CONFOUNDING EFFECTS OF AGE, DIET AND PHYSICAL ACTIVITY ON BLOOD PRESSURE

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ABSTRACT

OBJECTIVE

Elevated blood pressure is one of the most common and important risk factors for atherosclerotic cardiovascular disease. Both hypertension and cardiovascular diseases are prevalent in epidemic proportions due to genetic, environmental and metabolic factors associated with modern lifestyle. In the present study we investigated the role of age, diet and physical activity on arterial blood pressure.

MATERIALS AND METHODS

The study was conducted on randomly selected subjects with different dietary preferences and physical activity levels. They were placed in various groups based on their age, diet (Vegetarians/Non-vegetarians) and physical activity (sedentary/physically active). General body measurements, blood pressure and cardiac output were measured and using ANOVA, the data was analysed.

RESULTS

All the three age groups showed changes in mean arterial pressure and cardiac output. The cardiac output values were raised in the non-vegetarian groups in comparison with the vegetarian groups of all the ages and in the physically active groups when comparing with the physically inactive groups. The physically active vegetarian group has significantly lower mean blood pressure values when compared with the physically inactive vegetarians. Similarly, non-vegetarians who are physically active have lower mean blood pressure values in comparison with the physically inactive non-vegetarian group. But when only diet was compared, non-vegetarians showed higher blood pressure values.

CONCLUSION

Vegetarian diet and increased physical activity act as confounding factors due to their varied action on blood pressure changes associated with age. Both diet and physical activity levels modify the blood pressure and cardiac output values, but the influence of vegetarian diet seems to be more than that of physical activity in the elderly age groups and impact of physical activity is more than diet in the younger age groups.

KEYWORDS

Blood Pressure, Physical Activity, Age, Vegetarian Diet.

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INTRODUCTION

Cardiovascular diseases are the number one cause of death globally. In 2008, 30% of all deaths were due to CVD and 16.5% of all these deaths could be attributed to high blood pressure.[1] Hypertension has been often described as a 'silent killer,' because it accelerates the process of atherosclerosis. According to the estimation of WHO, cardiovascular diseases will be the largest cause of death and disability by 2020 in India and nearly half these deaths are likely to occur in young and middle-aged individuals (30-69 yrs.[2] Framingham Heart Study indicates that blood pressure values between 130-139/85-89 mmHg are associated with more than two-fold increase in relative risk from cardiovascular disease as compared with blood pressure levels below 120/80 mmHg.

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The study demonstrates that systolic and diastolic pressure has a continuous, independent, graded and positive association with cardiovascular outcomes independent of other risk factors.[3] The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure providing an evidence-based approach to the prevention and treatment of hypertension states that in people older than 50 years of age, systolic pressure more than 140 mmHg is a more important cardiovascular risk factor than diastolic blood pressure.[4]

Many studies were conducted to evaluate the lifestyle factors affecting blood pressure including diet and physical activity, two major factors influencing the modern lifestyles. Many insights into the effect of dietary factors on blood pressure has been put forward. Studies on the effect of vegetarian food on blood pressure were done and randomized controlled trials tried to isolate the main factors in vegetarian diet with this phenomenon.[5,6]

They linked nutrients like dietary fat, fiber, potassium, magnesium levels to blood pressure; however, it is still not clear which nutrients may be directly responsible for this difference. Effect of diet on blood pressure has been well documented by the interventional DASH trial with a diet high in fruits and vegetables, low fat dairy, reduced red meat and

sugar and refined carbohydrates.[7] The blood pressure lowering effect of this diet was found to be enhanced by sodium reduction.

WHO bulletin observed that sedentary living has become a worldwide phenomenon and has been recognized to be a major contributor of ill health and unnecessary death. The leisure time physical activity is very little in the present day global scenario of television viewing and computer activities.[8] Epidemiological studies have associated lack of physical exercise with increased cardiovascular risk and increased morbidity and mortality. Controlled trials bring increasing evidence supporting the beneficial effects of increased physical activity on blood pressure. Many studies tried to link elevated blood pressure with age, sex, ethnicity, exercise, diet and many other factors in both normotensive and hypertensive populations.[9,10]

MATERIALS AND METHODS

The Study was conducted over a period of 4 months and subjects were randomly selected from the male attendants of patients present in the cardiothoracic department. After the institutional ethical clearance was obtained, the subjects were selected from a similar background to avoid discrepancies. After the sample collection, the power of the study was calculated with the help of stats to do online calculator in the analysis of variance. We obtained a power of one showing the study to be statistically acceptable.

The inclusion criteria were the subjects must be healthy, non-smoking, adult males between the ages of 25 to 50 yrs. with varied dietary habits and physical activity levels. Subjects with known endocrinal or cardiovascular disorders or hypertension were excluded from the study. Subjects with chronic diseases or taking any medication were also excluded. They were divided into three groups based on age as:

Group A- 25-30 yrs. (Mean 27 yrs.).
Group B- 35-40 yrs. (Mean 37 yrs.).
Group C- 45-50 yrs. (Mean 47 yrs.).

After taking the dietary history, they are again divided into vegetarian (Eating only plant based foods including milk) and non-vegetarian (Consuming animal produce also like fish/poultry/meat/eggs three or more times per week) subgroups. These subjects are then categorized as sedentary (Doing only routine life activities) (PA_0) and physically active (PA_1) (Similar professions, but who performed physical activity for a minimum of 30 minutes for 3 or >4 days a week for the last 5 years) subgroups.

Prior to the study, each subject was informed in detail of its objectives and the methods to be used and their written consent was obtained. The subjects were asked to refrain from alcohol consumption 24 hrs. before the test and not to eat or drink one hour prior to the testing. On arrival to the laboratory in the morning of the tests, the age of each individual is recorded in completed years and the height and weight were recorded in metres (mts.) and kilograms (kgs) respectively. Body Mass Index (Quetelet's Index), which has been shown as a good measure to represent the overall body mass is obtained by dividing weight in kgs by height.^{2} in mts.

Following a ten-minute rest, two blood pressure measurements were taken with a gap of five minutes for each subject using a mercury sphygmomanometer.

The first and the fifth phase of Korotkoff sounds were recorded as systolic and diastolic pressure, respectively. The heart rate was recorded by counting the pulse rate by palpating the radial artery for one minute. These recordings are made while the subject is made to lie flat on the table near the echocardiogram, after which on the same table echo was also done. A two-dimensional echocardiogram was used to determine the flow area of the aorta and pulsed Doppler flow signal was used to determine velocity. Cardiac output was calculated as the product of velocity-time integral and flow area at the aortic root.

Statistical Analysis of this study was done by using a Microsoft excel data sheet and SPSS 22 version software. As we had multiple dependent variables for the study of intergroup variations, the two factor variance analysis (ANOVA) with replication was used. Pair wise comparison between the groups was done using honestly significant difference (HSD) test. A 'p' value of ≤0.05 was used to determine statistically significant differences between the groups.

RESULTS

In our study there was a slight change in the BMI between the various age groups, but within each group change was not statistically significant. The values of cardiac output (L/min) in two dietary (Vegetarian and non-vegetarian) and two physical activity (PA_0 and PA_1) subgroups within the three different age groups are tabulated in Table 1. The significance changes between dietary and physical activity groups were calculated as percentage differences and the following results were observed.

Within the first age group (Group A), it is observed that the physically active (PA_1) vegetarians have significantly higher (9.31%) cardiac output compared to that of the sedentary (PA_o) vegetarian group. Similarly, the physically active non-vegetarian (PA_1) group had significantly higher levels (16.81%) when compared to the respective sedentary (PA_o) group. Cardiac output levels are also significantly raised (8.51%) in non-vegetarians than the vegetarians within the two physically active groups. In the second age group (Group B), the vegetarian group did not show any significant difference between the PA_o and the PA_1 subgroups, but significantly high values (5.33%) have been observed when the non-vegetarian PA_1 groups are compared with the vegetarian PA_1 group.

The non-vegetarian PA_1 subgroup also has significant change (5.78%) in comparison with the non-vegetarian PA_o subgroup. In the third age group (Group C), it can be observed that the non-vegetarian PA_1 group showed significant increase (13.5%) in the cardiac output values than the corresponding vegetarian subgroups. In PA_o groups also, the non-vegetarian subgroup showed a significant raise (5.97%) than the vegetarian group. Within the non-vegetarian groups, the PA_1 group has higher values (9.85%).

Age Groups	Dietary Subgroups	Activity Level Subgroups	
		PA_0	PA_1
Age group-I (25-30 yrs.)	Vegetarian	4.51± 0.03	4.93 ± 0.06*
	Non-vegetarian	4.58±0.04	5.35±0.04*#
Age group- II (35-40 yrs.)	Vegetarian	4.57±0.04	4.69±0.18
	Non-vegetarian	4.67±0.04	4.94±0.02*#
Age group-III (45-50 yrs.)	Vegetarian	4.69±0.04	4.81±0.19
	Non-vegetarian	4.97±0.05#	5.46±0.04*#

Table 1: Cardiac Output (L/min) of Individuals of different Age Groups Subdivided according to their Dietary Habits and Activity Levels

Data are presented as mean (25 observations) ± SEM.
* Indicates significant difference when compared to respective sedentary subgroup, and
#Indicates significant difference when compared to respective vegetarian subgroup.

Table 2 shows Mean Arterial Blood Pressure (mmHg) in the two dietary (Vegetarian and Non-vegetarian) and the two physical activity (PA_0 and PA_1) subgroups within the three different age groups. Within the first age group (Group A), it has been observed that the PA_1 vegetarians are showing significantly lower mean blood pressure values (-3.5%) when compared with the PA_0 vegetarian subgroup. Similarly, the non-vegetarians who are PA_1 are having lower values (-2.77%) on comparison with the non-vegetarian PA_0 group. But when the non-vegetarian PA_0 group is compared with the vegetarian PA_0 group, they showed higher blood pressure levels (4.05%). Also the non-vegetarian PA_1 group has higher values (4.84%) than the corresponding vegetarian subgroup.

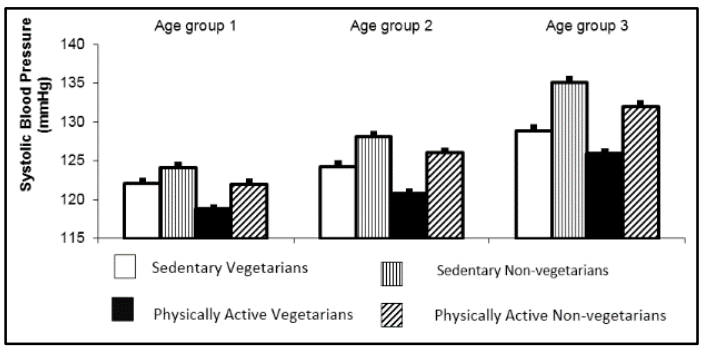
When the second age group (Group B) is studied, similar changes are observed with the vegetarian PA_1 group having low mean pressures (-3.55%) when compared with the vegetarian PA_0 group. The non-vegetarian PA_1 group showed higher mean blood pressure value (4.15%) in comparison with the non-vegetarian PA_0 group. Both the non-vegetarian groups have significantly higher mean blood pressure in comparison to the corresponding vegetarian groups. In the third age group (Group C), vegetarians who are physically active (PA_1) have low mean blood pressure values in comparison with similar age matched physically inactive vegetarians (PA_0).

The non-vegetarian physically active (PA_1) group showed lower mean blood pressure values when compared with the non-vegetarian physically inactive group (PA_0). But when we observed the dietary groups alone, both the non-vegetarian groups have significantly higher mean blood pressure values than the corresponding vegetarian groups.

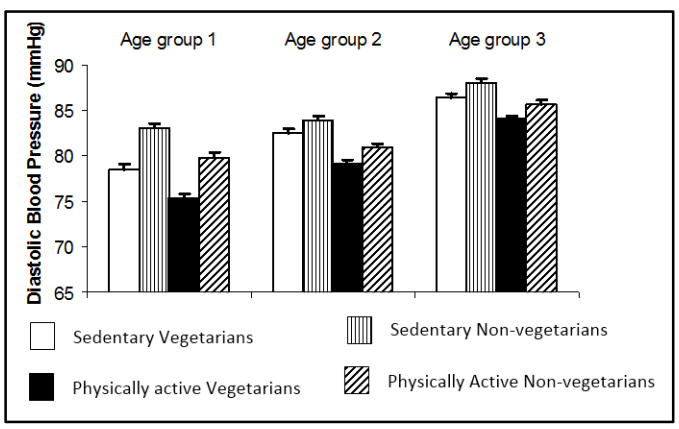
Age Groups	Dietary Sub Groups	Activity Level Sub Groups	
		PA_0	PA_1
Age group–I (25-30 yrs.)	Vegetarian	92.98±0.45	89.72±0.45*
	Non-vegetarian	96.75±0.38#	94.07±0.47*#
Age group–II (35-40 yrs.)	Vegetarian	96.32±0.38	92.90±0.40*
	Non-vegetarian	98.63±0.42#	95.99±0.27*#
Age group-III (45-50 yrs.)	Vegetarian	100.48±0.42	97.92±0.37*
	Non-vegetarian	103.68±0.35#	101.17±0.34*#

Table 2: Mean Arterial Blood Pressure (mmHg) of Individuals of Different Age Groups subdivided according to their Dietary Habits and Activity Levels

Data are presented as mean (25 observations) ± SEM.
* indicates significant difference when compared to respective sedentary subgroup, and
# indicates significant difference when compared to respective vegetarian subgroup.



Graph 1: Systolic Blood Pressure (mmHg) of Individuals of Different Age Groups subdivided according to their Dietary Habits and Activity Levels



Graph 2: Diastolic Blood Pressure (mmHg) of Individuals of Different Age Groups subdivided according to their Dietary Habits and Activity Levels

DISCUSSION

In our study we find that mean pressure tends to increase with age and the effect of diet is more pronounced in the higher age groups, but in the lower ages the effect of physical activity is found to be significant. Cardiac output values were significantly higher in physically active individuals irrespective of the diet in all the three age groups. But if diet also is taken into consideration, non-vegetarian groups have significantly raised levels, particularly in the third age group. So as age increases vegetarian diet plays a very significant role, but in younger individuals, physical activity is found to confound the effects of the vegetarian diet. R H Fagard, in his review article discusses that dynamic aerobic training is less effective than diet in lowering blood pressure and that exercise does not add to the blood pressure reduction by diet alone.[11]

EPIC study shows a high prevalence of hypertension (12-15%) in meat eaters than in vegetarians (6-8%).[12] In our study, we observed that blood pressure levels increased in the non-vegetarian groups than in the vegetarian groups even though the Indian non-vegetarians eat less meat and more vegetables than their western counterparts. Frank B Hu reviewed the effects of plant-based diets and concluded that a diet including whole grains, unsaturated fats, abundant fruits and vegetables and adequate n-3 fatty acids can play an important role in preventing CVD.

He also suggests that inclusion of fish, poultry and low fat dairy in the diet will add healthy fats and protein to the diet.[13] The Framingham Heart study shows a linear rise in systolic blood pressure from 30-84 years and an earlier concurrent rise of diastolic and mean blood pressures.[3] We have observed that in our study of three age groups, the mean blood pressure showed a significant rise with age. Our study shows that the effect of physical activity on mean arterial blood pressure is more significant in the lower age groups, but in the higher age groups the effect of diet is more pronounced. The lower levels of mean blood pressure in physically active younger age groups was similarly observed in the study of Betty J Pettersen et al and they conclude that this blood pressure lowering effect is partly due to their lower body mass.[14]

In our study we did not find significant changes in body mass within each age group, but observed some increase in the elderly age groups. Fagard et al studied physical activity and its role in hypertension and showed that training reduced mean blood pressure by 4-9%. This effect can be attributed to a decrease in systemic vascular resistance and heart rate. This lowering of blood pressure by training is multifactorial and involves the sympathetic nervous system, the renin-angiotensin-aldosterone system and endothelial factors.[11]

In elderly athletes, the significantly low values of systolic blood pressure was explained to be due to a shift in the sympathetic:parasympathetic tone ratio towards a strong parasympathetic influence.[15] Regular vigorous physical activity and strengthening patterns declined consistently through the teenages.[16] This lowering of physical activity leads to the development of non-communicable, chronic diseases such as coronary heart disease, hypertension, stroke, diabetes, cancer, etc.[8] Anderssen S et al show that diet and diet+exercise are about equally effective in reducing blood pressure and the effects may be dependent on the baseline level.[17] The Seventh Report of Joint National Committee on the Prevention, Detection, Evaluation and Treatment of High Blood Pressure recommends strongly, lifestyle modifications, in particular increased physical activity as an adjunct to the pharmacological therapy.[4]

Limitations of the Study

Both diet and physical activity habits are from self-reporting by the subjects, so there may be inaccuracies. In the current study, the individual nutrients are not assessed due to various restraints. In the present day globalization scenario, dietary habits are changing and analysing them correctly may be difficult but essential.

CONCLUSION

Based on the findings of our study, we believe that dietary influences play a significant role in higher age groups, so embracing a vegetarian diet may be an effective way to a healthy life. Usually awareness of diet and changing to vegetarianism itself increases other healthy changes in lifestyle such as increasing regular physical activity, maintaining a desirable weight, abstaining from smoking and alcoholism. For the lower age groups, increased physical activity must be encouraged from childhood and continued throughout life.

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