Original Article

The Relationship between Blood Pressure and Body Mass Index among Primary-School Children

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Abstract

Background: Hypertension is Common and is a third on the list of chronic pediatric diseases (after asthma and obesity), Obesity on the Other hand is a growing problem worldwide and both are consider being major causes of morbidity and mortality in many countries, and can lead to long-term health risks in children. **Objective:** is to examine the association between blood pressure and Obesity in Baghdad primary school. **Materials and Methods:** cross sectional study, from January 1, 2016 to June 1, 2016. Clusters of 1044 children aged 6–12 years from primary schools in Baghdad were surveyed, excluding those who have cardio vascular, renal and endocrine diseases. Data on age, gender, height, weight, systolic and diastolic blood pressure were collected, body mass index has been measured. Classification of children was based on age and sex-specific BMI percentile groups as normal weight, overweight,and obese. **Result:** The overall prevalence of hypertension in the current study is 19.6%, (7.6%) prehypertension, (72.7%) normal, obesity prevalence is 19.1%,(15.4%) overweight and (61.6%) normal, after comparison between blood pressure values and age-sex-body mass percentile groups, the result revealed that blood pressure values were higher in obese groups (9.6%) than those in normal weight groups(6.3%) for both sex. **Conclusion:** Hypertension is not uncommon problem in 6–12 years old children and it is more prevalent in overweight and obese children Blood pressure should be routine and frequent checking in children, especially obese children.

Keywords: Body mass index, hypertension, obesity

Introduction

Systemic hypertension (HTN) is not uncommon in children. Its reported prevalence in developed countries is about 1–3% with an increase in recent times to 4.5% largely due to the epidemic of obesity and insulin resistance.[1] HTN is mostly silent except when severe and hence likely to be missed unless measuring blood pressure (BP) becomes part of routine pediatric practice as is growth monitoring and immunizations.[2]

HTN is third on the list of chronic pediatric diseases (after asthma and obesity). Factors that increase the likelihood for (pediatric) HTN include family history, ethnic background, birth weight, weight percentile and body mass index (BMI), nutritional sodium intake, sulin resistance, and sympathetic nervous system activation. Many of the latter variables are amenable to modification. HTN in childhood is a risk factor for adult HTN, accelerated atherosclerosis, and premature cardiovascular complications.[3,4]

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Definable causes of HTN are the rule in the early years of life, whereas essential HTN is more common in adolescence. Consequently, techniques for the evaluation and diagnosis of HTN differ, at least in part, by age group.[5]

Definition

The definition of "normal" BP in children is statistical: <90th percentile for age, gender, and height. Consequently, HTN is defined as a systolic or diastolic BP(DBP) ≥ 95th percentile for age, gender, and height on at least three separate occasions.

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Pre HTN(high normal) if BP>=90th to< 95th percentile, in adolescents if BP >=120/80 mmhg consider pre hypertension even if <90th percentile.

Hypertension has two stages

Stage 1HTN:BP 95th to 99th percentile plus 5 mmhg

Stage 2HTN: BP >99th percentile plus 5 mmhg[3]

The overall frequency of major causes of HTN in the primary care: Essential 27%,Obesity-associated 45%,Secondary (renal parenchymal disease,coarctation of the aorta,renovascular,endocrinopathy and others 28%[6,7]).

Obesity in the pediatric population is a growing problem. Approximately 1 in 5 children is overweight and 1 in 10 children are obese. Multiple different indices and techniques can be used to estimate the degree of adiposity. The most commonly used measure is BMI, defined as kilograms (kg) of body weight per height in square meters (m^2),and the BMI percentile is a more accurate index of body mass in the pediatric age group,[8] Consequently obesity and overweight are defined using

BMI percentiles

Children >2 yr old with a BMI ≥95th percentile meet the criterion for obesity, and those with a BMI between the 85th and 95th percentiles fall in the overweight range.[9]

The aim of this study was to assess the normal ranges of blood pressure and hypertension among school age children and to assess the prevalence of overweight, obesity with its relation to hypertension.

Materials and Methods

Study population

The study is cross sectional study, collected on (1044) children who are enrolled in two primary schools in (Dejla and Al-Mansoor Primary schools in Al-Mansor Sector/ Baghdad) from 1st of January 2016 to 1st of June 2016.

The Children's ages: between 6–12 years of both sexes.

Collected data represents information about age, gender, height, weight, SBP, DBP.

The data has been selected randomly and includes 551 Males and 493 Females between 6–12 years old.

Data exclusions

- Any Heart, kidney, liver diseases and all other major medical conditions.
- Those on drugs medication which may alter BPor chronic use of drug that may affect the normal weight, height such as antihistamines, alpha-adrenergic agents (nasal decongestant and cough medication),Steroid and caffeine.
- Three children were excluded from study as unable to check the blood pressure 3 times as they were frequently absence for attendance of school

Procedure and measurement

A simple explanation was given to the class so the participants know how to fill the questionnaire's information (name, age and Sex).Other questionnaire fields were filled after measuring BP, height and weight.

BP, weight and height measurements were done for all the 1044 participants by three permanent doctors who are in their third year studying the Iraqi Board For Pediatric.

The BP was measured using mercury sphygmomanometer as recommended by the forth report on the diagnosis, evaluation and treatment of high BP in children and adolescent.[10]

After insuring that the class had no previous sport lesson (which may affect BP measurements), BP started to be measured on the children who were sitting comfortably on their desk for more than 15 minutes.

During BP measurement, we were used three different cuff sizes (child size 9 X 18 cm, small adult size 10 X 24 cm and lastly adult size 13 X 30 cm).

SBP and DBP were determined by 1st korotkoff sound (K1) and disappearance of korotkoff. Those children with elevated BP was were recorded in a separate paper and be measured in 3 different time.

The weight and height were measured by an electric scale and stadiometer.

After finishing all the information required in the questionnaire, participants were classified according to age and sex.

* BMI and BMI percentile for every child was calculated using a medical calculator by an IOS application (MedCalc3000) using ipad (This calculator provides BMI and the corresponding BMI-for-age percentile according to Centers for Disease Control and Prevention BMI-for-age growth chart).

If percentile <5 mean underweight

Percentile >=5and <85 mean healthy weight

Percentile >=85 and <95 mean overweight

Percentile >=95 mean obesity

* Height percentile, Systolic Percentile, Diastolic percentile was also calculated individually for every child using another (MedCalc3000) calculator.

Data entry and statistical analysis

All the results obtained were introduced to Microsoft Excel 2010(version 14.0.7). Statistical package for social

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sciences version 22 was used for data analysis. Discrete variables presented as numbers and percentages and continuous variables presented as mean with standard deviation.

T test for two independent samples was used to test the significance of observed difference in means.

Pearson correlation coefficient was used to study the correlation between continuous variables

Chi square test for independence used to test the significance of associations between discrete variables.

The level of significance was set at P value equals to 0.05.[11]

Ethical approval

The study was conducted in accordance with the ethical principles that have their origin in the Declaration of Helsinki. It was carried out with patients verbal and analytical approval before sample was taken. The study protocol and the subject information and consent form were reviewed and approved by a local ethics committee according to the document number 104 (including the number and the date in 10/12/2015) to get this approval.

Results

The Study was done on 1044 children with age between 6 and 12 years old, 551(52.8%) males and 493(47.2%) females with the highest number of children are 9 years old group (164 children) and the lower number of children is on 7 years old group (139 children), however on interpretation of significance:

- There is no significant association between age and sex in sampled children.

Table 1: Distribution of sampled children according to age, BMI status and to BP status

Age (y)	BMI	Total		BP Category						P
				Normal		Prehypertensive		Hypertensive		
	Category	N	%	N	%	N	%	N	%	
6	Underweight	8	100.0%	7	87.5%	1	12.5%	0	0.0%	< 0.001
	Normal	88	100.0%	76	86.4%	7	8.0%	5	5.7%	
	Over weight	28	100.0%	21	75.0%	0	0.0%	7	25.0%	
	Obese	31	100.0%	17	54.8%	0	0.0%	14	45.2%	
7	Underweight	3	100.0%	3	100.0%	0	0.0%	0	0.0%	< 0.001
	Normal	92	100.0%	73	79.3%	6	6.5%	13	14.1%	
	Over weight	20	100.0%	11	55.0%	3	15.0%	6	30.0%	
	Obese	24	100.0%	9	37.5%	0	0.0%	15	62.5%	
8	Underweight	0	0.0%	0	0.0%	0	0.0%	0	0.0%	< 0.001*
	Normal	101	100.0%	81	80.2%	5	5.0%	15	14.9%	
	Over weight	9	100.0%	2	22.2%	1	11.1%	6	66.7%	
	Obese	31	100.0%	12	38.7%	4	12.9%	15	48.4%	
9	Underweight	4	100.0%	4	100.0%	0	0.0%	0	0.0%	< 0.001*
	Normal	98	100.0%	84	85.7%	1	1.0%	13	13.3%	
	Over weight	26	100.0%	18	69.2%	0	0.0%	8	30.8%	
	Obese	36	100.0%	11	30.6%	3	8.3%	22	61.1%	
10	Underweight	9	100.0%	8	88.9%	1	11.1%	0	0.0%	0.026*
	Normal	79	100.0%	67	84.8%	3	3.8%	9	11.4%	
	Over weight	27	100.0%	18	66.7%	5	18.5%	4	14.8%	
	Obese	27	100.0%	12	44.4%	6	22.2%	9	33.3%	
11	Underweight	6	100.0%	5	83.3%	1	16.7%	0	0.0%	0.001*
	Normal	87	100.0%	78	89.7%	3	3.4%	6	6.9%	
	Over weight	26	100.0%	19	73.1%	4	15.4%	3	11.5%	
	Obese	25	100.0%	11	44.0%	5	20.0%	9	36.0%	
12	Underweight	10	100.0%	8	80.0%	2	20.0%	0	0.0%	< 0.001
	Normal	99	100.0%	82	82.8%	12	12.1%	5	5.1%	
	Over weight	25	100.0%	17	68.0%	3	12.0%	5	20.0%	
	Obese	25	100.0%	4	16.0%	5	20.0%	16	64.0%	
All	Underweight	40	100.0%	35	87.5%	5	12.5%	0	0.0%	< 0.001
	Normal	644	100.0%	541	84.0%	37	5.7%	66	10.2%	
	Over weight	161	100.0%	106	65.8%	16	9.9%	39	24.2%	
	Obese	199	100.0%	76	38.2%	23	11.6%	100	50.3%	

* after merging normotensive with prehypertensive categories

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- Mean SBP readings for the children is 104.1 (SD 29.1), while mean DBP is 66.7(SD 24.7). There is no significant differences in mean of each of SBP and DBP between the two genders in any of the age group of sampled children ($P > 0.05$), the mean of SBP and DBP increase with age and more in males than in females in all age groups.
- Mean BMI is 18.4(SD 4) and mean body mass percentile is 61.5(SD 30.6).There is no significant differences in the mean of each of BMI and BMI percentile between the two genders in any of the age group of sampled children ($P > 0.05$).
- The distribution of children according to BMI status and age was found significant that underweight(BMI percentile<5) is least to be observed in all studied ages(3.8%) particularly at age of 8(0%), and majority of children has normal BMI(Percentile >=5and <85)regardless their age(61.6%), overweight (percentile>=85and <95) approaches 15% or more in most studied ages and the prevalence of obesity(percentile>=95) exceeds15% in most of studied ages ($P < 0.05$)

Percentage of preHTN is 5.7%, 9.9% and 11.6% among Normal, Overweight and Obese children respectively.

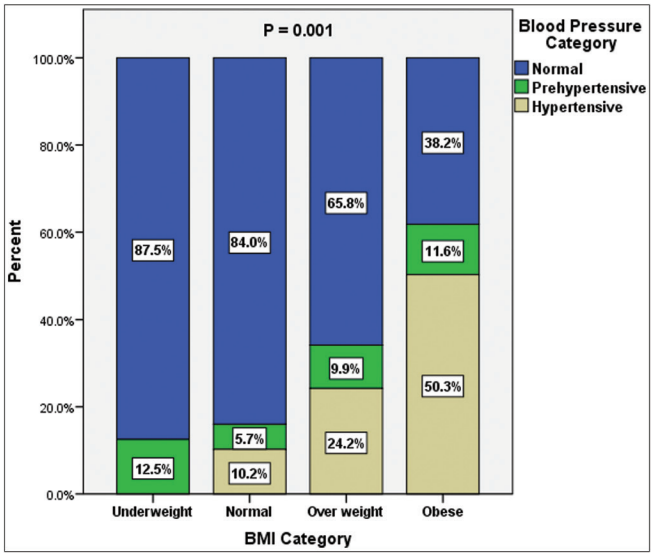

Figure 1: Distribution of sampled children according to BMI status and to BP status

Percentage of HTN is 10.2%, 24.2% and 50.3% among Normal, Overweight and Obese children respectively.

Hypertensive percentages are higher in the obese and overweight groups than in normal and underweight groups in all age categories [Table 1]. [Figure 1] shows the distribution of children according to BMI status and to BP status. It's so clear that HTN follows obesity as 50.3% of obese children have HTN and 24.2% of overweight have HTN also preHTN has an elevated percentage (11.6%) in obese children and surprisingly in underweight children (12.5%) but we can notice that there is zero percentage of HTN in underweight.

In the overall 1044 children, the overall percentage of HTN is 19.6%, (3.5%) of the healthy weight children prehypertensive and (6.3%) were hypertensive. in comparison to (2.2%) of the obese children were prehypertensive and (9.6%) were hypertensive [Table 2].

The total prevalence of HTN in this study which is equal to 19.6% (9.6% of them were Obese, 3.7% were overweight and lastly 6.3% were of normal weight) as in [Table 2].

On interpreting significance: Readings of percentiles for each of SBP and DBP were significantly directly correlated with BMI percentiles in all ages under study ($P < 0.05$) as in [Table 3].

Discussion

The overall prevalence of HTN in this study is 19.6%,compared to the study done in Tehran in 2011 is 24.2%[12] and Subhi MD in baghdad 2001showing 1.7%.[13]The study which focused on BP and its influencing factors in Iranian children and adolescents in 2005 shows that the prevalence of Systolic, Diastolic and Systolic or diastolic HTN are 4.2%, 5.4%, 7.7% respectively,[14] we can noticed that HTN is rising as extent and severity of HTN and obesity are increasing in the United States.[1,15,16]

The study shows a positive correlation between elevated BP and obesity (9.6%) in comparison to healthy weight children(6.3%), the same result King *et al.*[17] show a stronger relationship between BMI and elevated BP in the U.S. .The same result also was obvious in M Hosseini *et al.* study[18] in which a significant association between BP and BMI in all age group (7–18 years, a sample of 8,848 primary school children aged 7–12 year old [4,476 girls (50.6%) and 4,372 boys (49.4%)] who were collected in

Table 2: Number and percentage of normotensive, pre-HTN and HTN to Weight categories

	N	Total number of children	Percentage %	normotensive		preHTN		HTN	
				N	%	N	%	N	%
underweight	40	1044	3.8	35	3.4	5	0.4	0	0
Normal	644	1044	61.6	541	51.8	37	3.5	66	6.3
Overweight	161	1044	15.4	106	10.2	16	1.5	39	3.7
Obese	199	1044	19.1	76	7.3	23	2.2	100	9.6
Total	1044	1044	100	758	72.7	81	7.6	205	19.6

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Table 3: Correlations of percentiles of each of systolic and DBP with BMI percentiles

	Age (y)	SBP Percentile		DBP percentile	
		Pearson Correlation	P value	Pearson Correlation	P value
BMI Percentile	6	0.262	0.001	0.248	0.002
	7	0.307	< 0.001	0.256	0.002
	8	0.417	< 0.001	0.391	< 0.001
	9	0.580	< 0.001	0.514	< 0.001
	10	0.338	< 0.001	0.359	< 0.001
	11	0.550	< 0.001	0.399	< 0.001
	12	0.608	< 0.001	0.458	< 0.001
	All	0.406	< 0.001	0.331	< 0.001

2002 combined with similar data gathered in 2004 on 5837 guidance and secondary school children aged 12–18 year old [2,571 (45.7%) girls and 3,266 (54.3%)] in Tehran) this study whether in primary or high schools of Tehran have shown Mean SBP, DBP significantly increased with increasing BMI ($P < 0.0001$), another clear relationship between BP and BMI has been demonstrated in all age groups (6–14 years) in Turkey by Zuhal Gundogdu *et al*[19] in which the study has found an increase of 1 unit of BMI was associated with, on average, a 0.60 mmHg increase in SBP and a 0.64 mmHg increase in DBP in the obese children, Even in a low HPT prevalence study such as Sanchez-Zamorano *et al.*[20] in Morelos / Mexico where HPT found to be 3.9%. They concluded that a higher BMI is related to elevated BP whether Systolic or Diastolic.

In this study the Overall prevalence of HTN is 19.6% where in Subhi MD study was 1.7%. This may be related to low number of patients with obesity in 7.3% and large sample of patients done in 8 centers in low and higher social class associated with low bias.

In this study the percentage of hypertensive participants in obese children was (50.3%), overweight was (24.2%) and in normal weight (10.2%) this higher value percentages of hypertension in obese and overweight children may be due to the high percentage of obesity and overweight (19.1% and 15.4% respectively) as the two schools are located in Al-Mansoor Zone (high social class). The impact of gender on BMI and BP is controversial, in the current study, There is no significant differences in mean of each of SBP, DPB, BMI and BMI percentile between the two genders in any of the age group of sampled children ($P > 0.05$), also the mean of SBP and DBP increase with increasing age and more in males than in females in all age groups although it is not statically significant, this result was similar to results done by Zuhal Gundogdu *et al.*,[19] while in M Hosseini *et al.*[18] suggested an association between boys(more considerable) on BMI and BP in his study attributed to the effect of sex hormone on sodium excretion and renal homodynamic response to salts. The study of Zuhal Gundogdu *et al.*[19] done on 1899 children in Turkey reported that higher percent of boys than girls at or above 85 percentile of BMI. in the U.S. many survey done on 1999–2000 and 2007–2008 by Cynthia *et al.* that all concluded that percentages of overweight, obesity, and risk for obesity are higher in boys than girls.[21,22]

This study shows the same result as obesity and overweight are higher in males than in females (11.4% versus 7.7% for obesity) and (8% versus 7.5% for overweight).

Childhood obesity has been determined in the study as overall prevalence of 19.1% which was similar to the Sorof *et al.*[1] result which conducted in the U.S. reported a prevalence of 20%. Prevelence of obesity in Saudi Arabia is 6.3% done by Al-Rukban.MO.*et al*[23]which was similar to Zaini MZ *et al.*[24] conducted in Malysia.

Obesity prevalence was differed and attributed to ethnicity, culture, environmental factors,[25] less physical activity, poverty, socioeconomic status and western life style.

Conclusion

- HTN is not uncommon problem in 6 – 12 years old children and it is more prevalent in overweight and obese children
- obesity can be used to some extent as a predictor of childhood HTN.
- There was a positive and strong relationship between BMI and HTN, at all age groups.

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Conflicts of interest
There are no conflicts of interest.

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