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Original Article

Diurnal variability of FEV1 and Salivary cortisol with Anthropometric and cardiovascular parameters in healthy individuals

Tanuj Mathur[I*], Dileep Kumar Verma[2], Sandeep Pandey[3], Narsingh Verma[4], Sunita Tiwari[5]

[1]Senior Resident - Department of Physiology, Jawaharlal Nehru Medical College, Aligarh Muslim University, Aligarh
[4]Professor, Department of Physiology; [3]Research Scholar – Department of Biochemistry; [4]Professor & Head, Department of Physiology , King George's Medical University , Lucknow.
[5]Professor – Department of Physiology , Dr. Ram Manohar Lohia Institute of Medical Sciences , Lucknow

ABSTRACT

Background: *Airways exhibit a definite circadian variation in caliber and this phenomenon is amplified in excess of respiratory distress such as asthma or COPD. FEV1 is considered a reliable airway measurement. Body Mass index is linked with several diseases and affects various systems. Salivary cortisol, a direct measure of stress can impact respiratory and cardiovascular function. This study was taken up to find any association of FEV1 and salivary cortisol with BMI and pulse pressure.*
Methods: *Spirometric analysis was performed to check for diurnal variability of FEV1 among 18 – 35-year-old. BMI, PP and salivary cortisol were measured. SPSS 21.0 was used for analysis of data.*
Results: *Diurnal variations were found to be significant in both FEV1 and Salivary cortisol. FEV1 values increased from 2.71 ± 0.93 in the morning to 2.86 ± 0.57 in the evening while salivary cortisol decreased from 1.52 ± 0.30 to 1.17 ± 0.39. Pulse pressure showed no diurnal pattern. When compared between genders, all variable except BMI was found to be significant.*
Conclusion: *The correlation found will help us to categorise high risk population and prioritize early diagnosis and patient management.*

Keywords: *BMI, diurnal, pulmonary, lung function, obesity*

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***Corresponding Author**

Dr. Tanuj Mathur
Senior Resident - Department of Physiology , Jawaharlal Nehru Medical College, Aligarh Muslim University , Aligarh.
Email: dr.tanujmathur@gmail.com

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INTRODUCTION

Biological functions in humans exhibit variability across 24 hour time periods. Of which, Airway function has exhibited a reputable interest in respiratory medicine. Diurnal variability forms the foundation for lung function worsening at night in patients suffering with nocturnal asthma and COPD.[1,2] Diurnal variations in airway caliber are well appreciated in healthy subjects as well.[3] Literature evidence shows a 4% variation between early morning and evening values for FEV1, and 8% for PEF. This accounts to 140 ml of FEV1 diurnal change in a healthy male aged 44 years, measuring 1.70 m tall with a reading of 3500ml FEV1.[4] It is also proposed that nocturnal wheezing in asthmatics also exhibits diurnal changes, which is similar to that of healthy individuals.[5]

The prevalence of malnutrition has increased in the recent times in Asian countries owing to several factors such as dietary changes and lifestyle modifications. Studies have demonstrated obesity influencing pulmonary functions.[6,7] Obesity predisposes to respiratory symptoms like breathlessness, especially after workouts even in the absence of any existing respiratory illness. Concurrent presence of obesity and asthma bearing a mechanical effect on respiratory function can trigger or aggravate asthma,[8] has motivated many research on Body mass index (BMI).

Pulse pressure (PP) helps predicting cardiovascular outcomes. PP above 60 is regarded as a risk factor for heart diseases, particularly in the older individuals. 24 hour variability of PP is pointed out in literature.[9]

Salivary cortisol levels can act as non-invasive stress indicators in situations like work strain, schooling, noise issue or maltreatment of children. Cortisol shows a wide diurnal

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variation. Generally, salivary cortisol concentration rise in the morning and dips gradually, which is termed as cortisol awakening response (CAR). CAR is thought to be associated with compromised health effects and psychosocial disadvantages.[10]

Conceptualising diurnal variability in pulmonary function and its correlation with cardiovascular parameter helps physician to intercept pathologies in earlier stages and plan treatment appropriately. Also, understanding the relation of FEV1 with salivary cortisol facilitates doctors to detect stress level acting as an indirect indicator in altering physiological functioning. Hence the present study was undertaken to evaluate correlation of FEV1 with BMI, PP and salivary cortisol in healthy individuals.

METHODS

An observational study was conducted on 40 healthy individuals to evaluate for diurnal variation. Informed consent of all subjects was obtained after detailed explanation regarding the purpose of the study. Institutional Ethical Clearance was obtained from the IEC committee of the institution in which the study was done (Reference No.96 ECM II B- Thesis/P24 Dated 30 July 2019).

18 – 35 years individuals, of both gender from a community were recruited & study was done in physiology department of King George Medical University, Lucknow from 30/07/2019 to 30/07/2020.

Eligibility criteria: Apparently healthy adults with no history of respiratory ailments, allergy or chest deformity was included. Patients suffering from cardiovascular or respiratory illness in the previous month, stress incontinence, dependence on tobacco or alcohol and those not consenting to take part were excluded.

Clinical evaluation included assessment of anthropometric measurement, lung function test and salivary cortisol analysis.

Anthropomoteric evaluation: Height (in centimetres) of every individual was measured using a rigid stadiometer in standing position. Weight was assessed by a digital weighing scale. Subjects were instructed to have meals at least 2 hours before assessment and with minimal clothes. Body Mass Index was calculated as BMI – Weight / Height $^{2}{}_{(mt.)}$ [Expressed as kilogram per square meter square].BMI scores were categorised as underweight (< 18.5 kg/m2), normal (18.5– 24.9 kg/m2), overweight (25.0–29.9 kg/m2) and obese (>30.0kg/m2).

Measurement of Pulse pressure: Mercurial sphygmomanometer was used to record resting blood pressure (RBP). The readings were taken in the right arm in triplicate, and the average of the three readings was used as the individual's blood pressure. Pulse pressure was derived by subtracting diastolic pressure (DBP) from systolic pressure (SBP). PP = SBP – DBP.

Lung function test: FEV1 was recorded using Spirometer, with subjects in standing position after resting for 10 minutes. The recording was done when subjects inspired maximally through mouth and forcefully expired in a single blow, after nasal clipping of the nostrils. The procedure was done for three times, with a rest period of 5 minutes between each time and the best of the three reading was included for the final assessment.

Collection and analysis of saliva samples: Saliva samples were collected in number coded vials with strict hygiene protocols. Subjects were instructed to rinse their mouth before collecting the samples and were refrained from eating or drinking in the past 30 minutes. Collected samples were centrifuged at 3000 rpm for 15 minutes and analysed by ELISA method.

Statistical analysis: SPSS 21.0 version (IBM; Chicago) was used for data analysis. The results are presented as means ± standard deviation, percentages, and tables. Kolmogorov Smirnov Z test was used to check for the normality of the data collected. Paired t test was used to check for diurnal variation of FEV1, PP and Salivary Cortisol. Pearson correlation was run to determine the relation of FEV1 with BMI, PP and Salivary cortisol. P value lesser than 0.05 was considered to be statistically significant.

RESULTS

A total of 40 healthy subjects, with normal lung function were analysed in the present study. The mean age of the participants was 19.35 ± 1.68 years. A clear male predilection was noted. Data characteristics in both gender is presented in Table 1. When parameters were compared genderwise, significant differences were noted between males and females in all except BMI and salivary cortisol levels. (Table 2)

FEV1 values in the morning and evening was 2.71 ± 0.93 and 2.86 ± 0.57 respectively, which was significant, thus exhibiting diurnal variation. No significant difference was observed for pulse pressure for diurnal variability. Salivary cortisol values dipped in the evening time, which was statistically significant. (Table 3) Cortisol was negatively correlated with BMI, while pulse pressure showed no correlation at all as seen in Table 4. FEV1 also showed no significant correlation with BMI at p=0.44.

Table 1: Demographic parameters of the reviewed population

Parameter	Age (in years)	Height(cm)	Weight (kg)	BMI
Mean	19.35	167.65	61.60	21.80
S.D	1.68	7.58	11.08	3.04
Minimum	18	157	45	16.10
Maximum	28	182	88	29.40

Table 2: Gender distribution of parameters evaluated

Parameters	Males	Females	Anova statistic	P value
Age	19.48 ± 2.06	19.13 ± 0.74	0.389	0.536 (NS)
Height	171.40 ± 6.07	161.40 ± 5.46	27.328	<0.001*
Weight	64.36 ± 11.51	57.00 ± 8.87	4.507	0.04*
BMI	21.73 ± 3.34	21.92 ± 2.59	0.036	.851 (NS)
FEV1 morning	3.09 ± 0.46	2.56 ± 0.55	10.63	0.002*
FEV1 evening	3.07 ± 0.43	2.52 ± 0.62	10.53	0.002*
Pulse pressure morning	49.84 ± 6.32	38.26 ± 13.13	14.14	0.001*
Pulse pressure evening	51.60 ± 6.19	41.73 ± 9.00	16.87	<0.001*
Salivary cortisol morning	1.55 ± 0.29	1.48 ± 0.32	0.56	0.45 (NS)
Salivary cortisol evening	1.21 ± 0.41	1.09 ± 0.36	0.82	0.36 (NS)

*=Significant; NS=Not Significant

Table 3: Diurnal values all characteristics evaluated

Variables	Morning values	Evening values	T statistic	P value
FEV1	2.71 ± 0.93	2.86 ± 0.57	0.600	0.042*
Pulse Pressure	45.50 ± 10.89	47.90 ± 8.72	-1.705	.096 (NS)
Salivary Cortisol	1.52 ± 0.30	1.17 ± 0.39	4.336	<0.001**

*=Significant; NS=Not Significant

Table 4: Correlation of BMI with parameters

Pearson Correlation coefficient	BMI (r and p value)	PP (r and p value)
FEV1	-0.12	0.39
	0.44 (NS)	0.075(NS)
Cortisol	-0.66	0.031
	0 .012*	0.740(NS)

*=Significant; NS=Not Significant

DISCUSSION

The present study was conducted on 40 healthy individuals aged 18 -35 years to evaluate the diurnal variability of FEV1, BMI, PP and Salivary cortisol. The existing knowledge regarding pulmonary function variability is principally from clinical and occupation studies. Rarely, these studies are done in healthy individuals or general population. Hence this study marks a significant impact in understanding of respiratory physiology and its relation to other body systems. The current study showed significant difference in diurnal variation between males and females at p=0.002. This observation is contradictory to the study of Borsboom et al[11] showing no difference in their Dutch population. Gender presented a significant effect on lung volume (FEV1), with mean values in men ranging higher in both morning and evening times in the current study. This is similar to the studies conducted by Ali Baig et al[12] and Hari Khan et al[13] reporting elevated baseline pulmonary function amongst males. This difference in gender could probably be attributed to bigger lung size and muscularity in males as compared to females of the same height.

The present study results showed an inverse relationship between BMI and cortisol levels in the morning, which is in line with other studies existing in literature.[14,15] Urinary cortisol levels also have been linked positively to anthropometric measurements as per the study.[16] These results might be explained by the cortisol metabolism's physiology. It is believed that 11-beta-hydroxysteroid dehydrogenase-1 (11-HSD1) expression results in higher intradipose tissue cortisol levels in obese subjects, possibly due to its reverse reductase action. 11-HSD converts hormonally active glucocorticoids like cortisol into inactive metabolites like cortisone.[17] Salivary cortisol . showed a significant decline from morning to evening from 1.52 ± 0.30 to 1.17 ± 0.39 in our study. A well-known diurnal pattern for cortisol secretion is seen in that it raises rapidly in the morning within 30 to 45 minutes after waking and then gradually declines during the rest of the day.[18] Though our study showed a significant correlation of BMI with cortisol values, contradictory results were found in the study of Champaneri S et al,[19] where no association of cortisol was found with any BMI.

Our study findings showed no correlation of BMI with FEV1. This could be possibly because all our study participants fell in the category of normal weight or lean category BMI (18.5 - 22.9 kg/m^2 as per Indian standards. Previous research has shown FEV1 to be negatively correlated with obese individuals.[20] Decreased lung compliance due to increased BMI can be attributed to several reasons. A as a person puts on weight, the location of the diaphragm in the thoracic cavity is significantly elevated. This alteration leads to a reduction in pulmonary function demanding greater effort for breathing. Secondly, fat build-up on the chest wall will prevent the thoracic cage from moving due to either direct resistance or aberrant intercostal muscle action. Thirdly, obesity raises the lung's production of inflammatory indicators such the hormone leptin. These inflammatory markers mostly affect lung tissue, with a minor impact on airway diameter.

FEV1 was not correlated to pulse pressure in the current study, which is contradictory to the study of Mathew D et al[21] who reported a definite negative correlation in their study. This could probably be because their sample included individuals aged 40 years and above. Individuals with compromised lung function are at a higher risk for cardiovascular disease. FEV1 has been proven to be equivalent to serum cholesterol as a predictor of death from ischemic heart disease and to be a substantial predictor of all-cause mortality.[22] The relationship between lung function and heart disease may be explained by a connection between lower lung function and arterial stiffness, which causes higher myocardial work and decreased myocardial perfusion.[23]

The study sample could be a possible limitation as the study was done in an institute. This could be overcome by conducting multi-centric studies recruiting larger population size. Also, owing to the descriptive study design, temporal association cannot be established. Inspite of all this, the study is unique in that it is the first of its kind to be conducted in this part of the country in healthy individuals.

CONCLUSION

The study demonstrated a significant difference between gender for the diurnal values of FEV1, PP and Salivary cortisol amongst healthy individuals. No correlation was found between BMI and FEV1 and PP, but was seen for salivary cortisol. Our study results suggests that BMI can be used as a potential diagnostic marker for detecting stress levels, but recommends multicentric trials with larger sample size for determining the relationship between BMI and FEV1.

REFERENCES

1. Turner-Warwick, M. The management of chronic asthma. In P. J. Barnes, I. W. Rodger, and N. C. Thomson, editors. Asthma: Basic Mechanisms and Clinical Management. Academic Press Limited, London 1988. 721–732.
2. Storms, W. W., S. F. Bodman, R. A. Nathan, and P. Byer. Nocturnal asthma symptoms may be more prevalent than we think. J. Asthma 1994; 31:313–318.
3. Hetzel, M. R., and T. J. H. Clark. 1980. Comparison of normal and asthmatic circadian rhythms in peak expiratory flow rate. Thorax 35:732–738.
4. van Pelt, W., G. J. J. M. Borsboom, B. Rijcken, J. P. Schouten, B. C. van Zomeren, and P. H. Quanje. . Discrepancies between longitudinal and cross-sectional change in ventilatory function in 12 years of follow-up. Am. J. Respir. Crit. Care Med 1994; 149:1218–1226.
5. Hetzel, M. R. The pulmonary clock [Editorial]. Thorax 1981; 36:481–486.
6. Saxena Y, Sidhwani G, Upmanyu R. Abdominal obesity and pulmonary functions in young Indian adults: a prospective study. Indian J Physiol Pharmacol. 2009; 53(4):318–26.
7. Babb TG, Wyrick BL, Delorey DS,Chase PJ, Feng MY. Fat distribution and end expiratory lung volume in lean and obese men and women. Chest. 2008; 134:704–11.
8. Piper AJ, Grunstein RR. Big Breathing: the complex interaction of obesity, hypoventilation, weight loss, and respiratory functions. J Appl Physiol. 2010; 108:199–205.

9. Neeraj Dhaun, Rebecca Moorhouse, IainM. MacIntyre, Vanessa Melvill, Wilna Oosthuyzen, Robert A. Kimmitt et al. Diurnal Variation in Blood Pressure and Arterial Stiffness in Chronic Kidney Disease. The Role of Endothelin-1. Hypertension 2014; 64(2): 296-304
10. Hiromitsu Kobayashi, Chorong Song, Harumi Ikei, Bum-Jin Park, Takahide Kagawa and Yoshifumi Miyazaki. Diurnal Changes in Distribution Characteristics of Salivary Cortisol and Immunoglobulin A Concentrations. Int. J. Environ. Res. Public Health 2017, 14, 987-995
11. Borsboom GJJM, van Pelt W, van Houwelingen HC, van Vianen BG, Schouten JP, Quanjer PH. Diurnal variation in lung function in subgroups from two Dutch populations: consequences for longitudinal analysis. Am J Respir Crit Care Med 1999;159:1163 – 1171.
12. Ali Baig M, Qureshi RH. Pulmonary function tests: normal values in non-smoking students and staff at the Aga Khan University, Karachi. J Coll Physicians Surg Pak 2007; 17:265-8.
13. Harik-Khan RI, Wise RA, Fleg JL. The effect of gender on the relationship between body fat distribution and lung function. J Clin Epidemiol. 2001; 54:399-406.
14. Walker BR, Soderberg S, Lindahl B, Olsson T. Independent effects of obesity and cortisol in predicting cardiovascular risk factors in men and women. J Intern Med. 2000;247(2):198–204.
15. Bjorntorp P, Holm G, Rosmond R. Hypothalamic arousal, insulin resistance and Type 2 diabetes mellitus. Diabet Med. 1999;16(5):373–83.
16. Pasquali R, Cantobelli S, Casimirri F, et al. The hypothalamic-pituitary-adrenal axis in obese women with different patterns of body fat distribution. J Clin Endocrinol Metab. 1993;77(2):341–6.
17. Anagnostis P, Athyros VG, Tziomalos K, Karagiannis A, Mikhailidis DP. Clinical review: The pathogenetic role of cortisol in the metabolic syndrome: a hypothesis. J Clin Endocrinol Metab. 2009;94(8):2692–701.
18. Ranjit N, Diez-Roux AV, Sanchez B, et al. Association of salivary cortisol circadian pattern with cynical hostility: multi-ethnic study of atherosclerosis. Psychosom Med. 2009;71(7):748–55.
19. Champaneri S, Xu X, Carnethon MR, Bertoni AG, Seeman T, DeSantis AS, Diez Roux A, Shrager S, Golden SH. Diurnal salivary cortisol is associated with body mass index and waist circumference: the Multiethnic Study of Atherosclerosis. Obesity (Silver Spring). 2013 Jan;21(1):E56-63.
20. Banerjee J, Roy A, Singhamahapatra A, Dey PK, Ghosal A, Das A. Association of Body Mass Index (BMI) with Lung Function Parameters in Non-asthmatics Identified by Spirometric Protocols. J Clin Diagn Res. 2014 Feb;8(2):12-4.
21. Matthew D. Jankowich, Tracey Taveira, Wen-Chih Wu, Decreased Lung Function Is Associated With Increased Arterial Stiffness as Measured by Peripheral Pulse Pressure: Data From NHANES III, *American Journal of Hypertension* 2010; 23(6): 614–619.
22. Hole DJ, Watt GC, Davey-Smith G, Hart CL, Gillis CR, Hawthorne VM. Impaired lung function and mortality risk in men and women: findings from the Renfrew and Paisley prospective population study. BMJ. 1996 Sep 21;313(7059):711-5;
23. Zureik M, Benetos A, Neukirch C, Courbon D, Bean K, Thomas F, Ducimetière P. Reduced pulmonary function is associated with central arterial stiffness in men. Am J Respir Crit Care Med. 2001 Dec 15;164(12):2181-5.