EFFECT OF SITTING VS STANDING BODY POSITIONS ON PULMONARY FUNCTION TEST OF HEALTHY KASHMIRI INDIVIDUALS

Muhammad Junaid Khan*, Sajjad Haider, Asghar Khan*****

*Department of Medicine, Ayub Teaching Hospital, Abbottabad - Pakistan

**Al-Madinah International University (MEDIU), Selangor - Malaysia

***Department of Orthopedic, Ayub Teaching Hospital, Abbottabad, KPK, Pakistan

Address for correspondence:
Muhammad Junaid Khan
Department of Medicine, Ayub Teaching Hospital, Abbottabad - Pakistan

E-mail:drmjunaidkhan@yahoo.com

ABSTRACT

Objective: The aim of this study was to find the effect of sitting and upright standing postures, factors like height, weight, respiratory rate and ethnicity on spirometric indices of healthy adult Kashmiri individuals and to establish a prediction equation on basis of these factors.

Method: After the screening, 52 (100%) subjects were recruited. Among them, 14 (26.9%) were female and 38(73.1%) were male, mean age was 19.54±1.02 years, height was 170.77±7.93 cm, weight was 67.69±12.33 kilograms, body mass index was 23.077± 3.18, and respiratory rate was 18.46±3.62 per minute. Under standard condition for all, they performed spirometry in two positions-sitting and standing. Data was recorded trice and interpreted by STATA 14.1. Paired t test was applied for finding relation of spirometric indices with body postures and multiple regression test with biometric values. Prediction equation was also derived.

Results: No significant difference was found between spirometric indices and both body position. However, changing the body position, height and weight affected some variables whereas, respiratory rate did not show any significance result.

Conclusion: In adult Kashmiri population, spirometry can be done in both recommended positions. It appeared that height and weight has sound effect on FVC, FEV1sec, MVV and FVC, FEV1sec/FVC respectively whereas, respiratory rate has no effect on spirometry while changing the body position.

Keywords: Body Positions; Pulmonary Function Test; Spirometry; Weight

This article may be cited as: Khan MJ, Haider S, Khan A. Effect of sitting vs standing body positions on Pulmonary function test of healthy Kashmiri Individuals. Pak J Chest Med 2017; 23 (4): 144-50.

INTRODUCTION

Pulmonary function tests (PFT) provide important clinical information. They are mainly designed to identify and quantify defects and abnormalities in the function of the respiratory system. However, presently, the spirometer has scored pervasive and broad use across the world for the assessment, diagnosis, quantification and management of many respiratory diseases in both tertiary and primary care centers.[1] Even, chronic obstructive respiratory disease (COPD), a major devastating disease, is defined and diagnosed by spirometry.[2]

Spirometry is a physiological test. It measures the amount of air an individual inhales or exhales as a function of time.[3] It is the most commonly performed PFT and is used in a wide variety of health care and research settings. Different parameters like, forced vital capacity (FVC in liters), forced expiratory volume in one second (FEV_1 in liters), their ratio FEV_1/FVC (%), peak expiratory flow (PEF L/sec) at 0, 25 and 75 percent, expiratory reserve volume (ERV in liters), inspiratory reserve volume (IRV in liters), maximum voluntary ventilation (MVV in $L/_{15sec}$), Slow Vital Capacity (SVC) etc. are measured by spirometry. The interpretation of these values obtained from individuals are compared with that of reference (predicted) values and results are derived for clinical assessment. Prediction equations which are based on age, gender, BMI, ethnicity and many other factors are derived equations.[4-5] Other factors like obesity,[6] socio-economic, medical/surgical conditions of the subject, practitioner characteristic and setting of performing test etc. have also been associated with different pulmonary function values.[5,7] Respiratory rate is another vital factor which has influenced on PFT[8] yet, its association with PFT is not documented. Instead of BMI which is the index of height and weight, this article focused on respiratory rate as a variable for prediction equation. As the reference values differ from population to population, therefore, derivation of prediction equations for healthy Kashmiri population was needed.

Since mid-19's, many authors established an association between different body positions and thoraco-abdominal kinetics.[9] Various body positions affect the distribution of ventilation and lung blood flow, as well as it has a considerable impact on lung capacity, dynamics of the ribcage and thoraco-abdominal muscles. So the effect of different body positions on lung function is obvious.[10]

Body positions like upright, slumped and slouched,[3] sitting with lumber and sacrum support,[11] supine at 0° and 45°, sitting with hanging down legs,[12] different recumbent positons[9] and many others have been studied. Moreover, the guidelines of standardization of spirometry suggest both sitting and standing positions suitable for spirometric assessment.[12] However, some researchers found the recommended positions contentious. A study done on healthy subject, mentioned higher values for sitting position then standing and supine.[9,12] Another study found no significant different values in three different aspect of sitting positions (sitting upright, slumped and slouched).[3] Whereas, Chun-Ting Li concluded with a positive relation between different sitting positions and pulmonary PFT.[11] Another author studied FVC and FEV_1 in asthmatic patients and ensued higher values in standing then sitting position.[13] As it may lead to false interpretation of PFT therefore, it is momentous to know about the effect of different body postures especially the recommended postures on spirometric indices in normal individuals.

A lot of work has been done on spirometry even in Pakistan, but literature lacks any data about healthy Kashmiri population. This population resides in sub-tropical highland type of climate in the northern area of Pakistan, which may also affect the PFT. Supine (standing) and sitting positions are recommended, yet it was needed to find and derive prediction equation for normal Kashmiri population so that scientific based recommendation can be presented to them. Precisely speaking, literature lacks any data which include almost all parameters of PFT. This study emphasized on eleven (11) spirometric indices and among them, FEV1, FEV1sec/FVC, FVC and MVV has been considered as primarily indicators of PFT.[3] The aim of this study was to find the effect of sitting and upright standing postures, factors like height, weight, respiratory rate and ethnicity on spirometric indices of healthy adult Kashmiri individuals and to establish a prediction equation on basis of these factors.

MATERIAL AND METHOD

This was a cross-sectional study, done at physiology laboratory, Azad Jammu and Kashmir Medical College, AJK, (Pakistan) during March-April 2014. Healthy medical students aged between 18-24 years were requested to take part in the study. Their participation was purely on volunteer basis. After obtaining informed written consent, they were screened for inclusion and exclusion criteria. Non-smoker male and female between age 18-24 years, BMI 18-29 (defined as weight in kilograms divided by height in meter square), good posture and willing to participate, participant with normal range of motion, no sever perceptual or cognitive impairment which could affect the procedure were included in the study. A spirometry pre-screening questionnaire was used to fulfill the exclusion criteria. This included any recent (6 weeks) major surgery or hospitalization for heart disease, known hypertensive patient, any respiratory infection over last 3 weeks, used bronchodilator, caffeinated beverages or took heavy meal during last one hour. Those who were wearing tight clothing were requested to loosen them and with dentures were also excluded. All the spirometries was done by a certified lab technician. Two recommended positions, first sitting on stainless steel-round top stool with feet flat on the floor and back straightly upright without support while leg-thigh and thigh-back at 90° to each other (now onward known as right-angled sitting position) and then standing (upright with straight spine) were used. The procedure was explained to each participant and a test drive was run to ensure the accuracy. Disposable mouth piece was used for each and a nose-clip was applied to block the nasal airway. The procedure was conducted between 10 AM-12 PM under the same environment for all participants.

According to the manual guidelines of the tool Bionet Cardio touch spirometer (model: cardio touch-

3000[EKG-3000]), three measurements were taken and the average of them was used for the statistical analysis. Data were collected on structured record form and were analyzed by STATA 14.1. Study was approved from Ethical Review Board of Azad Jammu and Kashmir medical college, Muzaffarabad. Biometric variables were presented with mean±standard deviation, minimum and maximum. Paired t-test was employed to find the statistically significant difference between two positions and spirometric indices. $P < 0.05$ (probability of rejecting the null hypothesis) was considered statistically different. Multiple Regression was conducted for finding the strength of relationship between the spirometry values and the biometric values (weight, height and respiratory rate) of the subjects.

Following formula was used to derive a prediction equation.

Parameter = β_1+ β_2(Ht)+β_3(Wt)+β_4(RR)+μi

(β_1-average constant, β_2-coefficient of height, β_3=coefficient of weight, β_4-coefficient of respiratory rate)

RESULTS

Total 61 healthy subjects participated in the study. Among them, 9 subjects' data were discarded due to exclusion criteria. The remaining 52 (100%) subjects were considered for the analysis in which 14 (26.9%) were female and 38(73.1%) were male. Mean age was 19.54±1.02 years, height was 170.77±7.93 cm, weight was 67.69±12.33 kilograms, body mass index was 23.077±3.18 and respiratory rate was 18.46±3.62 per minute as shown in Table.1

In this research, Cardio touch spirometer (version. 6.08C) measured about 11 different spirometric parameters. It was aimed to testify that whether the mean difference between the value of spirometry obtained from two sets of observations i.e. sitting vs standing is zero or otherwise. The null hypothesis in paired t-test is stated as under:

Ho: Mean(sitting)= Mean(standing)

Ha: Mean(sitting)≠ Mean(Standing), two-tailed test.

Since the probability values (p values) obtained against each variables are greater than 0.01, thus, we cannot reject the null hypothesis (Ho). Consequently, it is determined that at 1% significance level, the values of spirometry are same in sitting and standing position.

We further extended our investigation by using Multiple Regression Models so that we can find the strength and the direction of the relationship between the spirometry values and the biometric values of the subjects. In order to keep this research parsimonious, four most important spirometry parameters were regressed against the height (htcm), weight (wt) and the respiratory rate (RR/min) of the subjects.

At the end, while in standing position, height affects FVC, FEV1sec and MVV significantly ($p<0.001$, $p<0.01$ and $p<0.05$ respectively). Whereas in sitting position, weight affects FVC and FEV1sec/FVC at 5% significant level ($p < 0.05$). However, respiratory rate has no effect on spirometry while changing the body positions as analyzed in Table 3 and Table 4 respectively.

Table 1: Descriptive Statistics

S. No	Parameters	Gender	Minimum	Maximum	Mean	Std. Dev
1	Age (years)	Female	19	21	20.43	0.756
		Male	18	21	19.21	0.905
		Total	18	21	19.54	1.019
2	Respiratory Rate/min	Female	14	26	17.00	3.464
		Male	13	26	19.00	3.564
		Total	13	26	18.47	3.616
3	Height (cm)	Female	154	187	171.43	11.092
		Male	161	184	170.53	6.575
		Total	154	187	170.77	7.930
4	Weight (kg)	Female	50	90	64.86	13.231
		Male	53	92	68.74	12.002
		Total	50	92	67.69	12.334
5	Body Mass Index	Female	18.37	27.17	21.94	3.008
		Male	17.71	30.81	23.49	3.173
		Total	17.71	30.81	23.08	3.177

Table: 2 Data comparison for results obtained for spirometry in sitting vs. standing position. (Paired t-test)

S.No	Variables	Position	Mean Value± St. dev	95% confidence interval		Mean difference	Two tailed-P-value
				minimum	maximum		
1	FVC	standing	5.188±1.870	4.667	5.708	0. 1037	0.7180
		sitting	5.084±1.613	4.635	5.544		
2	FEV_1	standing	3.472±1.471	3.063	3.882	0.1975	0.2516
		sitting	3.275±1.260	2.924	3.606		
3	FEV_1/FVC	standing	135.960±31.698	127.136	144.785	11.19	0.1018
		sitting	124.770±36.296	114.666	134.875		
4	PEF	standing	5.614±2.067	5.039	5.806	0.293	0.0927
		sitting	5.322±1.741	4.837	6.190		
5	PEF_{25}	standing	4.976±2.060	4.402	5.549	0.3662	0.0932
		sitting	4.6101.767	4.118	5.102		
6	PEF_{50}	standing	4.977±2.098	4.393	5.560	0.274	0.1397
		sitting	4.702±1.888	4.177	5.228		
7	PEF_{75}	standing	4.024±1.739	3.540	4.508	0.236	0.1629
		sitting	3.787±1.448	3.384	4.190		
8	MVV	standing	20.726±9.295	10.138	23.313	-0.711	0.4672
		sitting	21.438±12.399	17.986	24.090		
9	SVC	standing	9.766±3.805	8.706	10.824	0.460	0.2139
		sitting	9.305±3.140	8.431	10.179		
10	ERV	standing	2.581±1.568	2.144	3.017	-0.227	0.0339
		sitting	2.808±1.135	2.491	3.124		
11	IRV	standing	5.159±1.930	4.621	5.696	0.099	0.7307
		sitting	5.06±1.867	4.540	5.580		
		sitting	7.304±2.292	6.665	7.940		

$P < 0.05$ is considered statistically different

Table 3: Multiple Regression of spirometric parameters (for standing position) in predicted equation.

Biometric values	FVC	FEV_{1sec}	FEV1sec/FVC	MVV
Height(cm)	0.125*** (3.61)	0.0922** (3.46)	0.0195 (0.03)	0.447* (2.29)
Weight (kg)	0.0161 (0.72)	0.0208 (1.21)	0.178 (0.38)	0.0220 (0.17)
Respiratory Rate(per min)	0.0231 (0.37)	-0.0524 (-1.08)	-1.257 (-0.94)	0.475 (1.34)
_cons	-17.73** (-3.35)	-12.71** (-3.13)	143.7 (1.29)	-65.83* (-2.22)

β-coefficient without parentheses
t statistics in parentheses
* $p<0.05$, ** $p<0.01$, *** $p<0.001$

Parameter = β1+ β2(Ht)+β3(Wt) + β4(RR)+μi

FVC = -17.73 + (0.125Ht)+ (0.016Wt) + (0.023RR)
FEV1sec = -12.71+(0.092Ht)+(0.020Wt)+(-0.052 RR)
FEV1sec/FVC = 143.73+(0.019Ht)+(0.178Wt)+(-1.257RR)
MVV = -65.83+(0.447Ht)+(0.022Wt)+(0.475RR)

Table 4: Multiple Regression of spirometry parameters (for sitting position) in predicted equation

Biometric values	FVC	FEV_{1sec}	FEV1sec/FVC	MVV
Height(cm)	0.0526 (1.77)	-0.769 (-0.92)	0.0277 (1.19)	0.424 (1.56)
Weight (kg)	0.0537* (2.80)	0.348 (0.64)	0.0470* (3.13)	0.0603 (0.35)
Respiratory Rate (per min)	-0.0574 (-1.06)	-0.271 (-0.18)	-0.0720 (-1.70)	0.573 (1.16)
_cons	-6.466 (-1.43)	237.6 (1.86)	-3.318 (-0.93)	-65.53 (-1.59)

-coefficient without parentheses
t statistics in parentheses
* p<0.05, ** p<0.01, *** p<0.001

FVC = -6.47+(0.053Ht)+(0.054Wt)+(-0.057RR)
FEV1sec = -3.32+(0.027Ht)+(0.047Wt)+(-0.072RR)
FEV1sec/FVC = 237.57+(-0.769Ht)+(0.348Wt)+(-0.270RR)
MVV = -65.53+(0.424Ht)+(0.060Wt)+(0.573RR)

DISCUSSION

As stated before, there is an obvious effect of different body positions on spirometric indices.[9,10] This study strongly rejects the aforementioned hypothesis. In shorts, the two recommended positions (sitting and standing) don't affect the PFT of healthy adult Kashmiri population. This is in accordance with three studies conducted on adult healthy subjects.[3,14,15] Similarly, no effect was found among obese (BMI > 30) asthmatic patients.[16] Sajal De also did not find any difference in FEV_1 among 75 COPD patients.[17]

Many researchers have found significant outcomes like different body postures change the spirometric values especially in FVC, FEV_1 and PEFR. Among them, some authors concluded with higher values of parameters for sitting position[11-13,17] and vice versa[3,18] and have presented many possible causes behind it but here, the results are opposite. The most probable logic behind this is the way that the participants were seated during the experiment, subtropical hilly area, acclimatized participants and minimum effect of the gravity.

Strictly speaking, during the procedure, the participants of this study kept their back (the spinal cord) fixed/stationary i.e. straightly up-right during sitting and standing positions. Due to this, the thoraco-abdominal kinetics remained unaffected except for shifting of the center of gravity. So this resulted in no or undetectable effect of intra-abdominal contents on diaphragm or changing from one position to other. Probably, it had the least effect on thoraco-abdominal and trans-thoracic diameter and pressure. Some articles mentioned the effect of change in the center of gravity of body on respiratory function.[19] Here, it is also dismissed by the fact of different geographic and sub-tropical highland climate of the northern area[20] (approximately 739 meters or 2,425 feet from sea level) which born no and/or minimum effect on the value of gravity.

Regarding factors affecting the PFT, Coates AL stated that "the taller the individual, the larger the lung volume" which indicate a positive correlation of height with PFT.[5] Similarly, our study also concluded that height has sound effect but only on FVC, FEV_{1sec} and MVV. This is in accordance with a study done on healthy Iranian subjects but there, instead of MVV, they found $PEF_{20-75\%}$ as third variable affected by height.[21] Whereas Nepal GB derived a maximum positive correlation with FVC and FEV_1 while sparing MVV and PEFR among healthy Nepalian adults.[4] Thereafter, it is proven that height has its influence on FVC and FEV_1 and to some extent on MVV and $PEF_{20-75\%}$. However, it is excluded while measuring normal values for a subject with kyphoscoliosis.[22] Another salient and conspicuous factor i.e. respiratory rate (which is never studied before) prevailed no co-relation with all studied spirometric indices. No data is available regarding respiratory rate and its affect and/or comparison on PFT.

In sitting position, the third important parameter, i.e. weight showed positive correlation with FVC and FEV1sec/FVC at 5% significant level. This corresponds to the same study of healthy Nepalian adults in which weight has been correlated significantly with FVC, FEV_1, PEFR and MVV.[4] However, in another study, conducted on 04-06 years old healthy children, this relation is nullified.[23]

Brazzale DJ stated that spirometry is minimally affected by mild to moderate obesity- and if it differs in morbidity obese patient, then other pathophysiological factors ought to be considered. He also stated that most of the predicted equations are derived from non-obese subjects. When these equations are applied to morbid obese subjects, the result interpretation would be compromised.[6] Does weight, either alone or as a function of BMI affect PFT? According to our statistics, yes it does but further work is needed to dig deeper into it. The prediction equations of different parameters for both sitting and standing position while using height, weight and respiratory rate have been derived. It is not recommended to use these equations in clinical setup however other anthropometric/biometric factors, if found, may help in developing new prediction equation.

CONCLUSION

It is concluded that both, right-angled sitting as well standing positions can be considered for performing spirometry in adult Kashmiri population. Among factors affecting spirometric parameters, in standing position, height has a sound effect only on FVC, FEV_{1sec} and MVV. Whereas in sitting position, weight affects FVC and FEV1sec/FVC at 5% significant level. ($P < 0.05$). However, respiratory rate has no effect on spirometry while changing the body position. This study also deduced that due to moderate attitude and sub-tropical climatic area, changing the body position does not affect the spirometry outcomes. Further work is needed to find relation of PFT with other anthropometry biometrics (like neck, abdomen, waist or hip circumferences), affect of different altitudes, climate and long-term acclimatization.

ACKNOWLEDGMENT

I'm highly grateful to one of my best teachers, who made me and guided me thoroughly for taking initiative of this research Dr. Azhar Iqbal, Professor Physiology, King Faisal University Saudia Arabia.

I also acknowledge the contribution and assistance of Dr. Saqib Malik, Assistant Professor Medicine, Ayub Medical College, Abbottabad.

REFERENCES

1. Johnson JD, Theurer WM. A stepwise approach to the interpretation of pulmonary function tests. Am Fam Physician. 2014 Mar 1;89(5):359-66.
2. Burney P, Jarvis D, Perez-Padilla R. The global burden of chronic respiratory disease in adults. Int J Tuberc Lung Dis. 2015;19:10–20.
3. Hojat B, Mahdi E. Effect of different sitting posture on pulmonary function in students. Journal of Physiology and Pathophysiology. 2011 Jul 31;2(3):29-33.
4. Nepal GB. Spirometric evaluation of pulmonary functions of medical students in Nepal. Asian Journal of Medical Sciences. 2014 Jun 25;5(3):82-6.
5. Coates AL Graham BL McFadden RG, et al., Spirometry in Primary Care. Can Respir J. 2013;20(1): 13-22.
6. Brazzale DJ, Pretto JJ, Schachter LM. Optimizing respiratory function assessments to elucidate the impact of obesity on respiratory health. Respirology. 2015 Jul 1;20(5):715-21.
7. Koefoed MM. Spirometry utilisation among Danish adults initiating medication targeting obstructive lung disease. Dan Med J. 2015 Feb;62(2).
8. Ruprai RK, Kamble P and Kurwale M. Effect of Yoga Training on Breathing Rate and Lung Functions in Patients of Bronchial Asthma. International Journal of Recent Trends in Science And Technology. 2013;5(3):127-129.
9. Naitoh S, Tomita K, Sakai K, Yamasaki A, Kawasaki Y, Shimizu E. The effect of body position on pulmonary function, chest wall motion, and discomfort in young healthy participants. Journal of manipulative and physiological therapeutics. 2014 Dec 31;37(9):719-25.
10. Gullo A. Anaesthesia, Pain, Intensive Care and Emergency Medicine - A.P.I.C.E. 1 ed: Springer-Verlag Mailand; 2005 November 12-15, 2004. XXIV, 760 p.
11. Li CT, Chang CH, Huang JH, Tsai KH. Comparison of Various Sitting Postures on Pulmonary Function, Lumbar Curvature, and Comfort Evaluations. International Journal of Bioscience, Biochemistry and Bioinformatics. 2014 Sep 1;4(5):331.
12. Patel AK, Thakar HM. Spirometric Values in Sitting, Standing and Supine Position. J Lung Pulm Respir Res 2(1): 00026. DOI: 10.15406/jlprr.2015.02.00026.
13. Melam GR, Buragadda S, Alhusaini A, Alghamdi MA, Alghamdi MS, Kaushal P. Effect of different positions on FVC and FEV1 measurements of asthmatic patients. Journal of physical therapy science. 2014;26(4):591-3.
14. Domingos-Benício NC, Gastaldi AC, Perecin JC, et al. Medi-das espirométricas em pessoas eutróficas e obesas nas posic¸õesortostática, sentada. Rev Assoc Med Bras. 2004;50:142-7.

15. Costa GM, Lima JGM, Lopes AJ. Espirometria: a influência dapostura e do clipe nasal durante a realizac¸ão da manobra. Pul-mão. 2006;15:143-7.
16. Razi E, Moosavi GA: The effect of positions on spirometric values in obese asthmatic patients. Iran J Allergy Asthma Immunol. 2007; 6: 151–54.
17. De S. Comparison of spirometric values in sitting versus standing position among patients with obstructive lung function. Indian J Allergy Asthma Immunol. 2012;26:86-8.
18. Mazidi M, Bayat M, Letafatkar A. The Effect of Spinal Postural Abnormalities on Spirometric indexes of Hormozgan medical University Students. World J. Sport Sci. 2012; 6 (4): 331-35.
19. Martinez BP, Silva JR, Silva VS, Gomes Neto M, Forgiarini Júnior LA. Influence of different body positions in vital capacity in patients on postoperative upper abdominal. Braz J Anesthesiol. 2015 May-Jun;65(3):217-21.
20. Saleem S, Shah S, Gailson L, Ahmad WZ, Wani TA, Wani AA, Khan UH. Normative spirometric values in adult kashmiri population. Indian J Chest Dis Allied Sci. 2012;54:227-33.
21. Etemadinezhad S, Alizadeh A. Spirometric reference values for healthy adults in the Mazandaran province of Iran. J Bras Pneumol. 2011;37(5):615-20.
22. Hyatt RE, Scanlon PD, Nakamura M. Interpretation of pulmonary function tests: a practical guide. 4th ed. Rochester: Lippincott Williams & Wilkins; May 8, 2014.7p
23. França DC, Camargos PA, Jones MH, Martins JA, Vieira Bda S, Colosimo EA, et al,.. Prediction equations for spirometry in four- to six-year-old children. J Pediatr (Rio J). 2016 Jul-Aug;92(4): 400-8.