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Overweight and obesity: worldwide risk factors for pediatric hypertension

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Original Article

Abstract

BACKGROUND: Childhood obesity and hypertension (HTN) are among serious global health concerns. Since risk factors of cardiovascular diseases (CVDs) should be managed early in life and there is little information about children under the age of 6 in the community, the study was designed aiming to address these issues.

METHODS: This cross-sectional study was performed on 1,091, 3-6-year-old children in Gorgan City, located in north of Iran. Height, weight, body mass index (BMI), and blood pressure were measured using standard techniques. All statistical tests were conducted using the Statistical Package for the Social Sciences (SPSS) for windows.

RESULTS: Given the study, respectively 3.8 and 4.5% of the boys and girls were underweight, 17.4 and 16.5% of the boys and girls were overweight, and 20.8 and 19.3% of the boys and girls were obese. In addition, 3.4, 0.7, and 0.4% of the subjects had presystolic, systolic, and prediastolic HTN, respectively. There is a significant linear relationship between BMI and systolic and diastolic blood pressures. It was found that the risk of obesity in mothers with college education was estimated to be almost 5 times higher than in mothers with lower levels of education.

CONCLUSION: Compared to the values announced by Centers for Disease Control and Prevention (CDC), the mean height, weight, and BMI of children in our study was higher. Educational interventions should be considered in society, especially for mothers with a high level of education and employed ones. It is recommended that blood pressure measurements, especially in obese children, be carefully considered at each pediatric visit so that children with HTN could be quickly identified and treated.

Keywords: Child; Hypertension; Obesity; Overweight

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Introduction

Obesity and hypertension (HTN) are important causes of cardiovascular diseases (CVDs) in adulthood.[1] Studies suggest that CVDs account for about three quarters of all deaths in developing countries.[2,3] Childhood overweight and obesity have increased in recent years.[4-6] It is estimated that by 2025, the prevalence of overweight in preschool children will reach 11% in the world.[7]

Obese children are at increased risk for HTN, dyslipidemia, and increased risk of obesity in adulthood.[3,8,9] Iran is at high risk for CVDs and overweight is one of the most common risk factors for acquired heart disease in children.[10,11] During the years 2005-2014, the prevalence of overweight and obesity in children under 18 years of age was 5.0-13.5% and 3.2-11.9%, respectively.[12] A study was conducted on children aged 7-12 years, reporting that the prevalence of obesity and overweight was respectively 5.8 and 12.3%.[13] A study of 2-5-year-old children in Gilan and Sistan provinces in Iran showed that the prevalence of overweight and obesity at the age of 2-3 years was 20.3 and 24.3% in girls and 5.2 and 7.6% in boys, respectively.

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Moreover, the prevalence of overweight and obesity at the age of 4-5 years was 22 and 27.6% in girls and 7.5 and 8.7% in boys, respectively.[14] Obesity and overweight in Markazi Province, Iran were 9.9 and 15.5% at the age of 6-7 years.[15] In the Caspian study, the prevalence of obesity in the age group of 6 years was higher than that in the age group of 6-18 years old (7.8%).[16]

HTN also increases with obesity in children worldwide. Studies have shown that weight and HTN are closely related, and obesity-related blood pressure is a major risk factor for CVDs in societies.[17-20] In the Caspian study, the prevalence of systolic and diastolic HTN was respectively 4.2 and 5.4%, with this rate being 7.7% for systolic or diastolic HTN.[21-23] A study conducted in Turkey on children aged 5-14 years indicated that systolic HTN stage 1 and 2 were 6.8 and 3.2% and diastolic HTN stage 1 and 2 were 1.1 and 5.5%, respectively.[24]

Since studies have shown an increase in the prevalence of HTN and obesity in the pediatric community,[25] related risk factors should be screened and managed early in life to prevent CVDs.[8,9,16,26,27] Because there is little information about children under the age of 6 in the community, the present study was designed aiming to explore this issue.

Materials and Methods

This cross-sectional study was performed on 1,091 3-6-year-old children in Gorgan City, Iran. The sample was drawn using two-stage cluster sampling, so that in the first stage, 35 kindergartens as individual clusters were randomly selected from among 76 kindergartens in Gorgan district. In the second stage, from every 35 selected clusters, 40 children were randomly selected based on age group. The study inclusion criteria were parental consent, no specific illness, no HTN, and no medication during the past week. This study was carried out after the approval of the ethics committee of Golestan University of Medical Sciences, Gorgan and the approval of the State Welfare Organization of Iran by referring to the kindergartens of Gorgan. After coordination with the Welfare Organization, the trained person went to the kindergartens to measure blood pressure, weight, and height. Written consent was obtained from the parents and the questionnaires were completed for the individuals.

The weight of the children was measured using a digital scale weighting approximately 100 grams. The children were in minimal clothing and without shoes and were examined with heels attached to the standard height gauge at a height of 0.5 cm without shoes. The body mass index (BMI) was evaluated based on weight calculation in kilograms divided by height in square meters.

The height, weight, and BMI of each child were scored based on the Centers for Disease Control and Prevention (CDC) growth chart and their percentages were evaluated. The height and weight charts for children aged 2-20 were used separately for girls and boys to mark height and weight, and the related percentage was determined for each child.[28] To evaluate BMI, the BMI chart for age was used separately for boys and girls. According to the CDC, the BMI of 85-95%, 95% and more, and under 5 was considered as overweight, obese, and underweight, respectively.[28,29] Blood pressure in the sitting position was performed using ALPK2 sphygmomanometer (Zhejiang, China) with a suitable cuff according to the standard method. The measurements were taken in a quiet room and to do this, the children's right hand was wrapped around the heart. The sphygmomanometer was wide enough to completely cover at least two-thirds of the arm. The Kurtkov's first and fifth sounds were recorded as systolic and diastolic pressure. Blood pressure was taken three times at intervals of 5 minutes and the mean was recorded. To determine blood pressure, the table presented in the fourth report on the diagnosis, treatment, and evaluation of HTN in children and adolescents (prepared by the American Heart, Lung and Blood Institute) was used. In the presence of HTN based on the first two measurements, the children were re-checked three times in the next 1-2 weeks based on the above method and in case of HTN in three visits, they were considered as HTN. HTN was defined as the mean systolic or diastolic blood pressure at three times of measurements, which was greater than or equal to 95% plus 5 mmHg according to blood pressure levels for the percentiles of height. Pre-HTN was defined by mean systolic or diastolic blood pressure greater than 90% but less than 95%.[30]

Statistical Analysis: All statistical tests were conducted using the Statistical Package for the Social Sciences 19.0 (SPSS Inc., Chicago, Illinois, USA) for Windows. Continuous data were expressed as mean ± standard deviation (SD), and categorical data were expressed as frequency and percentage. The Pearson's chi-squared test and linear-by-linear association were used for nominal and ordered contingency tables. Crude and adjusted logistic regression models were used to evaluate odds ratio (OR) with 95% confidence interval (CI).

Table 1. Mean and standard deviation (SD) of height, weight, body mass index (BMI), and systolic and diastolic blood pressure (BP) by sex and age

Age (years)	Sex	n	Height (cm)	Weight (g)	BMI (kg/m²)	SBP (mm Hg)	DBP (mm Hg)
			Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
3-4	Male	121	99.30 ± 4.08	16490.91 ± 2630.91	16.65 ± 1.81	97.98 ± 7.38	52.19 ± 3.09
	Female	106	97.40 ± 4.57	15267.92 ± 2298.14	16.03 ± 1.47	94.76 ± 7.41	52.41 ± 3.40
4-5	Male	141	106.35 ± 4.80	18388.65 ± 2814.35	16.22 ± 1.91	98.40 ± 7.13	54.33 ± 5.01
	Female	152	104.37 ± 4.89	17753.95 ± 2724.69	16.23 ± 1.65	97.01 ± 5.65	53.68 ± 4.59
5-6	Male	206	112.92 ± 5.32	20935.92 ± 4537.38	16.30 ± 2.52	100.63 ± 6.60	53.83 ± 5.49
	Female	197	111.57 ± 4.57	20505.58 ± 3859.64	16.40 ± 2.43	97.56 ± 5.92	52.66 ± 4.39
6-7	Male	85	117.58 ± 4.92	23901.18 ± 5729.57	17.20 ± 3.52	103.41 ± 8.63	56.18 ± 6.44
	Female	83	116.06 ± 5.34	21665.06 ± 4508.08	15.95 ± 2.29	97.59 ± 6.22	56.57 ± 5.52

SD: Standard deviation; BMI: Body mass index; BP: Blood pressure

Pearson correlation coefficient was used to evaluate the relationship between blood pressure and BMI data. A P-value < 0.05 was considered as statistically significant.

Results

The study involved 1,091 children aged 3 to 6 years, of who 553 (50.7%) were boys and 538 (49.3%) were girls. 227 (20.8%), 293 (26.9%), 403 (36.9%), and 168 (15.4%) children were 3-4, 4-5, 5-6, and 6-7 years old, respectively. The mean height, weight, BMI, and systolic and diastolic blood pressure are listed in table 1 by age and sex.

In the BMI study, 3.8% of the boys and 4.5% of the girls were underweight. Besides, 17.4% of the boys and 16.5% of the girls were overweight, and 20.8% of the boys and 19.3% of the girls were obese. The difference of frequency of BMI distribution in children was not statistically significant by sex (Table 2).

In children aged 3-4 years, the normal and underweight categories had a statistically significant difference with obese and overweight boys and girls (P = 0.02), but this difference was not significant in other age groups.

1046 (95.9%) children had normal systolic blood pressure, 37 (3.4%) had pre systolic HTN, and 8 (0.7%) had systolic HTN. 1087 (99.6%) children had normal diastolic blood pressure and 4 (0.4%) cases had pre diastolic HTN (Table 3).

There was no significant relationship between gender and obesity. The risk of obesity in girls with age adjustment was 0.8 of that in boys (OR = 0.880; 95% CI: 0.672-1.152) (Table 4).

The risk of obesity and overweight in children was significantly correlated with the level of education of mothers. The risk of obesity with and without age adjustment in mothers with university education was 4.96 and 1.87 times higher than that in mothers with diploma education and lower (OR = 4.968; 95% CI: 2.846-8.672), (OR = 1.857; 95% CI: 1.110-3.108) (Table 4).

Table 2. Underweight, normal, overweight, and obese children by sex and age (n/% within sex)

Age (years)	Sex	Underweight (< 5th)	Normal (5-85th)	Overweight (85-95th)	Obese (≥ 95th)	P*
		n (%)	n (%)	n (%)	n (%)	
3-4	Total	11 (4.8)	134 (59.0)	43 (18.9)	39 (17.2)	0.020
	Male	5 (4.1)	64 (52.9)	26 (21.5)	26 (21.5)	
	Female	6 (5.7)	70 (66.0)	17 (16.0)	13 (12.3)	
4-5	Total	7 (2.4)	168 (57.3)	57 (19.5)	61 (20.8)	0.600
	Male	5 (3.5)	79 (56.0)	30 (21.3)	27 (19.1)	
	Female	2 (1.3)	89 (58.6)	27 (17.8)	34 (22.4)	
5-6	Total	20 (5.0)	238 (59.1)	62 (15.4)	83 (20.6)	0.340
	Male	9 (4.4)	129 (62.6)	29 (14.1)	39 (18.9)	
	Female	11 (5.6)	109 (55.3)	33 (16.8)	44 (22.3)	
6-7	Total	7 (4.2)	102 (60.7)	23 (13.7)	36 (21.4)	0.060
	Male	2 (2.4)	49 (57.6)	11 (12.9)	23 (27.1)	
	Female	5 (6.0)	53 (63.9)	12 (14.5)	13 (15.7)	
Total	Total	45 (4.1)	642 (58.8)	185 (17.0)	219 (20.1)	0.400
	Male	21 (3.8)	321 (58.0)	96 (17.4)	115 (20.8)	
	Female	24 (4.5)	321 (57.9)	89 (16.5)	104 (19.3)	

*Linear-by-linear test was used.

Table 3. Underweight, normal, overweight, and obese children by sex and age (n/% within sex)

Age (years)	Sex	BMI < 85th	BMI ≥ 85th	P*	Normal (< 90th)		Pre-HTN (90-95th)		HTN (≥ 95th)	
					SBP	DBP	SBP	DBP	SBP	DBP
3-4	Total	145 (63.9)	82 (36.1)	0.015	220 (96.9)	226 (99.6)	6 (2.6)	1 (0.4)	1 (0.4)	0 (0)
	Male	69 (57.0)	52 (43.0)		117 (96.7)	120 (99.2)	3 (2.5)	1 (0.8)	1 (0.8)	0 (0)
	Female	76 (71.1)	30 (28.3)		103 (97.2)	106 (100)	3 (2.8)	0 (0)	0 (0)	0 (0)
4-5	Total	175 (59.7)	118 (40.3)	0.527	282 (96.2)	293 (100)	11 (3.8)	0 (0)	0 (0)	0 (0)
	Male	84 (59.6)	57 (40.4)		132 (93.6)	141 (100)	9 (6.4)	0 (0)	0 (0)	0 (0)
	Female	91 (59.9)	61 (40.1)		150 (98.7)	152 (100)	2 (1.3)	0 (0)	0 (0)	0 (0)
5-6	Total	258 (64.0)	145 (36.0)	0.122	390 (96.8)	403 (100)	11 (2.7)	0 (0)	2 (0.5)	0 (0)
	Male	138 (67.0)	68 (33.0)		196 (95.1)	206 (100)	8(3.9)	0 (0)	2 (1.0)	0 (0)
	Female	120 (60.9)	77 (39.1)		194 (98.5)	197 (100)	3(1.5)	0 (0)	0 (0)	0 (0)
6-7	Total	109 (64.9)	59 (35.1)	0.119	154 (97.1)	165 (98.2)	9(5.4)	3 (1.8)	5 (3.0)	0 (0)
	Male	51 (60.0)	34 (40.0)		73(85.9)	82(96.5)	7 (8.2)	3 (3.5)	5 (5.9)	0 (0)
	Female	58 (69.9)	25 (30.1)		81(97.6)	83(100)	2 (2.4)	0 (0)	0 (0)	0 (0)
Total	Total	687 (63.0)	404 (37.0)	0.237	1046 (95.9)	1087 (99.6)	37 (3.4)	4 (0.4)	8 (0.7)	0 (0)
	Male	342 (61.8)	211 (38.2)		518 (93.7)	549 (99.3)	27 (4.9)	4 (0.7)	8 (1.4)	0 (0)
	Female	345 (64.1)	193 (35.9)		528 (98.1)	538 (100)	10 (1.9)	0 (0)	0 (0)	0 (0)

SBP: Systolic BP; DBP: Diastolic BP; HTN: Hypertension
*Chi-square test was used. Data are presented n (%).

By adjusting the age of the child, it was found that the risk of obesity in mothers with college education was estimated to be almost 5 times higher than in mothers with lower levels of literacy, but the role of father literacy in this regard was not significant (Table 4).

The results of Pearson correlation coefficient showed that there was a significant linear relationship between BMI and systolic blood pressure ($r = 0.26$, $P < 0.001$) and also a significant linear relationship between BMI and diastolic blood pressure ($r = 0.18$, $P < 0.001$) was established.

Discussion

The study included 1,091 preschool children aged 3-6 years, about half of whom were girls and the other half were boys. Compared to those reported in CDC, the mean height, weight, and BMI of children in our study were higher.[27]

There were no statistically significantly differences between age and sex by BMI. In the study by Tabesh et al. in Ahvaz, which was performed on students aged 7-11 years, overweight and obesity were significantly higher in boys than in girls. It was reported that the prevalence of obesity and overweight increased significantly with age.[26] In the study of Hajian-Tilaki et al. performed on children aged 7-12 years, the prevalence of obesity in girls was significantly lower.[13] Of course, these studies were at a higher age range than that in our study, which could be the effect of the maturation factor on the developmental process of children at older ages.

Table 4. Generalized estimating equation (GEE) results of the intervention group in comparison with the control group on depression

Variable	Crude OR (95% CI)	Age-adjusted OR (95% CI)
Age group		
3	1.0	-
4	1.19 (0.83-1.71)	-
5	0.99 (0.71-1.39)	-
6	0.96 (0.63-1.45)	-
Sex		
Male	1.0	1.0
Female	0.91 (0.71-1.16)	0.88 (0.67-1.15)
Mothers' education		
Illiterate or primary, Elementary, and High school level	1.0	1.0
College Level	1.28 (0.93-1.77)	2.36 (1.66-3.36)** *
University level	1.86 (1.11-3.11)*	4.97 (2.85-8.67)** *
Fathers' education		
Illiterate or primary, Elementary, and High school level	1.0	1.0
College Level	0.94 (0.67-1.32)	1.45 (1.00-2.10)*
University level	1.02 (0.68-1.54)	1.52 (0.98-2.38)

OR: Odds ratio; CI: Confidence interval
*P < 0.050, **P < 0.010, P < 0.001

In this study, 43.0, 40.4, 33 and 40 percent of boys aged 3-6 years, 28.3, 40.1, 39.1 and 30.1 percent of 3-6-year-old girls were overweight and obese; This is a higher rate of obesity than that in the study of Dorosty et al. conducted on 2-5 year old children, indicating poor nutritional status and life style for these children.[14]

In this survey, 37 (3.4%) cases had pre-systolic HTN, and 8 (0.7%) and 4 (0.4%) cases had systolic and pre-diastolic HTN, respectively. This study had a lower rate of HTN compared to the study of Badeli et al, although this study mentioned in a higher age range. HTN especially in the early of childhood could impose irreparable damage to the health of the individual and society, and can be costly, therefore, it is recommended to identify the causative factors and design an intervention program to prevent this major problem.

With the adjustment of the child's age, it was found that the risk of obesity in mothers with academic literacy was estimated to be almost 5 times higher than in mothers with lower levels of literacy, but the role of father's literacy in this regard was not significant. This may indicate that employed mothers have less opportunity to manage their children's nutrition and lifestyle and prevent their obesity and overweight, which is consistent with the study of Hajian-Tilaki et al.[13] Because obesity and HTN are predisposing factors for CVDs in adulthood; it is necessary to educate mothers about healthy food and healthy life style.

The results showed that there was a significant linear relationship between BMI and high systolic and diastolic blood pressure, which is consistent with the studies of Zhang et al.,[18] Basiratnia et al.,[20] and Badeliet al.[25]. On the basis of these results, by reduction in BMI, blood pressure would be decreased. It is suggested that a study be conducted about the cause of obesity and overweight in this area to consider the necessary interventions based on the risk factors.

Conclusion

Compared to the values announced by CDC, the mean height, weight, and BMI of children in our study were higher. Since 33-43% of boys and 28.3-40.1% of girls were overweight and obese, and there was a significant linear relationship between BMI and systolic and diastolic blood pressures, which are important causes of CVDs, educational interventions should be considered in society, especially for mothers with a high level of education and employed ones. It is recommended that blood pressure measurements, especially in obese children, be carefully considered at each pediatric visit so that children with HTN can be quickly identified and treated.

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Conflict of Interests

Authors have no conflict of interests.

Authors' Contribution

Study concept and design: LB, MR; analysis and interpretation of data: LB, MR, MT and MV; drafting of the manuscript: LB, MR; critical revision of the manuscript for important intellectual content: LB, MR, and MT.; statistical analysis: MV

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