IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 21, Issue 11 Ser.1 (November. 2022), PP 47-60
www.iosrjournals.org

Comparative Analysis of Different Cardio-Respiratory Parameters with respect to changing Body Positions in Middle-Aged Health Population in Delhi-NCR.

Dr. Manish Kumar
Assistant Professor, Delhi Pharmaceutical Science and Research University, Govt. of NCT of Delhi, New Delhi, India.

MahatiBhadania (PT)
Physiotherapist, Delhi Pharmaceutical Science and Research University, Govt. of NCT of Delhi, New Delhi, India.

NavyaTondak (PT)
Physiotherapist, Banarasi Das ChandiwalaInstiitute of Physiotherapy, New Delhi, India.
Correspondence: Dr. Manish Kumar, Assistant Professor

Abstract
Background: The term "cardio respiration" refers to the body's cardiac and respiratory systems working together to ensure that enough oxygenated blood is transported throughout the body. Age-related changes in cardiorespiratory variables are well-known, but they should stay within. Among many other such variables, "body positioning" had demonstrated the correlation between a change in posture and cardiorespiratory parameters, that needs adjustments. Therefore, maintaining the ideal body position requires appropriate body positioning for cardiorespiratory parameters to operate properly and efficiently.
Aim of study: To study the effects of different body positions on Cardiorespiratory parameters in middle aged population.
Procedure: A total of 80 subjectshad been recruited for the study. The subjectshad been divided into two different groups based upon BMI. The subject was taken into 3 different positions namely; sitting, half lying with head up at 45 degrees, and standing; for 2mins each, and Cardiorespiratory parameters (PEFR, FEV1, SPO2, PR, RR, Lower CE, SBP, DBP, and PI) were recorded accordingly, and Cardiorespiratory parameters (PEFR, FEV_1, SPO_2, PR, RR, Lower CE, SBP, DBP, and PI) had been recorded accordingly. The factshad been analysed the usage of ANOVA and independent t-test.
Results: Show a considerableeffect on cardiorespiratory parameters whilesubjectshad been taken into exceptionalframe positions. It has beenfound that optimal positioning is in standing followed by sitting and then half lying with head up in a 45degree position.
Conclusion: It can be concluded from the present study that there is significant variation among cardiorespiratory parameters when position of the body is changed and BMI does affect the cardiorespiratory parameters of the body except SPO_2, PEFR and CE. The present study has undertaken middle-aged healthy and non-smoking adults into consideration. The study provides insight into how beneficial or adverse a body position can be in therapeutic intervention to the patients in particular & for individuals as a whole.

Keywords: *Cardiorespiratory parameters, middle aged healthy adults, body positions, Delhi NCR, BMI*

Date of Submission: 20-10-2022 Date of Acceptance: 04-11-2022

I. Introduction

"Cardio respiration" refers to the cardiac and respiratory system of the body functioning together to transfer the adequate oxygenated blood throughout the body (Canadian Physiotherapy Association, 2009). It is widely recognized that Cardiorespiratory variables changes with age, however it needs to remain within normal limit to maintain the Cardiorespiratory health in adults of 20 to 74 years of age [9]. Cardiorespiratory situations can restrict capacityto breath properly restricting oxygen supply to the frame when needed therefore affecting strength, power & capacity to feel healthy enough in everyday life [9]. These situations will reduce physical activities thereby worsening the situation and reducing the overall fitness level.

Cardiorespiratory parameters are the ones variables that at once impacts the functioning of coronary heart and lungs. These parameters are Pulse rate (PR), Blood Pressure (BP), Respiratory Rate (RR), Peripheral Oxygen Saturation (SpO_2), Perfusion Index (PI), Pulmonary Function Test (PFT), etc. Factors that normally effect these parameters are very exhaustive, however, the fitness of individuals had been widely been centric to most of the studies. In Aires et al in 2010, the study had shown relationships with many lifestyle indicators such as physical activity (PA), television time (TV), body positioning and adiposity [29]. Similarly, there are many more factors which had been taken into consideration showing association with anthropometric variables like waist-to-hip ratio, obesity, and BMI in Burns et al, study in 2013 [30].

Out of many such factors, "body positioning" as identified by Gordon et al in 2009, had shown the effects of change in posture with respect to cardiorespiratory changes [1]. Also, Alsufayan et al in 2010, had studied effects of body positioning on oxygen saturation, temperature, respiratory rate, and heart rate in healthy term and preterm infants and concluded that these variables get affected by changing body position [11]. Studies had been also been done in young healthy adults to evaluate the effects of body position on pulmonary functions and chest wall motion by Naitoh et al in 2007, concluded that there had been marked differences in pulmonary functions due to recumbent body positions producing feeling of discomfort [5]. Many of the studies had focused specifically on one single cardiorespiratory parameter like variation in arterial blood pressure with changing body position by Kohara et al in 2005 [14] or Masahiko Sato and Sheigeko Tanaka (1973) [7] focused on postural effects in relationship between oxygen consumption and heart rate in healthy young females.

However, there is very scarce information available on effects of body positioning on cardiorespiratory parameters in healthy middle-aged individuals in India in Delhi NCR. According to Craig et al, 1971, it is well known that body position can have an effect on gas exchange withing the body, however the magnitude of this effect has not been studied effectively [2]. This was understood to produced marginal changes in the body functioning and situational discomfort at times. In long run, such kind of discomfort and inappropriate feeling of the body may cause unnecessary cardiopulmonary issues with aged and elderly populations. Another study also shows that, Tapar et al in 2018, that changing body positions affect the hemodynamic of the body due to variable gravitational forces [2]. This factor supposed to alter the cardiac output by increasing the heart rate through baroreceptor mechanisms. Thus, it can be inferred that few positions are largely not suitable for the heart in particular and pulmonary system in general, to functions optimally that may produce feeling of discomfort. Patients who are not positioned correctly face the risk of harmful or may even lead to serious consequences by causing disruption of the ventilation/perfusion ratio (V/P Ratio) and a lowered cardiac flow rate [31]. Body position and its changes have an effect on the optimal transport of blood and oxygen. Placing the patient in the right position at the right time improves gas exchange and contributes to recovery [27]. Some of the physiological changes such as that in cerebral blood volume and blood pressure occur during postural changes in healthy people [28]. Wong et al (2014), also produced MRI of systemic and pulmonary blood flow at rest in two different positions in 24 healthy adults [29]. They concluded that pulmonary arterial blood flow did not differ between the prone and the supine position, however there was a decrease in blood flow to the left lower pulmonary vein in supine position.

Thus, the purpose of this study was to elucidate position dependent cardiorespiratory variation and to illustrate the optimum position in which cardiac & respiratory parameters function effectively and efficiently. While there are many studies on patients in this context, there is still uncertainty about which position promotes oxygenation to the best in healthy individuals. This study showed that body positions have a significant effect, statistically, on cardiorespiratory parameters in healthy subjects in Delhi NCR. Also, this study may guide comparatively good position for middle-aged population with situational discomfort with respect to heart and pulmonary functioning in the body, which may avoid any serious consequences in future in similar context. However, the study is limited to health middle-aged population with small sample size and hence can be conducted over large population and groups to see the impacts and its implications in future.

II. Materials And Methodology

Study design: Non-Experimental & Analytical Study.
Sample size: 80 (Randomized controlled trial)
Study centre: Delhi/NCR Inclusion criteria:

- Subject aged 40-59 yrs.
- Both male and female subjects, Subjects
- BMI as classified by WHO (for grouping)- 18.5-22.9kg/m^2 (normal) 23.0-24.9kg/m^2 (overweight),
- Patients with occasional discomfort due to recumbent body positions.

Exclusion criteria

- Subject with chronic respiratory illness.
- Post-surgical patients with history of less than 3 weeks.
- Subjects with hypertension.
- Subjects with any neurological ailments.
- Pregnant women.
- Subjects with cardiovascular disorder.
- Smoking history
- Individuals with of high nicotine consumption.
- Individuals with anaemic history.

Procedure

There were in total 80 subjects recruited for the study. The subjects were selected according to the inclusion criteria of the study. Informed consent was obtained from the all subjects. Thereafter, the subjects were divided into two groups according to BMI. The data was then recorded according to the protocol of the study. Subjects were assigned respective groups according to the BMI calculated for them (WHO Asian classification):

GROUPS	CATEGORY	RANGE
A	Normal	18.5 to 22.9 kg/m^2
B	Overweight	23.0 to 24.9 kg/m^2

The subjects of each group were assigned generalised 3 standardized positions namely:

- Sitting.
- Head up (45-degree) Supine flat lying.
- Standing.

Subjects of both the groups were instructed to attain each position for 5min in the given sequence.
Measurement was taken as follows: (In that order)

- Pulse Oximeter for pulse measurement and perfusion index measurement;
- Hand cuff BP Analogue machine with stethoscope was used to measure the BP of the subject, with 3 reptation in same position;
- PFT was measured using handheld portable spirometer machine;
- Chest expansion was measured using measuring tape (commonly used in tailoring purpose).

III. Data Analysis

The data entry was done on Microsoft excel-2013 and statistical analysis was done by using statistical package for the social sciences (SPSS) software version 11.5
The demographic profile was analysed by using descriptive statistic.

IV. Result

Total 80 subjects were analysed according to the protocol designed, & based on inclusion-exclusion criteria. It can be inferred that there is significant variation between the CR parameters among different body positions.

PARAMETERS WISE

BP (SP & DP):
It shows significant difference (F-value-10.081 (SBP), 12.632(DBP), p-value<0.05), in all three different body positions.

PR, PI, FEV_1:
It also shows significant difference between PR, PI, FEV_1 (p-value < 0.005) among all the three different body positions.

SPO_2, CE, PEFR:
However, there was no significant difference found between SPO_2 (F-value-1.103, p-value = 0.335), CE (Fvalue = 2.183, p-value = 0.117), and PEFR (F-value = 1.703, p-value = 0.182) in any of the positions.

POSITION WISE
The subjects move from Sitting to Head up 45-degree position, PR, RR, PI, FEV_1 slightly varies, though not significantly and there after increases from Head up 45-degree to Standing position (on comparing mean values). (Refer to Graphs 1, 2, 3, 6, 7, 8, 9, 10, 11 respectively)

From the Table 1 shows demographic analysis with respect to BMI between Group A & Group B.

GENERAL INTERPRETATION

BP (SP & DP) shows significant difference (F-value=10.081(SBP),12.632(DBP), p-value<0.05). It also shows significant difference between PR, PI, FEV_1 (p value < 0.005) among all the three positions. But there was no significant difference found between SPO_2 (F value-1.103, p value0.335), CE (F-value = 2.183, pvalue = 0.117), and PEFR (F-value =1.703, p-value = 0.182) in any of the positions (p-value >0.005).

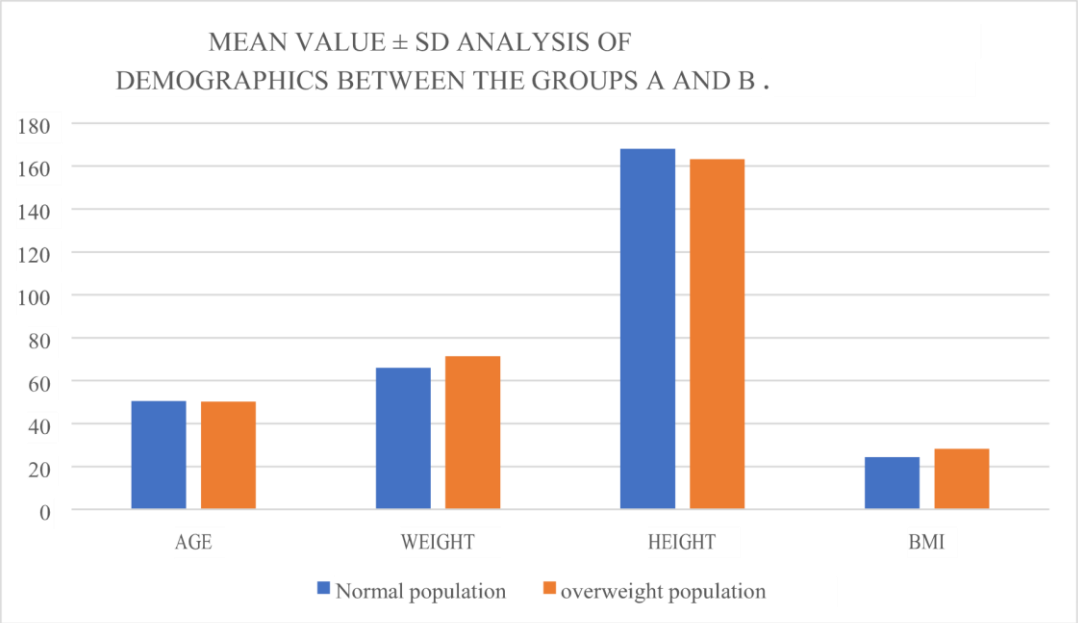
Table 2 & 3, shows that as the subjects move from Sitting to Head up at 45-degrees position. PR, RR, PI, FEV_1 slightly but within range and there after increases from Head up to Standing position (on comparing mean values).

From the above Table 2 & 3 (Graph 3), it can be inferred that there is significant variation between the CR parameters among different body positions. SBP (F value-9.888, p value-0.000) and DBP (F-value6.374, pvalue = 0.002) shows significant difference (p-value<0.05). It also shows significant difference between PR, PI, FEV_1 (p-value < 0.005) among all the three positions. But there was no significant difference found between CE (F-value =1.229, p-value = 0.296), and PEFR (F value-1.434, p-value =0.242) in any of the three positions.

Table 2 & 3 (Graph 2 & 3), shows that as the subjects move from Sitting to Head up position, PR, RR, PI, FEV_1, decreases and there after increases from Head up to Standing position (on comparing mean values & standard deviation).

Table 1

Demographic	Group A (NWP)		Group B (OWP)	
	Mean	Std. Deviation	Mean	Std. Deviation
Age	44.35	6.21	43.65	6.53
Hight	159.99	8.02	156.86	6.30
Weight	59.55	6.51	66.65	4.77
BMI	23.19	1.14	27.07	1.20

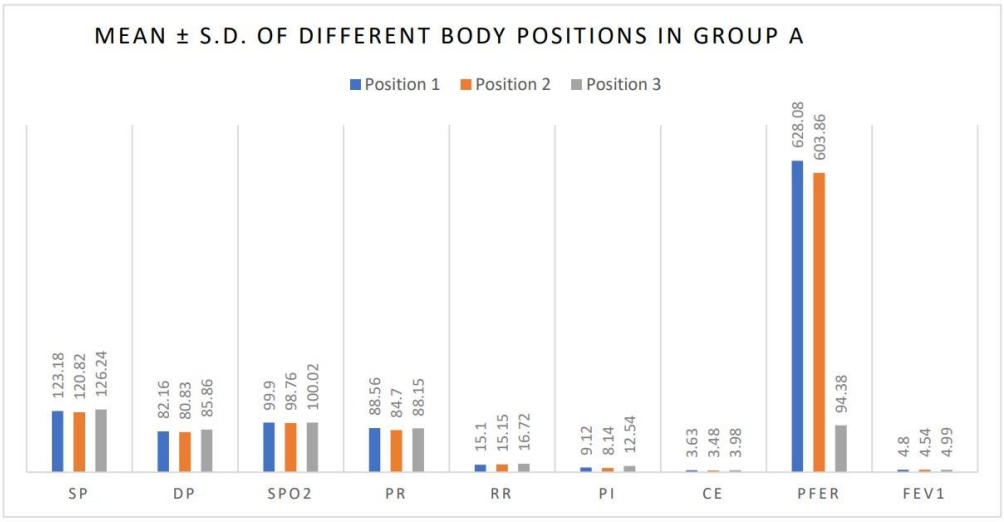


Graph 1

GROUP A – NWP

Table 2

Parameters	Sitting (Position 1)		Head -up (45- degree) supine flat lying (Position2)		Standing (Position 3)			
	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation	F-value	p-value
SP	118.05	5.13	115.90	4.92	121.00	5.24	10.081	0.000
DP	78.80	3.81	77.75	3.08	81.75	4.11	12.632	0.000
SPO2	98.98	0.92	97.18	1.58	99.15	0.87	1.103	0.335
PR	75.48	13.08	77.98	6.72	82.18	5.97	5.462	0.005
RR	13.45	1.65	13.60	1.55	15.20	1.52	15.188	0.000
PI	7.26	1.86	6.33	1.81	10.82	1.72	69.455	0.000
CE	2.67	0.96	2.53	0.95	2.97	1.01	2.183	0.117
PEFR	533.65	94.43	513.60	90.26	552.05	92.65	1.730	0.182
FEV1	3.83	0.97	3.61	0.93	4.17	0.82	3.801	0.025

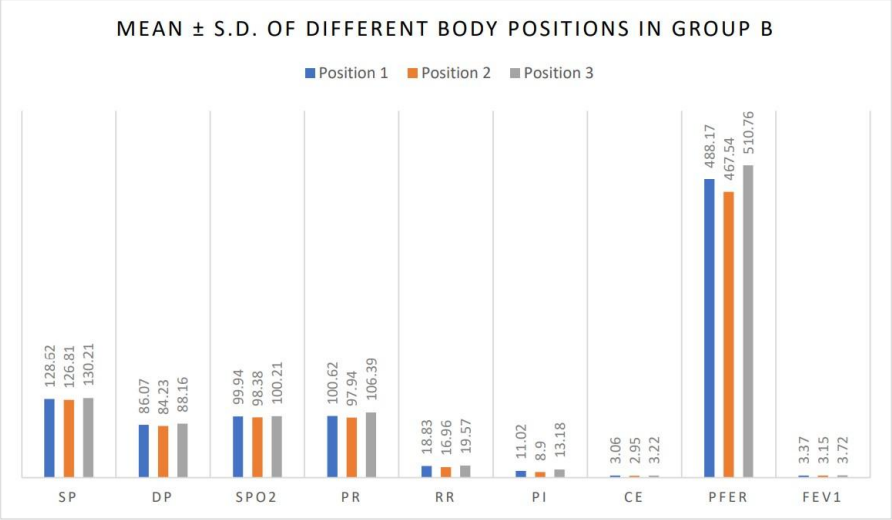


Graph 2

GROUP B – OWP

Table 3

Parameters	Sitting (Position 1)		Head up (45-degree) supine flat lying (Position 2)		Standing (Position 3)			
	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation	F -value	pvalue
SP	124.00	4.62	122.98	3.83	126.80	3.41	9.888	0.000
DP	80.80	5.27	80.38	3.85	83.70	4.36	6.374	0.002
SPO2	98.63	1.31	96.50	2.18	99.43	0.78	38.588	0.324
PR	92.73	7.89	92.00	5.94	98.70	7.69	10.355	0.000
RR	16.80	2.03	15.13	1.83	17.93	1.64	23.488	0.000
PI	9.73	1.29	7.59	1.31	11.90	1.28	111.011	0.000
CE	2.26	0.80	2.14	0.81	2.42	0.80	1.229	0.296
PEFR	378.78	109.39	359.98	107.56	401.15	109.61	1.434	0.242
FEV1	2.51	0.86	2.31	0.84	2.79	0.93	2.967	0.055



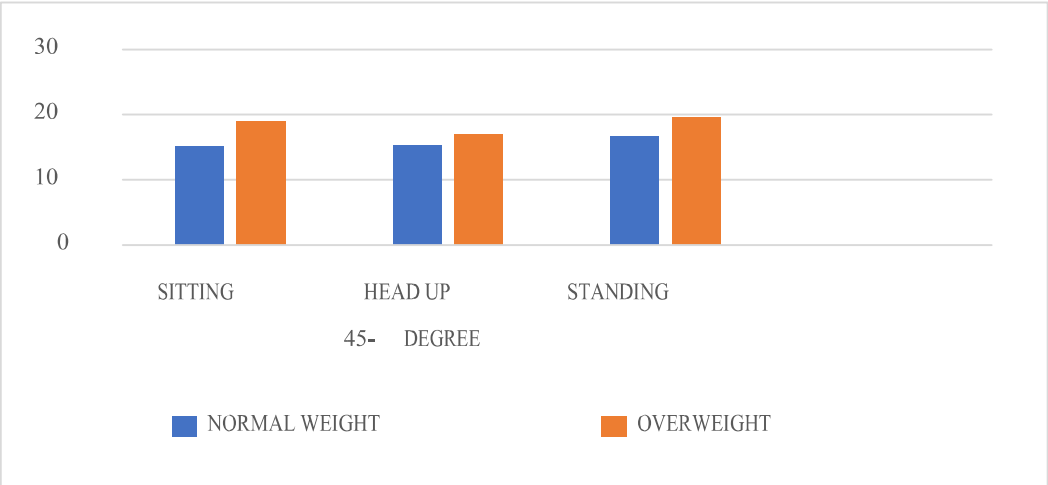
Graph 3

Table 4: Mean and S.D. comparison between 3 body positions in two groups among different Cardiorespiratory parameters.

Body positions	Parameters	GROUP A (NWP)		GROUP B (OWP)		t-test	p-value
		Mean	Std. Deviation	Mean	Std. Deviation		
Sitting (Position 1)	SP	118.05	5.13	124.00	4.62	-5.449	0.000
	DP	78.80	3.81	80.80	5.27	-1.945	0.055
	SPO_2	98.98	0.92	98.63	1.31	1.380	0.172
	PR	75.48	13.08	92.73	7.89	-7.141	0.000
	RR	13.45	1.65	16.80	2.03	-7.141	0.000
	PI	7.26	1.86	9.73	1.29	-6.917	0.000
	CE	2.67	0.96	2.26	0.80	2.056	0.043
	PEFR	533.65	94.43	378.78	109.39	6.778	0.028
	FEV_1	3.83	0.97	2.51	0.86	6.465	0.000
Head up (45-degree) supine -flat lying (Position 2)	SP	115.90	4.92	122.98	3.83	-7.180	0.000
	DP	77.75	3.08	80.38	3.85	-3.366	0.001
	SPO_2	97.18	1.58	96.50	2.18	1.583	0.118
	PR	77.98	6.72	92.00	5.94	-9.890	0.000
	RR	13.60	1.55	15.13	1.83	-4.025	0.000
	PI	6.33	1.81	7.59	1.31	-3.579	0.001
	CE	2.53	0.95	2.14	0.81	1.968	0.053

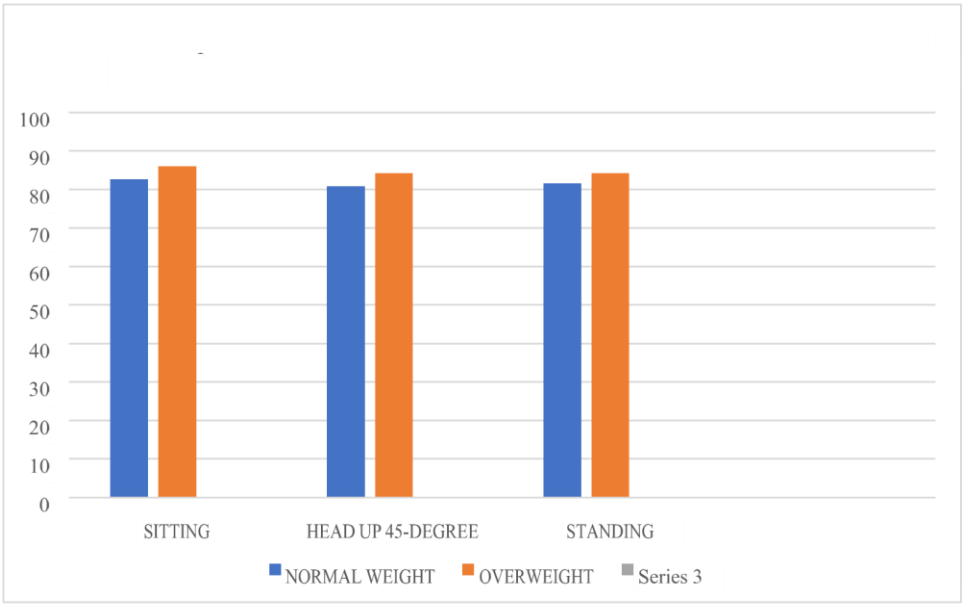
	PEFR	513.60	90.26	359.98	107.56	6.920	0.014
	FEV_1	3.61	0.93	2.31	0.84	6.520	0.000
	SP	121.00	5.24	126.80	3.41	-5.867	0.271
	DP	81.75	4.11	83.70	4.36	-2.058	0.043
	SPO_2	99.15	0.87	99.43	0.78	0.988	0.326
	PR	82.18	5.97	98.70	7.69	-10.739	0.000
	RR	15.20	1.52	17.93	1.64	-7.704	0.000
	PI	10.82	1.72	11.90	1.28	-3.188	0.002
	CE	2.97	1.01	2.42	0.80	2.719	0.008
Standing (Position 3)	PEFR	552.05	92.65	401.15	109.61	6.650	0.024
	FEV_1	4.17	0.82	2.79	0.93	7.000	0.000

MEAN ± S.D. OF SBP BETWEEN 3 DIFFERENT BODY POSITIONS IN TWO GROUPS



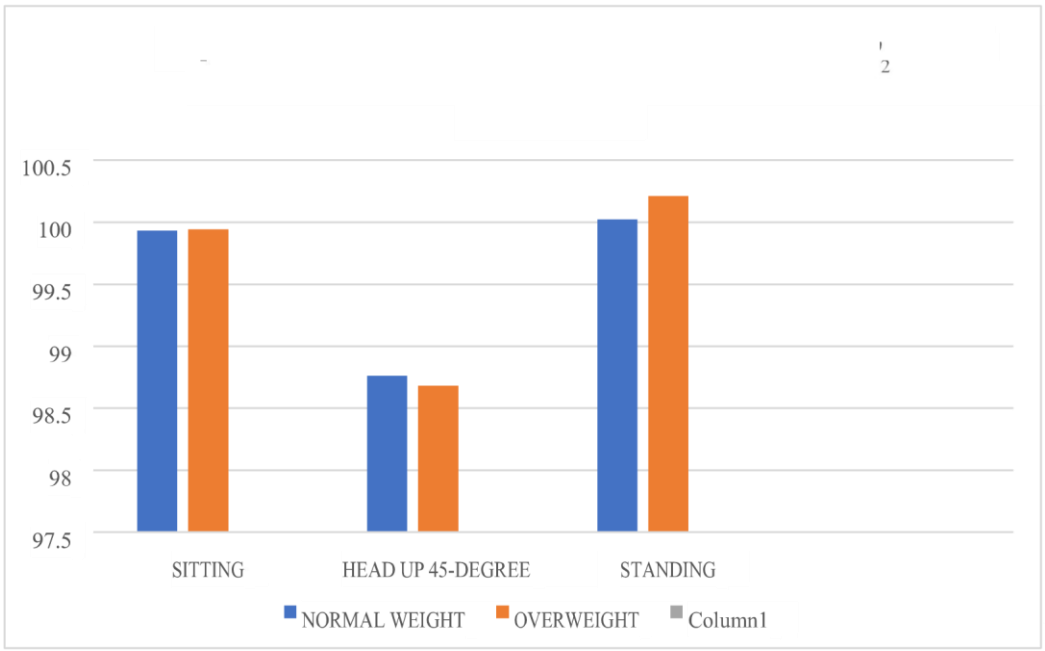
Graph 4

MEAN ± S.D. OF DBP BETWEEN 3 DIFFERENT BODY POSITIONS IN TWO GROUPS



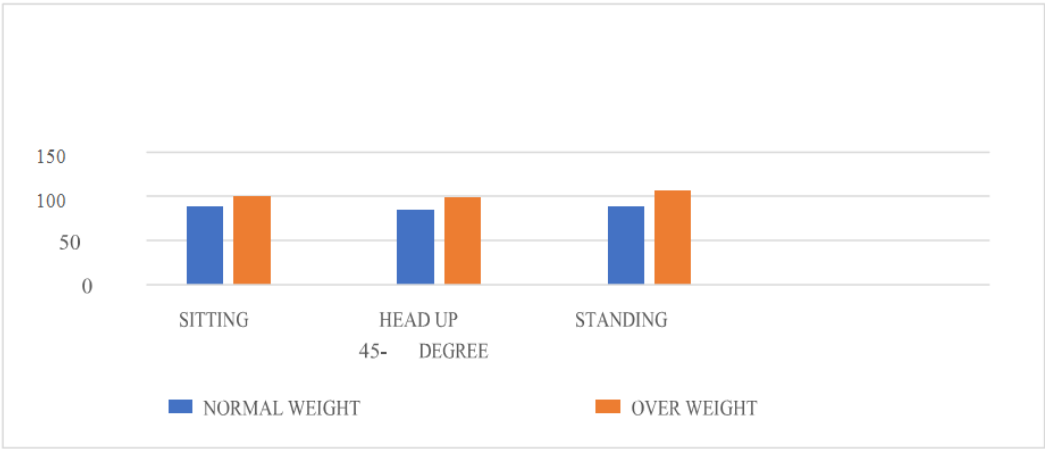
Graph 5

MEAN ± S.D. OF SPO_2 BETWEEN 3 DIFFERENT BODY POSITIONS IN TWO GROUPS



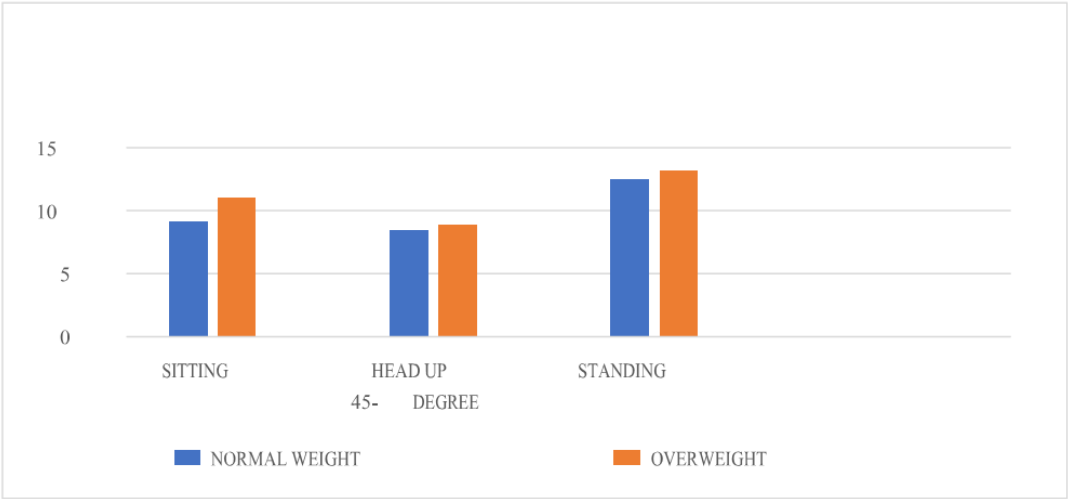
Graph 6

MEAN ± S.D. OF PR BETWEEN 3 DIFFERENT BODY POSITIONS IN TWO GROUPS



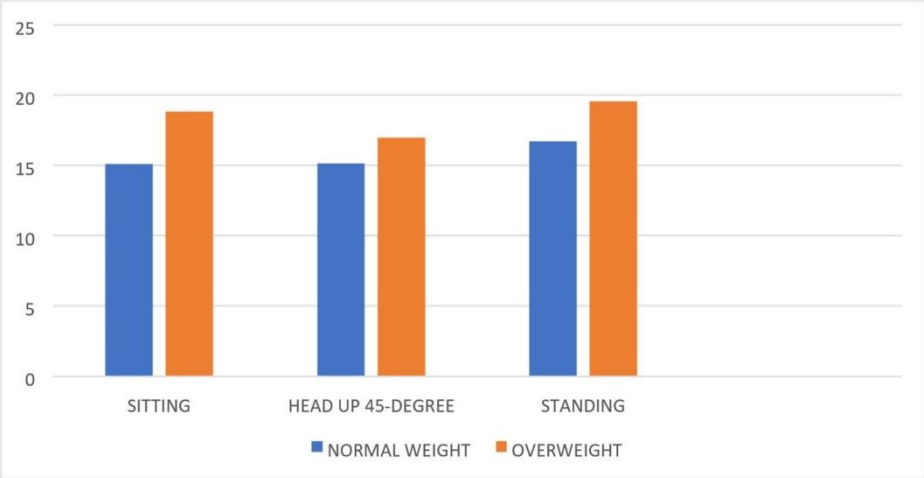
Graph 7

MEAN ± S.D. OF PI BETWEEN 3 DIFFERENT BODY POSITIONS IN TWO GROUPS



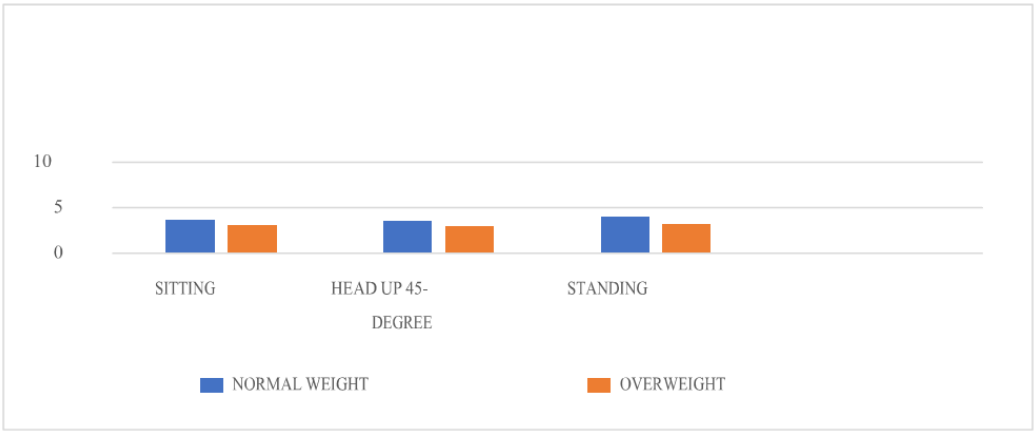
Graph 8

MEAN ± S.D. OF RR BETWEEN 3 DIFFERENT BODY POSITIONS IN TWO GROUPS



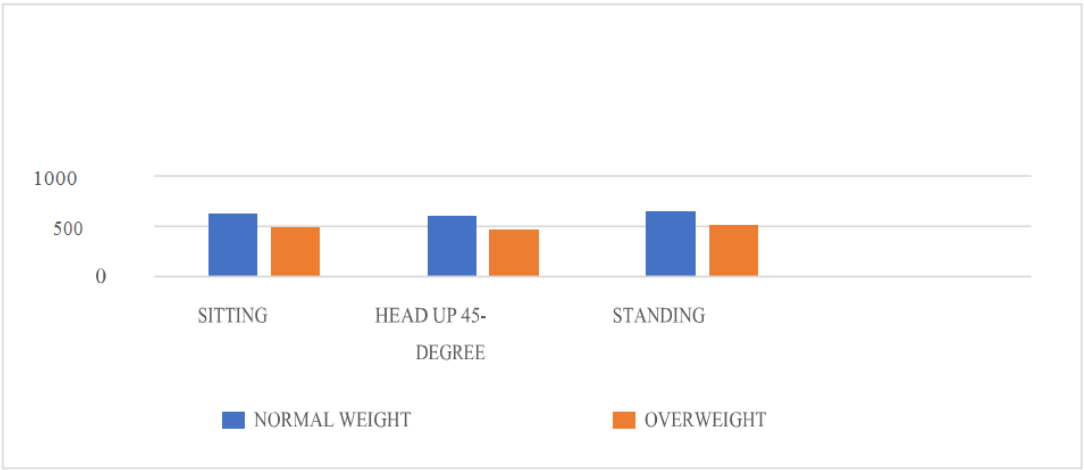
Graph 9

MEAN ± S.D. OF CE (LOWER) BETWEEN 3 DIFFERENT BODY POSITIONS IN TWO GROUPS



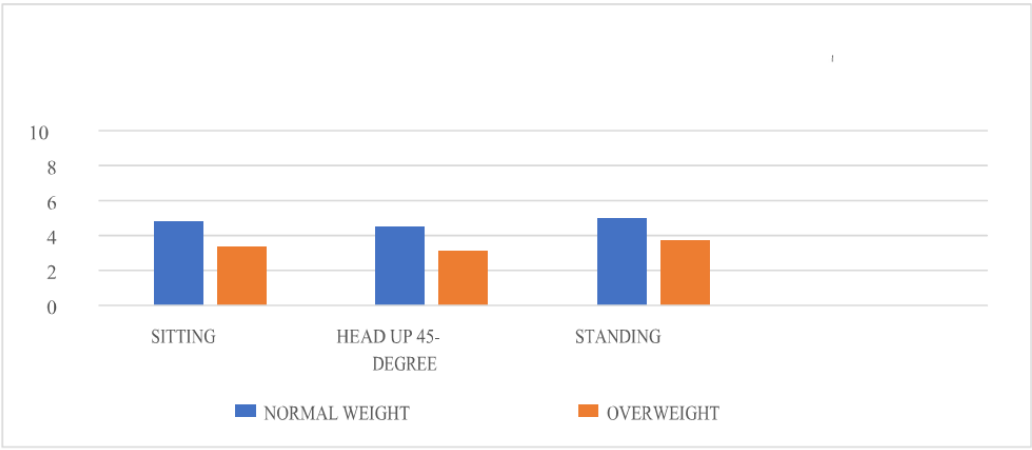
Graph 10

MEAN ± S.D. OF PEFR BETWEEN 3 DIFFERENT BODY POSITIONS IN TWO GROUPS



Graph 11

MEAN ± S.D. OF FEV_1 BETWEEN 3 DIFFERENT BODY POSITIONS IN TWO GROUPS



Multiple comparison of different position in Group A and Group Bwhile changing from one position to another:(p-value comparisons)

Parameters	Position association	Group A (NWP)	Group B (OWP)
SP	Sitting- HDS (45-degree)	0.147	0.485
	Sitting- standing	0.029	0.006
	HDS (45-degree)standing	0.000	0.000
DP	Sitting- HDS (45-degree)	0.414	0.908
	Sitting- standing	0.001	0.014
	HDS (45-degree)standing	0.000	0.004
SPO2	Sitting- HDS (45degree)	0.995	0.405
	Sitting- standing	0.435	0.205
	HDS (45-degree) --standing	0.308	0.146
PR	Sitting- HDS (45degree)	0.444	0.895
	Sitting- standing	0.001	0.004
	HDS (45-degree)-standing	0.105	0.000
RR	Sitting- HDS (45degree)	0.905	0.000
	Sitting- standing	0.000	0.020
	HDS (45-degree)standing	0.000	0.000
PI	Sitting- HDS (45degree)	0.059	0.000
	Sitting- standing	0.000	0.000
	HDS (45-degree)standing	0.000	0.000
CE	Sitting- HDS (45degree)	0.797	0.782
	Sitting- standing	0.344	0.646
	HDS (45-degree)standing	0.107	0.266
PEFR	Sitting- HDS (45degree)	0.597	0.721
	Sitting- standing	0.648	0.629
	HDS (45-degree)standing	0.155	0.213
FEV1	Sitting- HDS (45degree)	0.510	0.564
	Sitting- standing	0.236	0.343
	HDS (45-degree)standing	0.019	0.044

V. Discussion

This study was designed to analyse the variations of cardiorespiratory parameters on different body positions in middle aged adults. The present study infers that there is variation in cardiorespiratory parameters as the position of the body changes. Also, the study found that BMI of subjects does affect these changes.

Present study was supported by Gordon et al in 2009 whom had reported in a study that there are significant differences in cardiorespiratory variables among active older people (age >65years) when they change body position [1]. Jones et al in 2004, had also concluded that highest mean values for each variable (HR, RRP, BP and SPO_2) occurred in sitting in young healthy people [6]. Study by Tapar et al in 2018 showed that perfusion index values were affected by different body positions ($p<0.05$) and found it to be lowest in the sitting position and highest in individuals with Trendelenburg position. [2]

Another study by Behra et al in 2014 had found that pulmonary parameters are variable with increasing age (FEV_1, FEV_1 / FVC ratio and PEFR) and found that they vary in different body positions [23]. This result is supported by Smith et al 2010, with study conducted in healthy individuals where it was reported that no difference had been recorded in oxygen saturation values in two different body positions (supine and Fowler's). Also, it was found that CE does not vary with the positions in any of the two groups. Also, according to BMI, in this study it was found to be higher in overweight population as standing>sitting>head up 45-degree supine flat lying. SBP and DBP where almost similar in all the positions but when BMI is considered it was observed that they were significantly higher in overweight population.

It was demonstrated by present study that there exists a gravitational mechanism producing such effect. It is assumed that the venous return to the heart often gets affected significantly due to the gravity pull, as the body position takes an upright position. As a result, a decrease in cardiac output, also may increase heart rate that may in turn regulate BP and PR through"baroreceptor mechanism" of the heart. This affects the oxygen delivery system of the body in relation to changes in distribution of body's blood as well as peripheral resistance.

Thus, this can be concluded that the postural changes have affects with respect tothe relation between cardiorespiratory parameters. The latter is dependent, to some extent, upon the former. The constant effect on muscles &hemodynamic of body associated with varied cardiorespiratory parameters in different body positions.

VI. Conclusion

It can be concluded from the present study that there is significant variation among cardiorespiratory parameters when position of the body is changed and BMI does affect the cardiorespiratory parameters of the body except SPO_2, PEFR and CE. The present study undertakes middle aged healthy and non-smoking adults into consideration. The study insight into how beneficial or adverse a body position can be in therapeutic intervention to the patients in ICU or in general for all individuals as a whole.

LIMITATION OF STUDY

Study only took into consideration healthy non-smoking subjects between age group 40 to 59 years. It does not consider upper CE measurement. It does not consider subjects with any specific cardiorespiratory conditions and subjects under critical care unit. Study only considers two PFT parameters. It considered small sample size and within specific geographical location.

FUTURE SCOPE OF THE STUDY

Study could be performed on larger sample size Specific cardiopulmonary conditions can be considered for analysis of the same. More of the cardiorespiratory parameters can be considered for the study. Study can be performed on specifically ICU patients.

References

[1]. Gordon, S., Jones, A., Sealey, R., & Buettner, P. (2011). Body position and cardio-respiratory variables in older people. Archives of gerontology and geriatrics, 52(1), 23-27.
[2]. Tapar, H., Karaman, S., Dogru, S., Karaman, T., Sahin, A., Tapar, G. G., ... & Suren, M. (2018). The effect of patient positions on perfusion index. BMC anesthesiology, 18(1), 111.
[3]. Coonan, T. J., & Hope, C. E. (1983). Cardiorespiratory effects of change of body position. Canadian Anaesthetists' Society Journal, 30(4), 424-437.
[4]. Ceylan, B., Khorshid, L., Güneş, Ü. Y., &Zaybak, A. (2016). Evaluation of oxygen saturation values in different body positions in healthy individuals. Journal of clinical nursing, 25(7-8), 1095-1100.
[5]. Naitoh, S., Tomita, K., Sakai, K., Yamasaki, A., Kawasaki, Y., & Shimizu, E. (2014). The effect of body position on pulmonary function, chest wall motion, and discomfort in young healthy participants. Journal of manipulative and physiological therapeutics, 37(9), 719-725.
[6]. Jones, A. Y., & Dean, E. (2004). Body position change and its effect on hemodynamic and metabolic status. Heart & Lung, 33(5), 281-290.

[7]. SATO, M., & TANAKA, S. (1973). Postural effect on the relation between oxygen consumption and heart rate. Journal of human ergology, 2(1), 21-30.
[8]. Šipinková, I., Hahn, G., Meyer, M., Tadlanek, M., & Hajek, J. (1997). Effect of respiration and posture on heart rate variability. Physiol. Res, 46, 173-179.
[9]. Kaminsky, L. A., Arena, R., Beckie, T. M., Brubaker, P. H., Church, T. S., Forman, D. E., ... & Patel, M. J. (2013). The importance of cardiorespiratory fitness in the United States: the need for a national registry: a policy statement from the American Heart Association. Circulation, 127(5), 652-662.
[10]. Craig, D. B., Wahba, W. M., Don, H. F., Couture, J. G., &Becklake, M. R. (1971). "Closing volume" and its relationship to gas exchange in seated and supine positions. Journal of applied physiology, 31(5), 717–721. https://doi.org/10.1152/jappl.1971.31.5.717
[11]. Olufsen, M. S., Ottesen, J. T., Tran, H. T., Ellwein, L. M., Lipsitz, L. A., & Novak, V. (2005). Blood pressure and blood flow variation during postural change from sitting to standing: model development and validation. Journal of Applied Physiology, 99(4), 1523-1537.
[12]. Marklew, A. (2006). Body positioning and its effect on oxygenation–a literature review. Nursing in critical care, 11(1), 16-22.
[13]. Dean, E. (1985). Effect of body position on pulmonary function. Physical Therapy, 65(5), 613-618.
[14]. Tabara, Y., Tachibana-Iimori, R., Yamamoto, M., Abe, M., Kondo, I., Miki, T., &Kohara, K. (2005). Hypotension associated with prone body position: a possible overlooked postural hypotension. Hypertension research, 28(9), 741746.
[15]. Palatini, P., & Julius, S. (1997). Heart rate and the cardiovascular risk. Journal of hypertension, 15(1), 3-17.
[16]. de Victo, E. R., de Moraes Ferrari, G. L., & da Silva, J. P. (2017). Lifestyle indicators and cardiorespiratory fitness in adolescents. RevistaPaulista de Pediatria, 35(1), 61.
[17]. Roy, A. S., Bhattacharjee, I., Dalui, R., Pal, S., & Bandyopadhyay, A. (2014). Gender difference on the effects of body mass index in prediction of spirometric reference values in healthy young Indian adults. Int J Clin Exp Physiol, 1(1), 73-5.
[18]. Al Ghobain, M. (2012). The effect of obesity on spirometry tests among healthy non-smoking adults. BMC pulmonary medicine, 12(1), 1-5.
[19]. Vilke, G. M., Chan, T. C., Neuman, T., & Clausen, J. L. (2000). Spirometry in normal subjects in sitting, prone, and supine positions. Respiratory care, 45(4), 407-410.
[20]. Jensen, L. A., Onyskiw, J. E., & Prasad, N. G. N. (1998). Meta-analysis of arterial oxygen saturation monitoring by pulse oximetry in adults. Heart & lung, 27(6), 387-408.
[21]. Bongers, T., &O'driscoll, B. R. (2006). Effects of equipment and technique on peak flow measurements. BMC pulmonary medicine, 6(1), 1-6.
[22]. Behera, A. A., Behera, B. K., Dash, S., & Mishra, S. (2014). Variation of pulmonary function tests with relation to increasing age in healthy adults. Int J Health Sci Res, 4, 136-141.
[23]. Marklew, A. (2006). Body positioning and its effect on oxygenation–a literature review. Nursing in critical care, 11(1), 16-22.
[24]. Vollman, K. M., Lan, P. N., & INCC, C. (2015). Critical Care Nursing's Role in Prevention of Harm: Going Back to the Basics with Evidence.
[25]. Demura, S., Yamaji, S., & Uchiyama, M. (2010). Influence of high ambient temperatures on the physiological responses and body sway in healthy young adults after quickly standing. Journal of human ergology, 39(2), 69–78
[26]. Wong, D. T., Lee, K. J., Yoo, S. J., Tomlinson, G., & Grosse-Wortmann, L. (2014). Changes in systemic and pulmonary blood flow distribution in normal adult volunteers in response to posture and exercise: a phase contrast magnetic resonance imaging study. The journal of physiological sciences: JPS, 64(2), 105–112. https://doi.org/10.1007/s12576-013-0298-z.
[27]. Do, J. G., Park, C. H., Lee, Y. T., & Yoon, K. J. (2019). Association between underweight and pulmonary function in 282,135 healthy adults: A cross-sectional study in Korean population. Scientific reports, 9(1), 1-10.
[28]. Debouche, S., Pitance, L., Robert, A., Liistro, G., &Reychler, G. (2016). Reliability and reproducibility of chest wall expansion measurement in young health adults. Journal of manipulative andphysiological therapeutics, 39(6), 443-449.
[29]. Aires L, Pratt M, Lobelo F, Santos RM, Santos MP, Mota J. Associations of cardiorespiratory fitness in children and adolescents with physical activity, active commuting to school, and screen time. J Phys Act Health. 2011;8(2):S198–S205.
[30]. Yıldırım GO & Yavuz M (2009) The € hemodynamic and physiologic effects of supine positions given to the patients in intensive care units. Maltepe University Journal of Nursing Science and Art 2, 94–99.
[31]. Ryan Burns, James C. Hannon, Timothy A. Brusseau, Barry Shultz, Patricia Eisenman, "Indices of Abdominal Adiposity and Cardiorespiratory Fitness Test Performance in Middle-School Students", Journal of Obesity, vol. 2013, Article ID 912460, 8 pages, 2013. https://doi.org/10.1155/2013/912460.

Dr. Manish Kumar, et. al. "Comparative Analysis of Different Cardio-Respiratory Parameters with respect to changing Body Positions in Middle-Aged Health Population in Delhi-NCR." *IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)*, 21(11), 2022, pp. 47-60.