study population (Males only; n=275)

Parameter	Ethnicity	Measurement	South east Asian	Saudis	African
Age	South east Asian	Mean difference	–	15.0	10.68
		P value	–	< .001*	< .001*
	Saudis	Mean difference		–	-4.36
		P value		–	0.025*
	African	Mean difference			–
		P value			–
Height	South east Asian	Mean difference	–	-0.276	-0.0066
		P value	–	0.032*	0.890
	Saudis	Mean difference		–	0.020*
		P value		–	0.149
	African	Mean difference			–
		P value			–
Weight	South east Asian	Mean difference	–	2.30	0.749
		P value	–	0.782	0.985
	Saudis	Mean difference		–	-1.552
		P value		–	0.899
	African	Mean difference			–
		P value			–
		P value		–	0.511
	African	Mean difference			–
		P value			–

***Significant post hoc (Tukey)**

The Lung function parameters showed that the mean FVC for Saudis, South Asians and Africans was 3.5 liter (L), 3.3 L and 3.2 L, respectively. The mean FEV1 was 2.7 liter /second (L/s) for Saudis while it was 2.5 L/s for South Asians and 2.2 L/s for Africans. The mean FEV6 was 3.6 L/s for Saudis while it was 3.2 L/s for South Asians and 3.2 L/s for African populations (Table No. 4).

Table No. 4: Lung parameters of the study population (275)

Parameter	Ethnicity	Number	Mean	SD	SE	F	P value
FVC	South east Asian	35	3.3	0.7403	0.1251	3.32	0.03*
	Asian	207	3.5	0.8535	0.0593		
	African	33	3.2	1.1160	0.1943		
FEV1	South east Asian	35	2.5	0.7059	0.1193	7.29	<0.01*
	Asian	207	2.7	0.8695	0.0604		
	African	33	2.1	0.8822	0.1536		
FEV6	South east Asian	35	3.22	0.7404	0.1251	3.96	0.025*
	Asian	207	3.6	0.8926	0.0620		
	African	33	3.2	1.0841	0.1887		
FEV1/FVC	South east Asian	35	0.76	0.0901	0.0152	1.54	0.21
	Asian	207	0.78	0.1929	0.0134		
	African	33	0.71	0.2801	0.0488		

FEF25-75%	South east Asian	35	2.39	0.9600	0.1623	6.02	0.03*
	Asian	207	2.78	1.2603	0.0876		
	African	33	2.04	1.3354	0.2325		
FEF25-75%/FVC	South east Asian	35	0.71	0.2074	0.0351	2.68	0.076
	Asian	207	0.81	0.3561	0.0247		
	African	33	0.71	0.4522	0.0787		

***One –Way ANOVA significant**

On Tukey's post hoc test, lung function parameters of FEV1 (Saudis vs Africans; p<0.001) and FEF 25-75% (Saudis vs Africans; p<0.001) were significantly different (Table No. 5).

Table No. 5: Lung parameters mean of the study population (n=275)

Parameter	Ethnicity	Measurement	South east Asian	Asian	African
FVC	South east Asian	Mean difference	–	-0.234	0.145
		P value	–	0.311	0.774
	Asian	Mean difference		–	0.379
		P value		–	0.056
	African	Mean difference			–
		P value			–
FEV1	South east Asian	Mean difference	–	-0.197	0.401
		P value	–	0.415	0.130
	Asian	Mean difference		–	0.598
		P value		–	< .001*
	African	Mean difference			–
		P value			–
FEV6	South east Asian	Mean difference	–	-0.333	0.0337
		P value	–	0.109	0.987
	Asian	Mean difference		–	0.3663
		P value		–	0.078
	African	Mean difference			–
		P value			–
FEV1/FVC	South east Asian	Mean difference	–	-0.0191	0.0445
		P value	–	0.855	0.618
	Asian	Mean difference		–	0.0636
		P value		–	0.196
	African	Mean difference			–
		P value			–
FEF2575%	South east Asian	Mean difference	–	-0.393	0.353
		P value	–	0.193	0.467
	Asian	Mean difference		–	0.746
		P value		–	0.004*
	African	Mean difference			–
		P value			–
FEF25-75%/FVC	South east Asian	Mean difference	–	-0.0935	0.00414
		P value	–	0.319	0.999
	Asian	Mean difference		–	0.09768
		P value		–	0.306
	African	Mean difference			–
		P value			–

***Significant post hoc (Tukey)**

Further analysis was conducted on the Saudi population only. The correlation analysis revealed that FVC (r= -0.349; p<0.001), FEV1 (r= -0.248; p< 0.001) and FEV6 (r= -0.33; p<0.001) were all negatively correlated with age, while height was positively correlated (Table No. 6).

Table No. 6: Correlation coefficients (Pearson) and significance of lung parameters versus sex, age, height and weight in all subjects in Saudis participants

Demographic parameter	Measure	FVC	FEV1	FEV6	FEF 25-75%	FEF 25-75%/FVC
Age	Pearson's r	-0.349**	-0.248**	-0.322**	-0.176*	0.093
	P value	< .001	< .001	< .001	0.011	0.181
Height	Pearson's r	0.500**	0.427**	0.481**	0.335*	0.019
	P value	< .001	< .001	< .001	< .001	0.788
Weight	Pearson's r	0.020	0.049	0.012	0.049	0.039
	P value	0.777	0.485	0.859	0.485	0.580

Note. * p < .05, ** p < .001

DISCUSSION

The values of mean FEV1(2.7 L/s) and mean FVC (3.5 L) in our population are less than those reported from the Riyadh study where they reported a mean FEV1 of 3.7 L/s and a mean FVC of 4.5 L[5]. This is presumably because of the likely sedentary nature of work in university employees. Another study from the Tabuk region of Saudi Arabia reported a mean FEV1 of 3.54 L/s and a mean FVC of 3.98 L in the male population which is somewhat similar to our population[6]. This is likely because the population belonged to the Tabuk University which may have similar nature of job as that of our population.

The Sri Lankan male population with an age range of 51-55 years showed a mean FEV1 of 2.67L/s and a mean FVC of 3.17 L which is much similar to our study population[11]. A Pakistani study, conducted in 2007, showed much higher mean values of FEV1 (3.25 L/s) and FVC (4.05 L), in their population of age range 30-39 years of age[12]. Another study from Pakistan in the same year where the age range of the population was 15-65 years showed a mean FEV1 of 3.03 L/s and a mean FVC of 3.06 L[13]. These figures also show that these parameters are higher in the Pakistani population. The Iranian population of Mashhad with the age range of 18-65 also showed FEV1(3.78 L/s) and FVC (4.40 L) values that are higher than our population[14]. This may be because of the involvement of the general population in their study. The study from the Omani male population with an age range of 18-65 years showed a mean FEV1 of 3.33 L/s and a mean FVC of 3.95L which is somewhat higher than that found in our study population[15]. A 42-year-old study of the Jordanian population in the age range of 20-60 years showed a mean FEV1 of 4.12 L/s and a mean FVC of 4.92 L which is quite higher than the other populations, though it may be because of the old-style spirometers, used for the study.

The study from the Chinese male population with the age range of 18-80 years showed a mean FEV1 of 3.4 L/s and a mean FVC of 3.8 L which is slightly higher than our population[16]. From the western hemisphere, the study of the Belgian male population with an age range of 18-18 years also showed that the mean values for FEV1 and for FVC were not much different from the Global Lung Initiative predicted values[17]. The data from the older population with an age range of 48-89 years of age of another European country (Germany) also showed that the FEV1(4.14 L/s) and FVC (5.07 L) is on the higher side than our populations. The findings of our study suggest that there is a significant difference in lung function parameters between populations of various geographical regions. Therefore, it is necessary that we develop our own lung function parameters so that we can use our own references to better evaluate and treat our patients with lung problems.

CONCLUSION

The lung function parameters of Saudi participants are significantly different from the participants from other geographical regions. The lung parameters are significantly affected by age, height and ethnicity.

Recommendations: There is a need to allocate more resources in terms of funds, expertise and human resources towards establishing the Spirometric reference values for our population so that they can be evaluated in the proper context and can be provided appropriate care with suitable follow-up regarding their lung problems. Consequently, preventive strategies can be designed and employed to protect our population from respiratory problems. Our research can benefit employers and policymakers by raising awareness of the need to create a safe working environment that fosters healthy lung function among employees. Future research can investigate the correlation between lung function parameters and various lifestyle factors such as physical activity levels, diet, air pollution levels and stress levels. Finally, future studies can focus on the lung function parameters of individuals with lung diseases such as asthma and chronic obstructive pulmonary disease (COPD) and compare them to healthy individuals. This could provide insights into the impact of these diseases on lung function.

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Conflict of Interest: The study has no conflict of interest to declare by any author.

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