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Blood pressure and blood sugar levels in overweight adolescents from an industrial town of Western India

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High Body Mass Index (BMI) is the indicator of overweight. It was planned to compare blood pressure and blood sugar levels of adolescents with high BMI to that of adolescents with normal BMI of similar age group, to ascertain if BMI affects blood pressure and blood sugar level. One thousand adolescents in the age group of 10 to 18 years were screened for BMI. One hundred participants with normal BMI and 100 with high BMI were studied. BMI of all participants was calculated on the basis of their weight and height. They were divided into two groups- case and control. Waist hip ratio was calculated for all the participants. Their blood pressure and random blood sugar levels were compared. Approval of the Institutional ethics committee and written consent from the participants or their guardians were obtained. Statistical analysis was carried out by the SPSS software version 11. The blood pressure readings were higher in adolescents with high BMI compared to the ones in the adolescents with normal BMI ($p<0.0001$). Random blood sugar levels showed statistically considerable correlation ($p<0.0001$) between case group and control group. The comparison of WHR in the study group had statistically notable correlation ($p<0.0001$) between case group and control group. This study showed that hypertension and high blood sugar is related to the increase in the BMI. The study also revealed that High BMI, especially abdominal fat, is an important determinant of the blood sugar levels.

Key words: BMI, Obesity, Waist hip ratio, Blood pressure, Blood sugar, Overweight.

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1. INTRODUCTION

WHO designated obesity as a worldwide epidemic because of ever-increasing prevalence of the overweight in adults and children [1]. As far as India is concerned, one of the noticeable contrasts is abject poverty leading to malnutrition alongwith incidence of obesity which has almost tripled over a decade. Adolescence is a crucial period in life. Many healthy or unhealthy life-long habits begin during these periods which have a lifetime impact. Obesity among children is a marker of risk for development of multiple non-communicable diseases such as hypertension, stroke, diabetes, coronary heart disease, osteoarthritis and many more in their adulthood [2]. With more urbanization and industrialization there is a definite change in behavior patterns of the communities leading to sedentary life style and consumption of high fat and energy dense diets which are the major causes of obesity epidemic. Hereditary, genetic makeup also has an influence on BMI and body fat [3]. There are predictions by Indian Council of Medical Research and WHO that by 2015 cardiovascular disease would be the major cause of mortality and morbidity in India [2]. Lifestyle diseases like obesity, hypertension, diabetes mellitus, coronary artery diseases and stroke in adults have been related to the predominance of risk factors in childhood and adolescence [4]. The study was conducted to evaluate the relationship of blood sugar level and blood pressure with body mass index in adolescents. It was planned to determine if these reading are higher in overweight adolescents as compared to adolescents with normal body mass index.

2. MATERIAL AND METHODS

Total 1000 subjects were screened. Two hundred adolescents belonging to both sexes, aged between 10 to 18 years were included in the study. One hundred each of high body mass index and normal body mass index were randomly selected. They were enrolled from general schools in one of the industrial town of western India. Adolescents suffering from chronic diseases, cardiovascular, respiratory,

musculoskeletal, renal disorders and under-nutrition were excluded from the study. All other causes of obesity due to hereditary, genetic, metabolic, hormonal disorders were also excluded from the study. Institutional ethics committee's approval and written consent from participants or their guardians were obtained.

All subjects were weighed. Using standard technique, weight was recorded by an accurate, standard electronic weighing scale with a accuracy of ±10g. The height was recorded using stadiometer to the nearest 0.1cm.

Body Mass Index was measured by weight in kilograms divided by height in meter square. Based on the status of BMI, case and control groups were designed. Using WHO 2007 charts for BMI, normal range was between 5th and 84th percentile and ≥ 85th-94th percentile denoted overweight; ≥95th percentile denoted obese. Using measurements of Waist and Hip circumference, WHR was calculated. WHR ≥0.95 for boys and ≥0.8 for girls was suggestive of obesity [5].

Blood pressure was recorded in sitting position in right arm by auscultatory method using standard mercury manometer with a set of different sized cuffs. The cuff was wide enough to cover at least 2/3 of arm and long enough to encircle arm completely. Adolescents between 10-18 years with systolic or diastolic B.P>90th percentile but <95th percentile with respect to their age, sex and height were classified as having Pre-hypertension. The participants with systolic or diastolic B.P>95th percentile with respect to their age, sex and height were classified as having hypertension.

Using one of the branded blood glucose meter, random blood sugar levels were recorded in all subjects. According to American Diabetic Association, random blood sugar levels between 140 to 199mg/dL were taken as impaired glucose tolerance and >200mg/dL were considered as, "diabetic". We compared blood pressure and random blood sugar levels, based on their BMI, in the two groups, viz. case group and control group. Waist hip ratio was also compared between the two groups. Approval of the Institutional ethics committee and written consent from the participants or their guardians were obtained. The statistical analysis was carried out by "chi-square test" and "z test" in which p<0.05 is significant. The p value was determined by using a primer of biostatics of the SPSS software version11.

3. RESULTS

In the present study, a total of 1000 adolescents were screened. Out of the screened participants, 100(50%) with normal BMI and 100(50%) with high BMI were selected. They were divided into three groups in accordance with the stages of adolescence early, middle and late [4]. Maximum number of adolescents, 90 belonged to the age group of 17-18 years, out of which 44(22%) were from the case group and 46(23%) from the control group. 56 were from the age group of 14-16 years, out of which 20(10%) formed part of case group and 36(18%) that of the control group. Minimum numbers of adolescents, 54 were in the age group of 10-13 years, out of which 36(18%) were from case group and 18(9%) from the control group (Table 1).

Table 1
Distribution of cases according to age in study groups

Age (Years)	Case group (%)	Control group (%)	Total (%)
10-13	36(18)	18(9)	54(27)
14-16	20(10)	36(18)	56(28)
17-18	44(22)	46(23)	90(45)
Total	100(50)	100(50)	200(100)

Out of 1000 adolescents 149 were found to be having high BMI, the prevalence was 14.9% as per WHO Charts 2007. The distribution of overweight i.e. BMI between 85th-94th percentile was found to be 22(11%) and of obesity i.e. BMI >95th percentile was found to be 78(39%) in the case group. In control group, all the adolescents were normal with BMI between 5th-84th percentiles.

The mean Waist hip ratio in case group was 0.83 ± 0.05 and in control group it was 0.79 ± 0.05, showing statistically significant correlation (p <0.0001) between case group and control group (Table 2).

Table 2
Comparison of WHR in study groups

Parameter	Case group (n=100)	Control group (n=100)	z value	p value
	Mean ± SD	Mean ± SD		
WHR	0.83 ± 0.05	0.79 ± 0.05	5.40	<0.0001

As per WHO growth chart 2007, Blood Pressure was classified into normal (<90th percentile), pre-hypertension (between 90th and 94th percentile), hypertension (≥95th percentile). In case group (n=100), maximum number of adolescents, 33(16.5%) were found to have pre-hypertension, 37(19.5%) of them had hypertension, whereas 30(15%) of adolescents were normal. In control group (n=100), maximum number of adolescents 83(41.5%) were found to be normal, but 15(7.5%) and 2(1%) of adolescents were found to have pre-hypertension and hypertension, respectively. No one was found to be having hypertension. There was statistically significant correlation (χ^2 = 63.14, p<0.0001) of Blood Pressure between case group and control group (Table 3).

Table 3
Classification of hypertension by WHO 2007 in study groups

Hypertension by WHO	Case group (%)	Control group (%)	Total (%)
Normal	30(15)	83(41.5)	113(56.5)
Pre- hypertension	33(16.5)	15(7.5)	48(24)
Hypertension	37(18.5)	2(1)	39(19.5)
Total	100(50)	100(50)	200(100)

χ^2 = 63.14, p<0.0001

Family history of hypertension was elicited in all the participants. From a total of 200 adolescents, 55 had positive family history of hypertension, out of which 42(76.36%) were in the case group and 13(23.64%) were in the control group. In case group, 42(76.36%) adolescents had positive family history of hypertension, out of which 1(1.82%) adolescent had normal blood pressure, 15(27.27%) and 26(47.27%) were found to have Pre-Hypertension and Hypertension respectively. In control, 13(23.64%) adolescents had positive family history of hypertension, out of which 9(16.36%) adolescents had normal blood pressure, 3(5.45%) and 1(1.82%) were found to have Pre-Hypertension and Hypertension respectively. There was statistically significant correlation (χ^2 = 30.89, p<0.0001) of family history of Blood Pressure between case and control.

Random blood sugar was measured for all adolescents. Mean blood sugar levels were calculated in both the groups. Blood sugar levels were found higher in adolescents with high BMI as compared to those with normal BMI. There was statistically vital correlation (p<0.0001) in mean Blood Sugar Levels amongst case group (111.8 ± 20.9) and control group (94.4 ± 12.5) (Table 4).

Table 4
Comparison of blood sugar level in study groups

Parameter	Case group (n=100)	Control group (n=100)	z value	p value
	Mean ± SD	Mean ± SD		
Blood sugar level	111.8 ± 20.9	94.4 ± 12.5	7.13	<0.0001

4. DISCUSSION

Present study was conducted to evaluate the risk of diabetes and hypertension in overweight and obese children, based on assessment of family history of risk factors, blood pressure, blood sugar levels in comparison to waist/hip ratio and BMI.

Prevalence of high BMI out of 1000 healthy adolescents was 14.9%. Waist/Hip Ratio and family history of hypertension were found to be having statistically significant correlation and they were positive in adolescents with high Body Mass Index. Total 42(76.13%) adolescents in case group and 13(23.69%) in control group had family history of hypertension.

In this study, pre hypertension was found in 27.9% whereas hypertension in 6.8% of children with high BMI. Previous studies also show that children with high BMI have higher range of blood pressure [6]. The prevalence of hypertension in the present study correlates with the study done by Mohan B, *et al* [6] and Gillian S Boyd *et al* [7] and deviates from studies done by Gupta AK *et al* [8], Verma M *et al* [9] and Sorof JM *et al* [10], as pre hypertension was not considered in these studies.

With respect to assessment of blood sugar levels, statistically significant correlation (p≤0.0001) between case group and control group was observed. Blood sugar level was found to be 111.8 ± 20.9 in case group as compared to 94.4 ± 12.5 in control group. Hannon TS *et al* [11], Vijaylaxmi Bhatia, 2004 [12] and American Diabetes Association [13] showed higher incidence of dyslipidemia and insulin resistance in overweight as compared to normal weight children.

There was statistically significant correlation (p<0.0001) of WHR between the subjects of case and control groups. The mean WHR in the case group was 0.83 ± 0.05 which is significant when compared to that of the control group which was found to be 0.79 ± 0.05. Studies reveal that a higher BMI, especially increased truncal or abdominal fat, is an important determinant of blood glucose levels, insulin resistance and the development of diabetes. Moreover, intra-abdominal fat accumulation has been implicated as an independent risk factor for type2 diabetes and in some studies it has been shown to be an even stronger predictor of Type 2 diabetes than overall fatness [14-16]. The present study is similar to study done by Abate N [17] , Neovius M *et al* [18] and Sinha R *et al* [19] showed correlation of WHR with BMI as p<0.001 but was less significant when compared to waist circumference alone.

5. CONCLUSIONS

This study showed that occurrence of hypertension increases with increase in the body mass index. Study revealed that high BMI is an important determinant of blood sugar levels. Waist hip ratio has been found to be higher in adolescents with high body mass index. All the adolescents should be screened for hypertension and blood sugar levels so that these illnesses can be predicted and complications prevented at an early age.

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