

## POSTURAL CHANGES IN HEART RATE AND BLOOD PRESSURE WITH AGEING

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### ABSTRACT

**Introduction:** The change in arterial blood pressure and heart rate is one of the generally known physiological changes in aging of man. The present study was intended to evaluate BP and HR changes with age.

**Aim:** The objective of the study is to know the prevalence of orthostatic hypotension in healthy geriatric subjects.

**Materials and Methods:** The subjects selected are 120 in number with age group 35 to >65 years of both sex and they are categorized into 4 groups based on their age. Group- I: The age of 35-45 years; Group-II: The age of 45-55 years; Group-III: The age of 55-65 Years; Group-IV: The age of >65 years. Blood Pressure is recorded by using manual sphygmomanometer and orthostatic test was conducted in all the subjects. Heart Rate was calculated by using R-R interval by ECG machine.

**Results:** The examination of parameters, body mass index, Heart Rate, systolic and diastolic Blood Pressure during resting, immediate standing, after three minutes of standing i.e., postural variations were estimated for all subjects. The data was analyzed by using descriptive and inferential statistics.

**Discussion:** The findings suggested that the mean SBP and DBP are higher in Group IV compared to Group I which is statistically highly significant. After immediate standing in all the subjects the SBP is decreased and DBP is increased and this variation is variable in different groups. The Heart Rate in all four Groups increases. And this variation is also variable in different groups.

**Conclusion:** This study concluded that BP increases with increase in age due to stiffening of Blood vessels but the postural decrease in SBP in standing from lying down posture was more in elderly. Orthostatic Hypotension was found in only one elderly. So Orthostatic Hypotension was less prevalent in healthy elderly.

**KEYWORDS:** Blood Pressure, Heart Rate, Body mass index, Orthostatic Hypotension.

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### INTRODUCTION

The change in arterial blood pressure is one of the generally known physiological changes in aging of man. Many factors are responsible for the rise of blood pressure of which age is

one of the factor. As in the process of aging the structural, functional, and biochemical changes occur with the influence of various genetic and environmental factors.

When body position is changed from a supine

or sitting position to standing. Pooling of blood in lower extremities occur due to gravitational effects. It reduces venous return and stroke volume with a fall in systolic blood pressure. Then Short Term regulatory mechanism (baroreceptor reflex) is operated to maintain normal Blood Pressure.<sup>1</sup>This hemodynamic homeostasis becomes less effective with aging and is associated with a decreased ability to regulate blood pressure.

Orthostatic Hypotension is a common clinical disorder among the older population. Orthostatic blood pressure (OBP) is a measure of cardiovascular reactivity reflecting autonomic function.<sup>2</sup> Due to age related physiologic changes, the response of the sympathetic system is usually decreased. Hence elder people tend to be more vulnerable to orthostatic stress than the younger ones. Also such elder ones having some associated diseases like hypertension, diabetes mellitus, and low blood volume become further weaker.<sup>3</sup>The primary purpose of this study is to observe the postural variation of heart rate and blood pressure and to compare in different age groups.

## MATERIALS AND METHODS

**Selection of Groups:** The subjects selected are 120 in number with age group 35 to >65 years of both sex and they are categorized into four groups based on their age. **Group- I:** Subjects of 35-45 years, **Group-II:** Subjects of 45-55 years, **Group-III:** Subjects of 55-65 years, **Group-IV:** subjects of >65 years.

**Inclusion criteria:** The study includes healthy subjects, subjects of mixed socioeconomic status.

**Exclusion criteria:** Subjects with diabetes mellitus, hypertension, any other debillating illness, cardio-respiratory diseases and other diseases ,Subjects with obesity were excluded, Subjects with smoking and alcoholism, Subjects who are on medication were excluded, who unable to stand were excluded.

The participants were carried out the physical examinations including measurement of height and weight, and body mass index (BMI). BMI was calculated as weight (in kilograms) divided by height (in square meters) (Quetelet's index). The

Orthostatic Test was conducted on apparently healthy subjects. Readings were taken in supine posture followed by standing posture, both HR and BP are recorded at the same time. The test was performed between 7.30 AM and 9.00 AM before breakfast. Questionnaires evaluated about smoking habits, medication use and history of past illness. Orthostatic hypotension is defined as a reduction in systolic blood pressure of at least 20 mm Hg or a reduction in diastolic blood pressure of at least 10 mm Hg during the first 3 minutes of standing.

ECG machine is used to measure heart rate by calculation of R-R interval. It is recorded by using L II lead. Normal HR is calculated by the R-R interval at a paper speed of 25 mm/sec. As per speed of the paper, one minute is equals to 1500 small squares. So, the number of cycles that could be inscribed with in this length of paper will be the heart rate. (Heart rate=1500/ number of small squares in one RR interval).

## RESULTS

**Table 1:** Mean  $\pm$  SD, 'P' Values of BMI among Group – I, Group-II, Group- III & Group IV.

Parameter	Group-I (n=30)		Group-II (n=30)		Group-III (n=30)		Group-IV (n=30)		GI-GII	GII-III	GIII-IV	GIV
	Mean	$\pm$ SD	Mean	$\pm$ SD	Mean	$\pm$ SD	Mean	$\pm$ SD	'P' Value	'P' Value	'P' Value	'P' Value
BMI (kg/m <sup>2</sup> )	23.59	1.77	23.44	2.85	23.31	2.65	22.9	1.69	0.13	0.35	0.21	0.09

There is no significant difference among all the age groups but a slight decrease in Group-IV when compared with Group-I.

**Table 2:** Mean and Standard Deviation of HR, SBP, DBP in Lying down posture in Group – I, Group-II, Group-III & Group IV.

Groups	HR	SBP	DBP
	Mean $\pm$ Sd	Mean $\pm$ Sd	Mean $\pm$ Sd
GI	73.73 $\pm$ 4.95	118.47 $\pm$ 7.53	73.58 $\pm$ 4.83
GII	73.06 $\pm$ 4.75	128.11 $\pm$ 4.77	75.69 $\pm$ 3.98
GIII	73.13 $\pm$ 3.39	128.38 $\pm$ 3.37	78.30 $\pm$ 3.93
GIV	71.66 $\pm$ 4.49	130.87 $\pm$ 4.17	78.79 $\pm$ 3.47

The mean HR of Group-I and Group II are 73.73 $\pm$ 4.95 and 73.06 $\pm$ 4.75 respectively. No significant difference was observed in HR. But the SBP is significantly higher (P<0.001) in group II compared to Group I. The mean values are 118.47 $\pm$ 7.53 and 128.11 $\pm$ 4.77 in group I and Group II respectively. The mean values of DBP in group I & II are 73.58 $\pm$ 4.83 and 75.69 $\pm$ 3.98 respectively. There is no significant variation in DBP of Group I & II. The mean HR of Group II &

III are  $73.06 \pm 4.75$  and  $73.13 \pm 3.39$  respectively. The P value is not significant. The mean SBP of group II ( $128.11 \pm 4.77$ ) and group III ( $128.38 \pm 3.37$ ) is also not statistically significant. But the DBP is increased in Group III ( $78.30 \pm 3.93$ ) than Group II ( $75.69 \pm 3.98$ ). Which is statistically significant ( $<0.05$ ).

The mean HR of Group III & IV are  $73.13 \pm 3.39$  and  $71.66 \pm 4.49$  respectively. The P value is not significant for this. The mean SBP of group III ( $128.38 \pm 3.37$ ) is less than group IV ( $130.87 \pm 4.17$ ) which is statistically significant ( $<0.04$ ). The DBP is also slightly increased in Group IV ( $78.79 \pm 3.47$ ) than Group III ( $78.30 \pm 3.93$ ). The mean HR of Group I & IV are  $73.73 \pm 4.95$  and  $71.66 \pm 4.49$  respectively. There is slight decrease in HR of Group IV but the P value is not significant. The mean SBP of group IV ( $130.87 \pm 4.17$ ) is higher than group I ( $118.47 \pm 7.53$ ) which is statistically highly significant ( $<0.001$ ). The DBP is also statistically highly significant ( $<0.001$ ) that it is high in Group IV ( $78.79 \pm 3.47$ ) than Group I ( $73.58 \pm 4.83$ ).

**Table 3:** Mean and Standard Deviation of SBP, DBP in Immediate standing posture in different groups.

Groups	HR	SBP	DBP
	Mean $\pm$ Sd	Mean $\pm$ Sd	Mean $\pm$ Sd
GI	$73.73 \pm 4.95$	$118.47 \pm 7.53$	$73.58 \pm 4.83$
GII	$73.06 \pm 4.75$	$128.11 \pm 4.77$	$75.69 \pm 3.98$
GIII	$73.13 \pm 3.39$	$128.38 \pm 3.37$	$78.30 \pm 3.93$
GIV	$71.66 \pm 4.49$	$130.87 \pm 4.17$	$78.79 \pm 3.47$

Comparison of SBP, DBP on immediate standing in Group I and Group II showed that the mean SBP of Group-II ( $125.26 \pm 5.52$ ) is higher than Group-I ( $114.80 \pm 6.94$ ) which is statistically highly significant ( $<0.001$ ). The DBP is also slightly increased in Group-II ( $75.69 \pm 3.98$ ) than group I ( $73.58 \pm 4.83$ ) but the P value is not statistically significant. Comparison of SBP, DBP in immediate standing in Group II and Group III, There is no significant difference in the mean SBP of group II ( $125.26 \pm 5.52$ ) and group III ( $125.40 \pm 3.68$ ). The DBP is statistically highly significant ( $<0.001$ ) that the mean of Group-III ( $86.33 \pm 3.67$ ) higher than group II ( $75.69 \pm 3.98$ ). Comparison of SBP, DBP in immediate standing in Group III and Group IV showed that there is no significant difference in the mean SBP of group III ( $125.40 \pm 3.68$ ) and group IV

( $126.40 \pm 4.62$ ). The mean DBP of Group-III ( $86.33 \pm 3.67$ ) group IV ( $84.80 \pm 4.47$ ) was also not significant. Comparison of SBP, DBP in immediate standing in Group I and Group IV showed that the mean SBP of group IV ( $126.40 \pm 4.62$ ) is higher than group I ( $114.80 \pm 6.94$ ) which is statistically highly significant ( $<0.001$ ). The DBP is also slightly increased in Group-IV ( $84.80 \pm 4.47$ ) than group I ( $73.58 \pm 4.83$ ) but the P value is not statistically significant.

**Table 4:** Mean and Standard Deviation of HR, SBP, DBP at third minute of standing posture in different groups.

Groups	HR	SBP	DBP
	Mean $\pm$ Sd	Mean $\pm$ Sd	Mean $\pm$ Sd
GI	$76.76 \pm 5.08$	$115.43 \pm 6.97$	$80.76 \pm 4.93$
GII	$76.33 \pm 5.64$	$124.96 \pm 5.63$	$82.93 \pm 4.14$
GIII	$74.66 \pm 3.41$	$125.23 \pm 4.06$	$85.46 \pm 3.66$
GIV	$71.56 \pm 5.25$	$126.16 \pm 4.28$	$84.50 \pm 3.84$

Comparison of HR, SBP, DBP at third minute of standing posture in Group I and Group II were, the mean HR of Group I and Group II are  $76.76 \pm 5.08$  and  $76.33 \pm 5.64$  respectively. No significant difference was observed in HR. But the SBP is significantly higher ( $P < 0.000$ ) in group II compared to Group I. The mean values are  $115.43 \pm 6.97$  and  $124.96 \pm 5.63$  in group I and Group II respectively. The mean values of DBP in group I & II are  $80.76 \pm 4.93$  and  $82.93 \pm 4.14$  respectively. There is slight increase in Group II but no significant variation in DBP. Comparison of HR, SBP, DBP at third minute of standing posture in Group II and Group III showed that the mean HR of Group II and Group III are  $76.33 \pm 5.64$  and  $74.66 \pm 3.41$  respectively. No significant difference was observed in HR. There is no significant difference in the mean SBP of group II ( $124.96 \pm 5.63$ ) and group III ( $125.23 \pm 4.06$ ). The DBP is statistically significant ( $<0.05$ ) that the mean of Group-III ( $85.46 \pm 3.66$ ) is higher than group II ( $82.93 \pm 4.14$ ). Comparison of HR, SBP, DBP at third minute of standing posture in Group III and Group IV showed that the mean HR of Group III and Group IV are  $74.66 \pm 3.41$  and  $71.56 \pm 5.25$  respectively. The HR is decreased in group-IV which is statistically significant. There is no difference in the mean SBP of group IV ( $126.16 \pm 4.28$ ) and group III ( $125.23 \pm 4.06$ ).

in the DBP also there is no difference in these groups. Comparison of HR, SBP, DBP at third minute of standing posture in Group I and Group IV. Mean HR of Group I and Group IV are  $76.76 \pm 5.08$  and  $71.56 \pm 5.25$  respectively. The HR is decreased in group-IV which is statistically highly significant. The mean SBP of group IV ( $126.16 \pm 4.28$ ) is higher than group I ( $115.43 \pm 6.97$ ) which is statistically highly significant ( $P=0.000$ ). The DBP of Group IV ( $84.50 \pm 3.84$ ) is higher than group I ( $80.76 \pm 4.93$ ) which is statistically significant ( $<0.05$ ).

## DISCUSSION

BMI has no significant variation among all the age groups but a slight decrease in Group-IV when compared with Group-I. Body composition (BC) is relatively stable in good health conditions (Forbes GB et.al.). There are studies (Fukagawa NK et.al., Nassis GP et.al.) that have reported a stable free fatty mass (FFM) until 60-70 years of age in men and women after which only a decline was seen in male subjects. On the contrary, some studies (Fukagawa NK) have shown loss of FFM after 40 years of age while a few others have reported peaking of FFM between 35 and 45 years. Such variations in Body Composition changes and peaking time points may be explained on the basis of differences in ethnicity, method of Body composition determination, diet and life style, socio-economic conditions and so on.<sup>4</sup>

In the present study a small decrease is observed in heart rate in lying down posture in between all Groups. But it is not statistically significant. Variation in heart rate, whether at rest or in response to a stimulus is mediated by the combined effects of vagal and sympathetic nerves acting on the sino-atrial node.<sup>5</sup> Assessment of heart rate variability is, however, complicated by changes in the autonomic nervous system that occur with advancing age.<sup>6</sup>

The Comparison of SBP, DBP in lying down posture in all groups. In Group I and Group IV The mean SBP of group IV ( $130.87 \pm 4.17$ ) is higher than group I ( $118.47 \pm 7.53$ ) which is statistically highly significant ( $<0.001$ ). The DBP is also statistically highly significant ( $<0.001$ ) that it is high in Group IV ( $78.79 \pm 3.47$ ) than Group I

( $73.58 \pm 4.83$ ). Philip A Low studies shows that Healthy elderly subjects aged above 60 years had a higher baseline systolic and diastolic Blood pressure when compared to the younger age group. As people age, large arteries gradually stiffen and small arteries may become partially blocked and this tends to increase the blood pressure. This could be the reason for the higher baseline blood pressure in the subjects aged 60 years and above.<sup>7</sup>

At first min of standing the SBP is decreased and DBP is increased in all the four groups. When an individual stands up from a sitting posture earth's gravitational forces start acting in the long axis of body trying to minimize the venous return. This results in fall of cardiac output and stroke volume. BP triggers the sino-aortic mechanism. Vasomotor Centre (VMC) becomes active and so sympathetic discharge increases. This mainly increases PR and heart rate.<sup>8</sup> but as age increase this sensitivity of Baro receptor decrease. So in the elderly the systolic blood pressure decrease is more. Due to decreased elasticity of walls of blood vessels the diastolic blood pressure remains at high level compared to younger group. After 3 minutes of standing the DBP is brought back to normal or remains high. SBP remains low, as venous return remains low. Some rigorous tests shows increased systolic pressure variability in the elderly.<sup>9</sup>

In the present study HR in all the four groups' increases upon standing from supine posture. The HR is decreased in group-IV compared to Group I & III which is statistically significant. Oida, et.al., studies shows that Variation of heart rate is associated with postural change.<sup>10</sup> In accord with previous reports, this study showed that HR was highest in standing compared to sitting or lying posture.<sup>11,12</sup> It is hypothesized that the increase in HR with standing follows a decrease in venous return due to "venous pooling" in the lower limbs due to gravitational effects.<sup>13</sup> The increase in peripheral venous volume is accompanied by an increase in both venous and arterial pressure in the lower extremities. The shift in blood volume from the central to the peripheral system induces a decrease in venous return and central venous pressure. Bainbridge reflex takes place. The smaller the venous return, the smaller the end-

diastolic and subsequent stroke volume. A reduction in venous return will lead to a reduced cardiac output, which in turn will lead to a reduction in baro-receptor stimulation in the aorta and carotid arteries.<sup>14,15</sup> This reduction in baro-receptor firing results in decreased parasympathetic and increased sympathetic activity.<sup>16,17</sup> These two actions directly affect the cardiovascular centre in the medulla oblongata which increases the HR, the arteriolar and venous tones, and the cardiac contractility to compensate for the decrease in stroke volume and provide a cardiac output which can meet body demands.

In all the groups SBP is decreased when one stands from supine position. Whereas DBP is increased from supine to standing. But in elderly this decrease in SBP is more. Though there are small changes in SBP among all groups on standing, when values are compared among individuals there is orthostatic hypotension in one elderly (0.3%) among 30 members in group IV with BP changes SBP-134.6 and DBP-82.6 in lying down posture, & SBP-114 and DBP-72 in standing posture with a fall of SBP (20.6 mm Hg) and DBP (10.6 mm Hg). These changes are due to autonomic changes as discussed by Philip A Low. According to their studies in normal elderly subjects, the prevalence of OH is reported to be between 5 and 30%. Orthostatic hypotension in the elderly may be due to age-related physiologic changes in blood pressure regulation, to certain disorders, or to use of certain drugs. Since the study subjects were neither suffering from any disorders nor taking any medications the prevalence of OH was less.

## CONCLUSION

In conclusion the blood pressure increases with increase in age due to stiffening of blood vessels in the elderly. But the postural decrease in SBP in standing from lying down posture is more in elderly compared to younger due to decreased baro-receptor sensitivity. The heart rate response to standing declines with advancing age due to decrease in parasympathetic activity. The Orthostatic test was also conducted among all the groups. But orthostatic hypotension was found in only one elderly. These

results indicate that underlying disease process and the medications used for treatment is major causes for orthostatic hypotension in the elderly. In healthy elderly the prevalence of orthostatic hypotension is less. Further studies are required to confirm these findings especially using a large group of geriatric healthy subjects to represent the Indian population.

**Conflicts of interest:** None

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