Screening and Identifying Delhi school going adolescents (12-15 yrs) with Pre Hypertension and hypertension

Deepika Bahl, Kalyani Singh , Manisha Sabharwal

Department of food and Nutrition , Lady Irwin College (Delhi University) , New Delhi-110001

***Abstract*- Objective:** To determine the prevalence of pre hypertension and hypertension among school going adolescents and to investigate the association between blood pressure (BP) and different indicators of obesity.

Materials and Methods: Cross sectional study with 877 subjects in age group of 12-15 years were selected from four public schools of Delhi. Based on Body Mass Index, Waist Circumference, Waist to height ratio and family history, subjects were screened. Of the screened subjects' blood pressure was measured. Blood pressure values were compared with reference charts given by Fourth report on the diagnosis, evaluation, and treatment of high blood pressure in children and adolescents (2004) to classify subjects as normal, pre hypertensive or hypertensive.

Results: Prevalence of overweight and obesity among subjects was 14.7% and 16.6% respectively. Subjects with waist circumference greater than 90 percentile were 20.5% and 23.1% of subjects had waist to height ratio greater than 0.5. As per reporting, 12.34% of subjects had first degree familial history diabetes , hypertension or obesity . Thus 33.2% of subjects who were screened. blood pressure measured 69.4% of subjects were normal , 14% had pre hypertension and 16.6 had hypertension(stage 1 or stage 2). Statistically significant positive correlation of Systolic blood pressure was seen with weight (r=0.4; P<0.001), height (r=0.2; P<0.001), fat percentage (r=0.3; P<0.001), WC (r=0.3; P<0.001) and BMI (r=0.3; P<0.001).Diastolic blood pressure was positively correlated with weight (r=0.4; P<0.001), height (r=0.3; P<0.001), fat percentage (r=0.2; P<0.001), WC (r=0.3; P<0.001),BMI (r=0.3; P<0.001)

Conclusion: High prevalence of pre hypertension and hypertension among study subjects indicates the need of proactive preventive measures with focus on diet and physical activity to avoid future hypertensive epidemic and its co-morbidities.

***Index Terms*-** Obesity, BMI, Waist Circumference, Waist to height ratio , Adolescence, Hypertension

I. Introduction

Hypertension is a major health problem across the globe due to its high prevalence and association with increased risk of cardiovascular diseases (CVD) (1). Presence of CVD in an individual poses an impact on the overall growth and economy of a country both in direct and indirect ways. Direct costs include impact on families, healthcare sectors including consultation, investigations, medications, hospitalization, treating complications, transportation and time. Indirect costs include impact on society and government, which are related to productivity costs, work days lost, low productivity, disability payment, social security and depression(2). Various international organisations and researchers have provided ample evidence that hypertension in adults has its origin in childhood (3, 4). However, it goes undetected if not specifically looked for (5). Consequently screening of high risk adolescents and detection of hypertension would allow prophylactic interventions with the aim to decrease morbidity and mortality due to CVD in adulthood.

Although the prevalence of hypertension among adolescents is increasing but it is still not getting attention of public health professionals. There is need for a simple, easy and practical screening procedure that uses a single measurement which can help in determining whether further measurement of BP is needed or not. There is published data which says that obesity (6,7) is closely associated with hypertension. Thus the aim of present study was (i) to estimate the prevalence of pre hypertension and hypertension among screened subjects and (ii) to investigate the association between BP and different obesity indicators among subjects (12-15) of Delhi.

II. Material and Methods

It was a cross sectional school based study on adolescents (aged 12-15 yrs) of Delhi. The study consisted of two components (i) Screening of high risk subjects and (ii) Identification of subjects with hypertension and pre hypertension. Sample size for the study was calculated as 900 considering prevalence 21.5% (8) with level of significance 5%, 3% margin of error and 20% drop out and non response. As per Directorate of Education, in Delhi, public schools are located in 12 zones totalling 1291 public schools (as on August 2012) .Through simple random sampling method , four zones were selected. From these selected zones, four public co-ed schools were selected through purposive sampling. All the selected schools had nearly the same fee structure and infrastructure facilities. From every selected school, six sections from class VIth to IXth were selected through application of computer generated random tables. Students in these six classes were approached. Thus by this way, from every school, 225 adolescents were selected.

Permission of this study was obtained from Lady Irwin College Institutional Ethics Committee and Management of every School. Informed written consent was obtained from one of the child's parents and in addition assent was obtained from the child before conducting the study. Any subject with secondary cause of obesity, using of corticosteroids or subjects with age less than 12 and greater than 15 yrs or subject with any

physical disability were excluded from the study. If the subject fulfilled any of the following criteria (Subject with Body Mass Index (BMI) greater than 85 percentile and /or with Waist Circumference (WC) greater than 90 percentile and /or with Waist to height ratio (WtHr) greater than 0.5 and/or first degree family history of obesity or diabetes or hypertension or heart disease), then subjects was screened for blood pressure measurement.

Data on general information was collected by using pre designed and pre tested questionnaire and anthropometric measurements were taken by using standardised tools and techniques (9). Weight was measured using a digital scale. Daily the scale was calibrated and duplicate readings were taken for maintaining reliability and validity. Each student's weight was recorded to the nearest 0.1 kg. Height was measured using a microtoise and was recorded to the nearest 0.1 cm. For every subject duplicate readings of height were recorded and mean was calculated.

BMI was calculated for all participants, who then were neither classified as overweight, obese, or neither overweight nor obese according to WHO cut off. The WHO system defines overweight as a BMI > 1 SD and obesity as a BMI > 2 SD from the mean of the WHO reference population (10).

For WC, the tape was positioned at the midpoint of the last palpable rib and the top of the hip bone, making sure to wrap the tape over the same spot on the opposite side. Subject was made to stand with their feet together with weight evenly distributed across both feet; the arms were held in a relaxed position at the sides; subjects were asked to breathe normally a few times, and then make a normal expiration. By this way , duplicate reading were measured to the nearest 0.1 cm, making sure to keep the measuring tape snug but not tight enough to cause compression of the skin (10). Through this, WC and WtHr were calculated.

For analysis of WC of adolescents, there are no standard cut off values. In the current study, reference values by Kuriyan et al (11) have been used. For waist to height ratio cut off value for all the age groups which can be used globally is 0.5(12).

For estimating the subject's body fat, bio impedance analysis (BIA) was done. The subjects were made to stand barefoot on the scale for simultaneous measurements of body weight and impedance, with manual entry of the subject's gender, age , body type (standard or athletic) and height into the system via a digital keyboard. The subject's percentage body fat was displayed immediately. Certain precautions were taken to maintain the accuracy in BIA readings like BIA was not performed after the games period or just after exercise as the reading obtained may be lower than normal; nor after meals as the reading obtained may be higher than normal; the temperature of the medical room while taking reading was ambient, as cold temperature alters the reading.

Blood pressure (BP) measurements were done in school medical room where subjects were seated and the cubital fossa was supported at heart level, after at least 5 minutes rest. BP was measured using a mercury sphygmomanometer, with appropriate cuff. First tapping sound and disappearance of Kortkoff sound were taken as systolic and diastolic blood pressure respectively. In case of a high reading, BP was measured again after an interval of 10 minutes. 3 readings were taken maintaining an interval of 2 minutes between the readings. Systolic BP (SBP) and/or Diastolic BP (DBP) >90th percentile and <95th percentile was considered as pre hypertension; and SBP and/or DBP >95th percentile were classified as hypertensive (13).

III. Statistical Analysis

Data was entered in Microsoft access sheet and analysed using STATA 13. Both the descriptive and inferential data analysis were applied using the appropriate statistical test of significance. The confidence interval of 95% and significant difference of < 0.05 were taken as valid for test of significance.

IV. Results

The study excluded 21 subjects due to incomplete data for age, weight and height; 2 subjects withdrew their participation in between the course of study. Thus the final sample included 877 adolescents in phase 1, 64.3% (564) males and 35.7%(313) females. The mean age of the subjects was 13.04 ± 13.04 yrs. As per (table 1) maximum number of subjects 37.97 %(333) were in age group of 12- <13 and the least number of study subjects were in the age group of 15- <16 years.

Table 1- Age and Sex wise distribution of the Study subjects (N=877)

Age (Yrs)	Males n (%)	Females n (%)	Total
12- < 13	217 (38.4)	116 (37)	333
13 - <14	158 (28)	90 (28.7)	248
14 - <15	136 (24.1)	82 (26.1)	218
15- <16	53 (9.4)	25 (8)	78
Total	564 (64.3)	313 (35.7)	877

Mean BMI for males and females was 20.1 ± 4.4 and 20.5 ± 4.8 respectively with no statistical difference (p=0.82). Nearly 129 (14.7%) of the subjects were overweight and 163 (18.6%) were obese based on WHO (2007) reference values (Table 2). No change was seen when age adjusted combined prevalence of overweight and obesity was calculated (table 3). However, change was seen in gender adjusted combined prevalence which was 31.7 and 30.2 respectively.

Table 2: Classification of weight status of school going adolescents by gender (N=877)

WHO	Neither overweight nor obese n(%)	Overweight n(%)	Obese n(%)	P-Value
12 years	219 (65.77)	57 (17.12)	57 (17.12)	0.601
13 years	162 (65.32)	36 (14.52)	50 (20.16)	
14 years	148 (67.89)	29 (13.3)	41 (18.81)	
15 years	56 (71.79)	7 (8.97)	15 (19.23)	
Total	585 (66.7)	129 (14.71)	163 (18.59)	

*Neither overweight nor obese includes normal and underweight subjects

Table 3: Classification of weight status of school going adolescents by age (N=877)

WHO Classification System (2004)	*Neither overweight nor obese n (%)	Overweight n(%)	Obese n(%)	P-Value
Male	377 (66.84)	79 (14.01)	108 (19.15)	0.669
Female	208 (66.45)	50 (15.97)	55 (17.57)	
Total	585 (66.7)	129 (14.71)	163 (18.59)	

*Neither overweight nor obese includes normal and underweight subjects

Mean WtHr ratio of subjects was 0.43 ±.08 and it remained the same for males and females with no statistical difference (p=0.1). 23.1% (203) of subjects had value greater than 0.5 which is a global cut off for all the age groups [12]. However there was no statistical difference in males 20.7 % (138) and females 20.7% (65) (P = 0.213). Similarly there was no significant difference in waist to height ratio for subjects in different age categories.

On analysis of data for WC, mean WC of subject was 66.5 ± 13.1 cm and mean WC of males was significantly higher than of females 67.2 ± 13.3 cm and 65.3± 12.5cm respectively (p=0.04). WC greater than 90 percentile was seen in 20.5% (180) of subjects. On further investigation, a highly significant difference in males 23.4% (132) and females 15.3% (48) was seen (p=0.005) for WC>90 percentile. However no statistical difference was seen for WC at different ages.

On the basis of reporting, 12.34% (108) of subjects had first degree relatives with diabetes and /or obesity and / or hypertension.

On the basis of pre set screening criteria (BMI, WtHr, WC and first degree familial history) 33.2% (292) subjects were screened for further measurement of BP; however only 271 subjects agreed for BP measurement. Although none of the screened subject had first degree familial history as the only criteria out of all screening criteria.

Profile of screened subjects

Out of 271 subjects, 66.05 % (179) were males and 33.95% (92) were females. Mean age of subjects was 13 yrs. As per (table 4) maximum number of subjects 105 (38.74%) were in age group of 12- <13 and the least number of study subjects were in the age group of 15- <16 years.

Table 4: Age and Sex wise distribution of the screened subjects (N=271)

Age	Males n (%)	Females n (%)	Total
12- < 13	73 (40.8)	32 (34.78)	105
13 - <14	53 (29.6)	26 (28.26)	79
14 - <15	40 (22.34)	27 (29.30)	67
15- <16	13 (7.3)	7 (7.60)	20
Total	**179 (66.05)**	**92 (33.95)**	**271**

Table 5 Distribution of screening criteria among screened subjects (N=271)

S.No	Anthropometric Variable	Males n(%)	Female n(%)	P-value
1	**Weight Status** Normal weight Overweight Obese	 7(3.9) 49(27.37) 123(85.4)	 5(5.4) 34(36.9) 53(57.6)	0.193
2	Waist circumference (>90 percentile)	125 (69.8)	46 (50)	0.001
3	Wt to ht ratio (0.5)	138 (77.09)	61(67.3)	0.08
4	Family history	63(35.1)	38 (41.3)	0.325

Mean BMI of screened subject was 25.45±3.5, and a significant difference was seen in mean BMI of males (25.14 ± 3.27) and females (25.14 ± 3.27) (p=0.04). Amongst screened subjects, very few were normal weight, where as majority were overweight or obese as per WHO BMI classification (table 5). Weight status distribution of subject's was seen at different ages; only at age 14 yrs, results were significant (p=0.05). Males had significantly higher waist circumference than females but when the difference was studied at different ages, it was only at age 14 and 15 years the results were statistically significant (p= 0.000 and 0.035). Similarly for waist to height ratio, males had higher value than the females and when seen for different ages, it was only at age 14 yrs when results were statistically significant (p=0.003)

BP measurement of screened subjects (high BMI and/or WC and/or WtHr) indicated 69.4% (188) had normal BP, 14% (38) had pre hypertension and 16.6% (45) were hypertensive (stage 1 or stage 2). Prevalence of hypertension among overweight subjects (BMI> 85 percentile) was 13.2% and among obese subjects (BMI>95 percentile) was 18.75 (p<0.05).To estimate the gender difference , prevalence of pre hypertension was 18.6% and 15.2% amongst males and females respectively and hypertension was 16.2% in males and 17.3% in females ; however difference was not statistically significant(p<0.05).

Systolic Blood pressure (SBP)

Graphical distribution of SBP is depicted in fig 1. Mean systolic blood pressure of subjects was 115.6 ± 11.3 mm/hg. No gender difference was seen in mean SBP of males(115.4 ± 12.1 mm/hg) and females(116.0 ± 9.7 mm/hg) (p=0.6) As per systolic blood pressure measurement, 69.8% (186) of subjects were normal, 14.76% (40) had pre hypertension , 13.65% (37) had stage 1 hypertension and 2.9% (8) had stage 2 hypertension. Among males and females no difference was seen for different category of BP (table 6). Though difference was seen in males and females at all ages, it was only at age 15 where males and females showed statistically significant difference in BP category (p=0.05)

Statistically significant positive correlation of SBP was seen with weight (r=0.4; P<0.001), height (r=0.2; P<0.001), fat percentage (r=0.3; P<0.001), WC (r=0.3; P<0.001) and BMI (r=0.3; P<0.001)

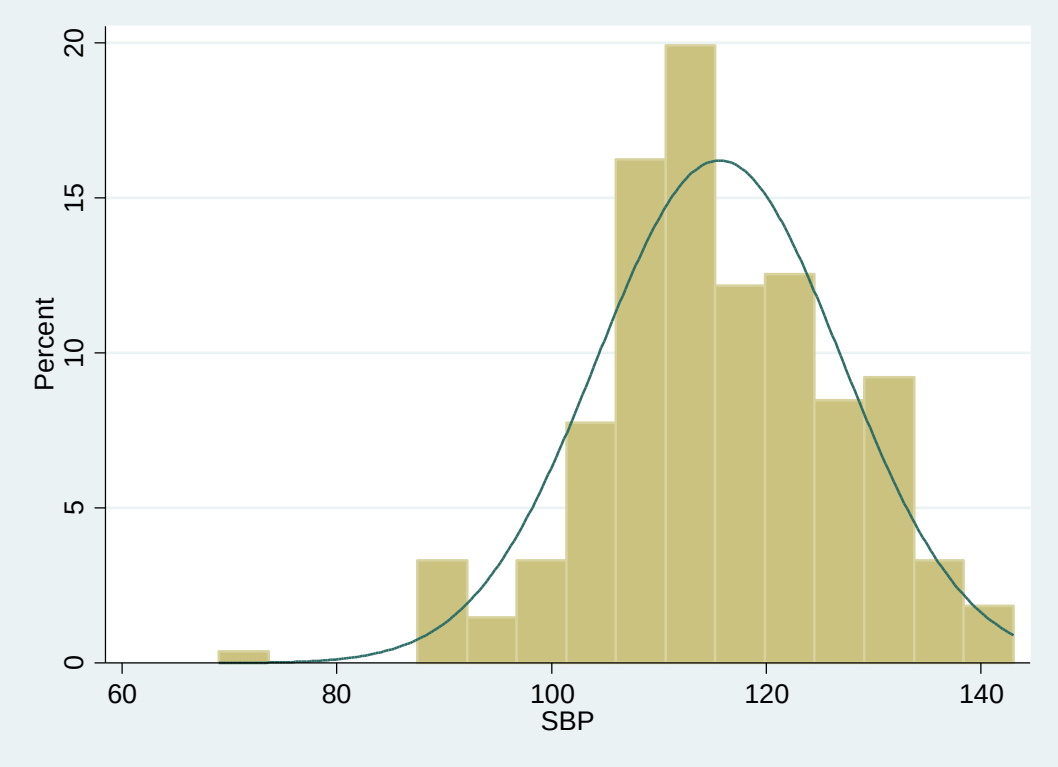

Fig 1: Graphical distribution of Systolic Blood pressure

Table 6: Prevalence of hypertension among screened subjects based on SBP (N=271)

SBP	Males n (%)	Females n(%)	Total	P value
Normal (<90percentile)	125(69.8)	61(66.3)	186	**0.833**
Pre hypertension (>90 <95)	25 (19.3)	15 (16.3)	40	
Stage 1 hypertension (95+5)	23 (12.8)	14 (15.2)	37	
Stage 2 hypertension (99+5)	6 (3.3)	2 (2.1)	8	

Diastolic Blood pressure (DBP)

Graphical distribution of DBP indicates a normal distribution (fig 2). Mean diastolic blood pressure of subjects was 67.9 ± 7.4 mm/hg. No gender difference was seen, mean DBP of males and females was 68.0 ± 7.2 mm/hg, 67.7 ± 7.7 mm/hg respectively (p=0.7).

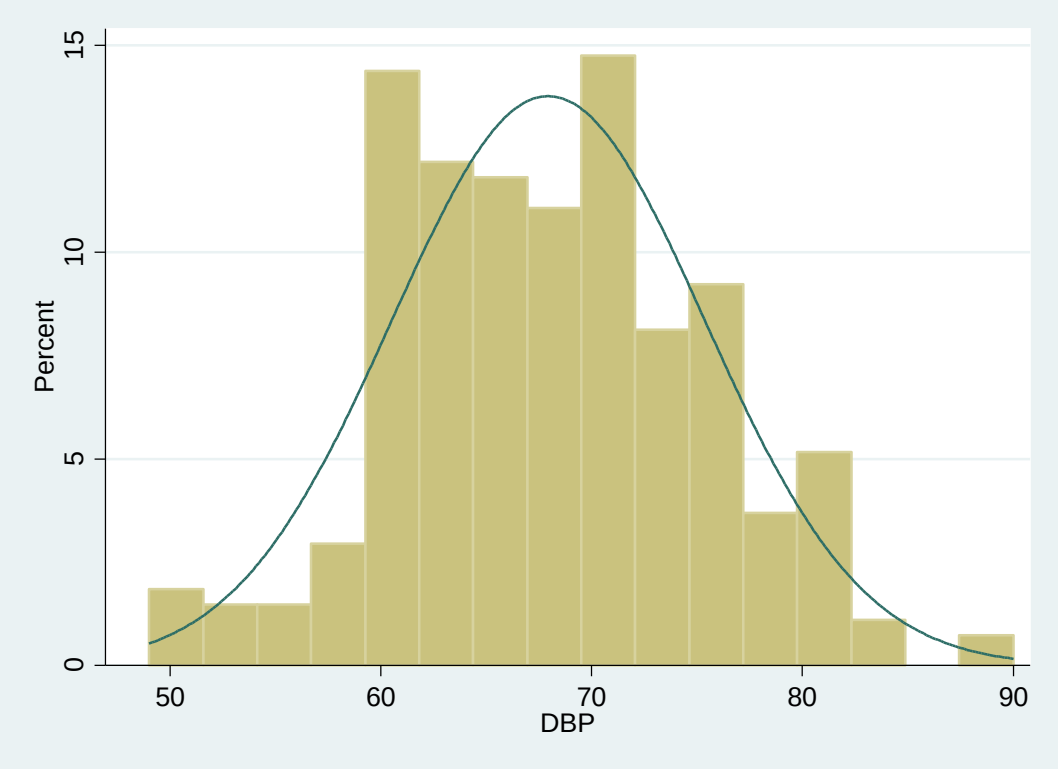

Fig 2: Graphical representation of diastolic blood pressure

As per diastolic blood pressure measurement, 86.72% (235) of subjects were normal, 10.7% (29) had pre hypertension, 2.21%(6) had stage 1 hypertension and 0.3% (1) had stage 2 hypertension. Among males and females no difference was seen (table 7).However; no statistical difference was seen when prevalence was estimated at different ages for males and females (p=0.5)

Statistically significant positive correlation of DBP was seen with weight (r=0.4; P<0.001), height (r=0.3; P<0.001), fat percentage (r=0.2; P<0.001), WC (r=0.3; P<0.001), BMI (r=0.3; P<0.001)

Table 7: Prevalence of hypertension among screened subjects based on DBP (N=271)

V. Discussion

Increasing prevalence of overweight and obesity among adolescents is a matter of concern. While the obesity rates have levelled off in developed nations but in developing countries like India, it is still in transition phases of the nutrition stabilization. The associated health risks with excess weight includes hypertension, hyperinsulinemia, glucose intolerance, type 2 diabetes, dyslipidemia, increased risk of early cardiac disease and psychosocial difficulties. Thus the current study has been done with school going adolescents mainly to study presence of obesity and hypertension in this group. Significant association of hypertension (SBP and/ or DBP) with BMI was seen in this study. These findings were similar to studies done in India viz study in Wardha in 2012 (14) , Aligarh in 2012 (15) , Kochi in 2010 (16) , Delhi in 2006 (17) , Ludhiana in 2004 (18) . In the present study, prevalence of hypertension among the adolescents who were screened (either high BMI and /or high waist circumference and /or or high waist to height ratio) was studied. Prevalence of pre hypertension and hypertension among overweight and obese adolescents was 14% and 16.6% respectively; this indicates it is a major public health problem. Similar reporting of prevalence of pre hypertension among overweight (by BMI) adolescents has been reported in other parts of India like Odisha in 2014 (19) and Ludhiana in 2004 (18).

A few studies have shown less prevalence like in Karnatka in 2004 (20) but prevalence of hypertension in obese subjects was reported much higher in comparison to our findings (18, 20, 21). The finding of present study signifies an alarming situation which requires some form of intervention as recommended by the Fourth Task Force (13).

The increasing evidence from observational studies have suggested that SBP is more important prognostic determinant of CVDs than DBP (22) and this can be generalized for adolescents. In adolescents mainly BP abnormality seen is usually a high SBP. In the current study too, SBP classified 13.65% with stage 1 hypertension and 2.9% with stage 2 hypertension where as DBP classified a few subjects to be hypertensive. Similar findings have been reported by other authors (8, 23).

In our study, statistically significant correlation was observed between BMI, weight , height , fat percentage and WC with SBP and DBP. Similar findings have been presented by other authors (15, 24).

VI. Conclusion

In conclusion early detection of obesity could be considered as a crucial screening step for identification of adolescents with hypertension, since in all private schools, anthropometric measurements are taken as a part of health check up. Thus the only effort needed by school staff is to take such measurements regularly and correctly so that high risk subjects can be separated and their BP can be measured. Other alternative is, school should encourage research organisations to do health related studies in school. Another step which is required is implementation of nutrition education program with focus on diet and practical physical activity sessions in schools and home for sensitising the subjects regarding obesity management which is considered as a risk factor for hypertension. This will not only prevent hypertension but also co-morbidities associated with it.

DBP	Males n (%)	Females n (%)	Total	P value
Normal (<90percentile)	**154(86)**	**81 (88)**	**235**	0.199
Pre hypertension (>90 <95)	**22(12.2)**	**7 (7.6)**	**29**	
Stage 1 hypertension (95+5)	**2 (1.1)**	**4 (4.3)**	**6**	
Stage 2 hypertension (99+5)	**1(0.5)**	**0 (0)**	**1**	

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AUTHORS

First Author – Deepika Bahl (Corresponding Author): JRF Ph.D , Lady Irwin College , University of Delhi, Email Id: bahl.deepa@gmail.com, Phone No. 9968294318
Second Author – Dr. Kalyani Singh : Associate Professor , Lady Irwin College, University of Delhi, Email Id:dr.kalyanisingh@gmail.com, Phone No. 9899450616
Third Author – Dr. Manisha Sabharwal: Assistant Professor, Lady Irwin College, University of Delhi, Email Id:sabharwalmanisha@hotmail.com, Phone No: 9810895026

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