ORIGINAL ARTICLE

CORRELATION BETWEEN BODY MASS INDEX AND BLOOD PRESSURE IN ADOLESCENTS

Manjeet Kaur
Department of Physiology, SGRDIMSAR, Amritsar, India

Background: The obesity and hypertension are the major risk factors of several life threatening diseases. The present study was conducted to study the correlation of Body Mass Index (BMI) the validated index of adiposity with blood pressure in adolescents. **Objectives**: To determine body mass index (BMI) and blood pressure of the adolescents and to find out the correlation between body mass index (BMI) and blood pressure.To advice about lifestyle modifications like aerobic exercises, diet management, and abstinence from alcohol and smoking. **Methods:** We obtained data from 300 healthy medical students (112 males and 188 females) and assessed the correlations between BMI and the systolic blood pressure (SBP) and diastolic blood pressure (DBP). In view of gender differences in autonomic regulation, data of male and female subjects were analysed separately. The statistical analysis was done using *t*-test. **Results**: There was highly significant ($p<0.001$) positive correlation between BMI with SBP and DBP in both male and female subjects. On further analysis, on the basis of BMI subgroups, it was found that the correlation was significant ($p<0.01$) only in overweight males (BMI>23 Kg/m^2) compared to overweight females. **Conclusion:** BP is linearly related to BMI. The observed differences between the BMI subgroups may be possibly due to differences in autonomic function and metabolism.

Keywords: Body Mass Index (BMI), Blood pressure, adolescents.

Pak J Physiol 2016;12(1):47–50

INTRODUCTION

The obesity is known as one of the most important health problems. The prevalence of overweight and obesity had increased slightly over the past decade in India, but in some urban and high socioeconomic groups it reached relatively high levels.[1] Globally the prevalence of childhood obesity varies from over 30% in USA to less than 2% in sub-Saharan Africa. National representative data for childhood obesity in India is unavailable, however, available studies of Chennai and Delhi has shown that prevalence of 6.2% and 7.4% respectively.[2,3] Obesity is usually defined in terms of BMI which provides an index of weight relative to height and is generally considered a valid index of adiposity.[4] Obesity is considered as a gateway disease, which can lead to heterogenous diseases such as metabolic syndrome, diabetes different gastrointestinal and respiratory disease, and certain types of cancers and hypertension.[5,6,7] As BMI increases, the risk increases for cardiovascular complications including hypertension (high blood pressure).

Hypertension is believed as a significant risk factor of adulthood diseases and unfortunately is getting more prevalent rapidly.[6] Hypertension is associated with the incidence of stroke, coronary heart disease, congestive heart failure and renal insufficiency.[8] It has been shown that high BP in adults can be originated from childhood.[7] The number of adolescents suffering from hypertension is increasing over the years, in no small part because there has been a striking shift in the lifestyle of children and teenagers. The rise of obesity and the lifestyle has resulted in a whole host of medical problems for youth. The prevalence of hypertension among all adolescents is approximately 3.5%.[9]

Blood pressure is regulated by activity in the autonomic nervous system.[10] Obesity is associated with sympathetic activation and is the leading risk factor for development of hypertension.[11] The use of body mass index (BMI) for the production of risk factor in adolescents has clinical utility.[12] This study was designed to see any correlation of BMI with BP in adolescents.

SUBJECTS AND METHODS

This study was conducted in the Department of Physiology, Sri Guru Ram Das Institute of Medical Sciences and Research, Amritsar. Three hundred medical students (112 boys and 188 girls) of age group17–19 years were included in this study. Ethical clearance was obtained from the Institute Ethical Committee. The students were briefed about the objectives of the study before taking their written consent. Routine history and physical examination was done to rule out any illness that would interfere with the outcome of the study.

Body Mass Index (BMI) was calculated using a Quetelet's index.

BMI=weight in (Kg)/(Height in meters)^2

Subjects were classified into three subgroups based on BMI: underweight (BMI<18.5 Kg/m^2), normal weight (BMI 18.5–23 Kg/m^2), and overweight (BMI>23 Kg/m^2).

Standard methodology[13] was used to measure blood pressure. Blood pressure was recorded in sitting position after giving rest for 5–10 minutes. Blood pressure recordings were expressed to the nearest 2 mm Hg. All blood pressure recordings were taken at the same time of the day, i.e., during afternoon hours and recorded by the same person and by the same instrument.

The correlation between BMI and Blood Pressure was assessed by calculating the correlation coefficient (r), and the $p<0.05$ was taken as significant.

RESULTS

Of the total 300 subjects, 112 were boys and 188 were girls. In view of the possibility that there could be gender differences in regulation of cardiovascular autonomic function[14–17], data were analysed in males and females separately.

In overall males the correlation coefficient (r) of BMI with systolic blood pressure (SBP) and diastolic blood pressure (DBP) was 0.338 and 0.377 respectively ($p<0.001$) (Table-1) (Figure-1a, b). On further analysis of 112 males on the basis of BMI subgroups it was found that in underweight (BMI<18.5 Kg/m^2) as well as normal weight (BMI 18.5–23 Kg/m^2) groups the correlation coefficient (r) were not significant. However, in the overweight subjects (BMI>23 Kg/m^2) the correlation coefficient (r) with SBP and DBP were 0.007 and 0.004 respectively ($p<0.01$) (Table-1).

Table-1: Correlation of BMI with SBP and DBP in males

Parameters	SBP		DBP	
	r	*p*	*r*	*p*
Overall (n=112)	0.338	<0.001**	0.377	<0.001**
BMI<18.5 Kg/m^2 (n=5) Underweight	0.202	0.745	0.489	0.403
BMI (18.5-23 Kg/m^2) (n=40) Normal weight	0.173	0.287	0.238	0.138
BMI>23 Kg/m^2 (n=67) Overweight	0.325	0.007*	0.348	0.004*

*$p<0.05$=Significant, **$p<0.001$=Highly significant

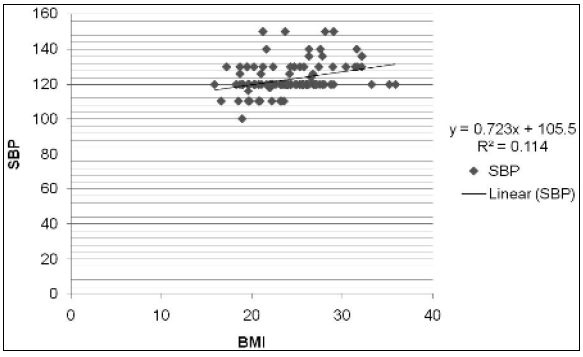

Figure-1a: Scatter diagram showing correlation of BMI with SBP in males

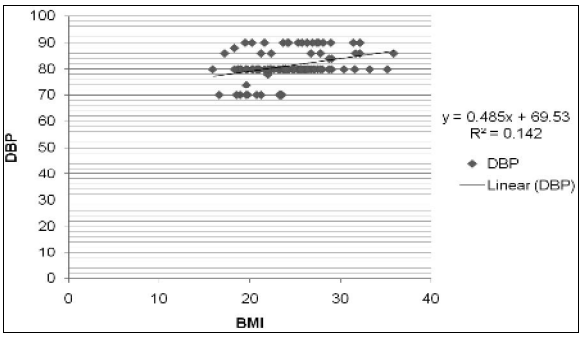

Figure-1b: Scatter diagram showing correlation of BMI with DBP in males

In total girls (188) the correlation coefficient (r) of BMI with the SBP and DBP were 0.297 and 0.263 respectively ($p<0.001$) (Table-2) (Figure-2a, b). There was no significant correlation of SBP and DBP in the underweight, normal and overweight girls (Table-2).

Table-2: Correlation of BMI with SBP and DBP in females

Parameters	SBP		DBP	
	r	*p*	*r*	*p*
Overall (n=188)	0.297	<0.001**	0.263	<0.001**
BMI<18.5 Kg/m^2 (n=34) Underweight	0.181	0.307	0.154	0.385
BMI 18.5–23 Kg/m^2 (n=100) Normal weight	0.175	0.081	0.050	0.623
BMI> 23 Kg/m^2 (n=54) Overweight	0.207	0.133	0.248	0.070

**$p<0.001$=Highly significant

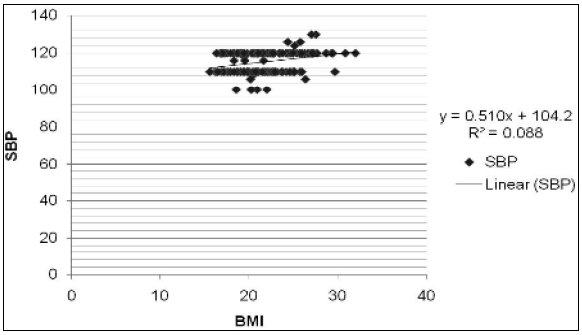

Figure-2a: Correlation of BMI with SBP in females

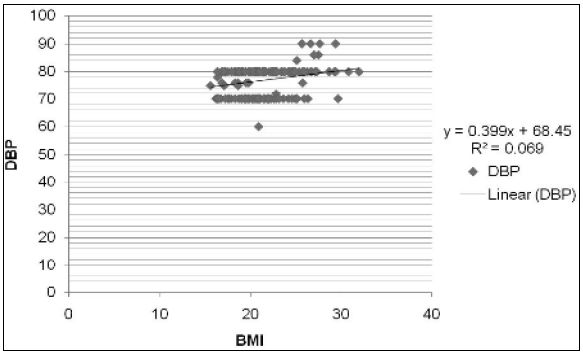

Figure-2b: Correlation of BMI with DBP in females

DISCUSSION

Hypertension is the most common universal contributor to cardiovascular mortality. Elevated blood pressure, labile or fixed, systolic or diastolic, at any age, in either sex is a contributor to all forms of cardiovascular diseases. Studies on hypertension in adolescents have the important advantage that they may help in the control and possibly prevention of high blood pressure before its harmful sequel can occur.

The present study was carried out on 300 adolescent medical students between the age group of 17–19 years, to correlate between body mass index and blood pressure. In our study groups, both males (112) and females (188) were found to have significant positive correlation between BMI and blood pressure (SBP and DBP). This was possibly due to differences in sympathetic tone between underweight and overweight subjects.[18] Analysing further on the basis of BMI subgroups, it was found that SBP and DBP were highest in overweight subject, which was statistically significant in males but not in female subjects. Thus, there were also gender differences in correlation between BMI and BP.[14–17] Similar results were also observed by other Researchers[19,20] where the above correlation was more significant in the males. The association of BMI with BP is also significant in children.[21,22] Other studies suggested key predictors of high BP among adolescents are BMI followed by increasing age, parental history and sedentary lifestyle.[23,24]

Our results indicate that there was a positive correlation between BMI and BP, which was highly significant in both male and female subjects. Further dividing them into various subgroups there was statistically significant correlation between overweight male and BP indices which were not significant in overweight female subjects. Thus the correlation was at best modest and it was likely that several factors besides BMI influence BP indices. Indeed, there has been evidence that genetic factors account significantly for the correlation observed between BMI and BP.[25]

One of the causes of hypertension is abnormal sodium and fluid balance. In obesity and hypertension, abnormal kidney function initially is due to increased tubular sodium reabsorption, which causes sodium retention and expansion of extracellular and blood volumes. Thus the obese individual requires higher levels of BP to maintain sodium fluid homeostasis. There are several potential mechanisms that could mediate the sodium retention and hypertension associated with obesity, including sympathetic nervous system activation, rennin-angiotensin-aldosterone system activation, and compression of the kidney.

Weight gain is almost invariably associated with an increase in BP. Thus, prevention of weight gain should be a primary target for reducing the problemd of hypertension. Regular physical activity and reduced dietary fat intake could be achieved by small life style changes for prevention of obesity-associated hypertension.

CONCLUSION

BP is linearly related to BMI. The observed differences between the BMI subgroups may possibly be due to differences in autonomic function and metabolism.

ACKNOWLEDGEMENTS

The author is grateful to the Director, Principal, and members of the Ethical Committee for granting permission to conduct this study. In addition, authors are thankful to the Physiology Department and all the subjects for their full cooperation and participation.

REFERENCES

1. Wang Y, Chen HJ, Shaikh S, Mathur P. Is obesity becoming a public health problem in India? Examine the shift from under to over nutrition problems over time. Obes Rev 2009;10(4):456–74.
2. Vedavathi S, Jayashree R, Rafi M. Prevalence of overweight and obesity in affluent adolescent school girls in Chennai in 1981. Indian Pediatrics 2003;40:775–9.
3. Kapil U, Singh P, Pathak P, Dwivedi SN, Bhasin S. Prevalence of obesity among affluent adolescent school children in Delhi, Indian Pediatrics 2002;39:449–52.
4. Gundogdu Z. Relationship between BMI and blood pressure in girls and boys. Public Health Nutr 2008;11(10):1085–8.
5. Li L, Law C, Power C. Body mass index throughout the life-course and blood pressure in mid adult life: a birth cohort study. J Hypertens 2007;25(6):1215–23.
6. Neilsen GA, Andersen LB. The association between high blood pressure, physical fitness, and body mass index in adolescents. Prev Med 2003;36(2):229–34.
7. Raj M, Sundaram KR, Paul M, Sudhakar A, Kumar RK. Body mass index trend and its association with blood pressure distribution in children. J Hum Hypertens 2010;11:1–7.
8. Lauer RM, Clarke WR. Childhood risk factors for adult blood pressure: The Muscatine Study. Pediatrics 1989;84(4):633–41.
9. Flynn Joseph T, Falkner Bonita E. Obesity Hypertension in Adolescents: Epidemiology, Evaluation and Management. J Clin Hypertens (Greenwich) 2011;13(5):323–31.
10. Ganong WF. Cardiovascular regulator mechanisms. In: Review of Medical Physiology, (International edition), New York: McGraw Hill; 2003. p. 599–613.
11. Rahmouni K, Correia MLG, Haynes WG, Mark AL. Obesity associated hypertension. Hypertension 2005; 45:9–14.
12. Katzmarzyk PT, Srinivasan SR, Chen W, Malina RM, Bouchard C, Berenson GS. Body mass index, waist circumference and clustering of cardiovascular disease risk factors in a biracial sample of children and adolescents. Pediatrics 2004;114:e198–e205.
13. National High Blood Pressure Education Program. Working Group on High Blood Pressure in Children and Adolescents. The fourth report on the diagnosis, evaluation, and treatment of high blood pressure in children and adolescents. Pediatrics 2004;114:555–76.
14. Beske SD, Alvarez GE, Ballard TP, Davy KP. Gender difference in cardiovagal baroreflex gain in humans. J Appl Physiol 2001;91:2088–92.
15. Laitinen T, Hartikainen J, Vanninen E, Niskanen L, Geelen G, Lansimies E. Age and gender dependency of baroreflex sensitivity in healthy subjects. J Appl Physiol 1998;84:576–83.

16. Christou DD, Jones PP, Jordan J, Diedrich A, Robertson D, Seals DR. Women have lower tonic autonomic support of arterial blood pressure and less effective baroreflex buffering than men. Circulation 2005;111:494–8.
17. Tank J, Diedrich A, Szezceh E, Luft FC, Jordan J. Baroreflex regulation of heart rate and sympathetic vasomotor tone in women and men. Hypertension 2005;45:1159–64.
18. Sorof J, Daniels S. Obesity hypertension in children. A problem of epidemic proportions. Hypertension 2002;40:441–7.
19. Ravisanker P, Madanmohan, Udupa K, Prakash ES. Correlation between body mass index and blood pressure indices, hand grip strength and handgrip endurance in underweight, normal weight and overweight adolescents. Indian J Physiol Pharmacol 2005;49(4):455–61.
20. Moafi A, Rahgozar S, Ghias M, Vahdatahar E, Amirbahador, Sabbaghi A, *et al*. A study on Body Mass Index, Blood Pressure, and Red Blood Cell indices in new entering students of the University of Isfahan. Int J Prev Med 2011;2(4):280–5.
21. Nanaware NL, Gavkare AM, Surdi AD. Study of correlation of body mass index (BMI) with blood pressure in school going children and adolescents. Int J Recent Trends Sci Technol 2011;1(1):20–6.
22. Hosseini M, Ataei N, Aghamohammadi A, Yousefifard M, Taslimi Sh, Ataei F. The relation of body mass index and blood pressure in Iranian children and adolescents aged 7–18 years old. Iranian J Publ Health 2010;39(4)126–34.
23. Soudarssanane MB, Karthigeyan M, Stephen S, Sahai A. Key predictors of high blood pressure and hypertension among adolescents: A simple prescription for prevention. Indian J Commun Med 2006;31(3):164–9.
24. Mane SV, Agarkhedkar SR, Karwa DS, Pande V, Singhania SS, Karambelkar GR. Study of risk factors for lifestyle diseases among adolescents in western India. Int J Pharm Biomed Sci 2012;3(4):224–8.
25. Cui J, Hopper JL, Harrap SB. Genes and family environment explain correlations between blood pressure and body mass index. Hypertension 2012;40:7–12.

Address for Correspondence:

Dr Manjeet Kaur, Associate Professor in Physiology, SGRDIMSAR, Amritsar, India. **Cell:** +91-981-5311717
Email: manjeetdr@rediffmail.com

Received: 10 Nov 2015 Revised: 20 Dec 2015 Accepted: 29 Dec 2015