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Original article

Incidence of obesity, overweight and hypertension in children and adolescents in Ahvaz southwest of IRAN: Five-years study

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ABSTRACT

Objective: The purpose of this study was to investigate the incidence of obesity, overweight and hypertension in children and adolescents aged 10–15 in Ahvaz.
Methods: This is a epidemiologic study performed on 176 people aged 10–15 in Ahvaz. In 2009, 300 people underwent weight, height and blood pressure measurements. Five years later, the same people were reassessed for obesity, overweight and hypertension, of whom a total of 176 people agreed to repeat the procedure.
Results: The study included 100 (57%) males and 76 (43%) females. Mean BMI was 22.1 ± 4.3 kg / m2 in year 2014, without any significant difference between the two sexes (P = 0.518). In the same year, the prevalence of obesity and overweight was 26 (14.8%) and 13 (7.4%), respectively. After 5years, BMI increased significantly (P < 0.001). Of the 150 norma participants with normal BMI in 2009, 15 (10%) and 6 (4%) became overweight and obese in 2014 respectively. The mean systolic and diastolic blood pressures increased significantly over 5 years P = 0.042 and P < 0.001.
Conclusions: This study shows an increase in mean BMI and mean systolic and diastolic blood pressures after 5 years among people aged 10–15 in Ahvaz.

1. Introduction

Obesity is associated with problems such as depression, becoming antisocial, decreased self-esteem, and frustration in children [1]. Studies have also shown that adult obesity has a direct correlation with childhood and adolescent obesity. In addition, obesity also increases the risk of cardiovascular disease, diabetes, and hypertension [2]. Obesity is rising rapidly in developed and developing countries among childhood and adolescence [3,4]. Results of 160 cross-sectional studies in 94 developing countries have shown that the overall prevalence of overweight was 3.3% and that the countries of the eastern Mediterranean, North Africa, and Latin America had the highest prevalence. In terms of the number of people affected, Asia is the highest, and 60% (10.6 million) of the overweight children in developing countries live in these areas [5].

Iran is one of the seven countries with the highest prevalence of childhood obesity, and between 1993 and 1999, the prevalence of overweight and obesity in childhood in Iran doubled [6,7]. A national study on children and adolescents aged 6–18 from 23 provinces reported prevalence rates of 8.82% and 4.5% at risk of overweight and overweight, respectively according to CDC criteria [8]. Based on a meta-analysis on 107 studies, the prevalence of overweight and obesity in Iranian children and adolescents has been reported to be 10.8% and 5.1%, respectively [9]. In the meantime, hypertension is another major global health problem today, with about 7.6 million premature deaths occurring due to hypertension and 54% of the causes of stroke and 47% of ischemic heart disease being associated with it [10]. Evidence suggests that an increase in childhood blood pressure is predictive of hypertension in later stages, and a risk factor for atherosclerosis in the future [11]. A review study on studies on the prevalence of hypertension in Iranian children and adolescents in 2017 estimated the general prevalence of hypertension in this population to be 8.9% (10.3% for boys and 9.1% for girls) and the prevalence of diastolic and systolic hypertension to be 6.6% and 6.9%, respectively [12].

Since several studies have been conducted on the prevalence of overweight, obesity and hypertension in children and adolescents in Ahvaz [13–16], they have all examined the prevalence of these disorders. Therefore, the purpose of this study was to investigate the incidence of obesity and hypertension in children and

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adolescents aged 10–15 in Ahvaz during a five-year period (2009–2014).

2. Method

This epidemiological study was carried out in two phases. The population of the study was adolescents aged 10–15 living in Ahvaz. In the first stage in 2009, a number of health centers were selected using cluster sampling method. By distributing notices and fliers in areas under the coverage of these centers, we invited adolescents aged 10–15 to be subject to overweight, obesity, and blood pressure measurements. Three hundred people referred, and after recording their demographic information including age, sex, place of residence, and contact number, their weight, height and blood pressure were measured, and their fasting blood glucose and lipid profiles were examined. Five years later in 2014, in the second phase, the same people were contacted for re-evaluation of their overweight, obesity and hypertension status. Finally, 176 patients referred, their weight, height and blood pressure were measured, their blood glucose and lipid profiles tests were performed, and the results were recorded in their medical record. The study was approved by Ahvaz Jundishapur University of Medical Sciences and oral informed consent was obtained from all individuals or their parents to participate in the study.

The height of people was measured using a tape measure in standing position beside the wall and without shoes, while the scapulars were in normal condition. The subjects' weight was measured with minimum clothing and no shoe using digital scales. Body mass index (BMI) $\frac{\text{Weight (Kg)}}{\text{Height (m)}^2}$ was used to define overweight and obesity. Accordingly, the subjects were divided into three groups: normal (BMI less than 85 percentile), overweight (BMI 85–95), and obese (BMI above 95 percentile) [17]. The waist circumference was measured in its narrowest area using an inelastic band of meter without imposing any pressure on the body of the participants while they were at the end of their natural exhalation.

To measure blood pressure, the subjects were asked to rest for 15 min. Then, blood pressure in the sitting position from the right arm of the subjects was measured twice, with a minimum of 30-second interval, using a standard mercuric pressure gauge, and the mean of the two measurements was considered as the final blood pressure of the individual. Systolic blood pressure was recorded by hearing the first korotkoff sound and the diastolic blood pressure was recorded when there was no sound. Increased blood pressure was considered as follows: a) systolic or diastolic blood pressure equal to or greater than 90 percentile based on age, gender and height in subjects 17 years and below, b) systolic blood pressure equal to or greater than 130, and diastolic blood pressure equal to or greater than 85 in subjects 18 years of age and higher or c) a history of taking antihypertensive drugs [18].

Given that 176 people provided data from both phases, the results were reported in this group of individuals. SPSS 22 was used to analyze the data. Qualitative variables were characterized by frequency and percentage and quantitative variables with mean and standard deviation. To compare the change, paired t-test, McNemar test and marginal homogeneity test were used. $P < 0.05$ was considered as the significant level.

3. Results

Of the 176 participants, 100 (57%) were male and 76 (43%) females with an average age of 12 ± 1 years. Fifteen (9%) were at the age of 10, 38 (22%) at 11, 34 (19%) at 12, 28 (16%) at 13, 37 (21%) at 14 and 24 (13%) were at the age of 15 years. Thirty-three (19%) had a family history of obesity, which showed no significant difference between boys and girls (19, 19% vs. 14, 18%, $P = 0.922$).

The range and mean of BMI in year 2009 in all participants were 12.1–30.9 kg / m2 and 18.3 ± 3.5 kg / m2 respectively, which was significantly higher in girls than boys (respectively 19.1 ± 3.8 kg / m2 and 17.7 ± 3.1 kg / m2, $P = 0.008$). The prevalence of overweight and obesity in 2009 was 18 (10.2%) and 8 (4.5%), respectively, and there was no significant difference between the two sexes ($P = 0.256$). However, with increasing age, there was a significant increase in the prevalence of overweight and obesity, with the highest prevalence at age 15 (Table 1).

The range and mean of BMI in year 2014 in all participants were 11.2–36.3 kg / m2 and 22.1 ± 4.3 kg / m2, respectively, which did not have a significant difference between the two sexes (in boys 21.9 ± 4.4 kg / m2 and in girls was 22.4 ± 4.3 kg / m2, $P = 0.518$). The prevalence of overweight and obesity in this year was 26 (14.8%) and 13 (7.4%), respectively, which had no significant difference between the two sexes ($P = 0.461$).

During the 5 years, from 2009 to 2014, the mean (SD) of the BMI significantly increased (from 18.3 ± 3.5 kg / m2 to 22.1 ± 4.3 kg / m2, $P < 0.001$). Also, in terms of the incidence of overweight and obesity in 2014 as compared to 2009, of the 150 people with normal BMI in 2009, 15 (10%) were overweight and 6 (4%) were obese in 2014. Of the 18 overweight people in 2009, 5 (28%) were obese in 2014 (Table 2). In subjects who were normal or overweight BMI at the beginning of the study, there was a significant increase in BMI in 5 years, while in subjects with obesity, there was no significant change in BMI (Table 3). Also, in both groups with and without a family history of obesity, a significant increase in BMI occurred over a five-year period (Table 3); however, there were no significant differences in these rates between the two groups ($P = 0.611$).

In total, 34 (19%) of the subjects had a family history of hypertension, which showed no significant difference between boys and girls (19 cases (19%) versus 15 (20%), $P = 0.902$, respectively). The mean systolic and diastolic blood pressure increased significantly over the 5 years (Table 4). With regard to BMI status, there was no significant change in systolic blood pressure in each of the normal, overweight and obese groups, while diastolic blood pressure was significantly increased in subjects with normal BMI ($P < 0.001$). There was no significant change in overweight and obesity. Also, systolic blood pressure did not change significantly in people with a family history of hypertension in year 2014, while in subjects without family history of hypertension, there was a significant increase ($P = 0.012$). In addition, diastolic blood pressure significantly increased in both groups with and without a family history of hypertension ($P < 0.05$) (Table 4).

The prevalence of systolic hypertension, diastolic hypertension, and hypertension in year 2009 was 11 (6.3%), 10 (5.7%) and 17 (9.7%) respectively. In 2014, these rates were in 1 (0.6%), 6 (3.4%) and 6 (3.4%) individuals, indicating statistically significant decrease in high systolic blood pressure ($P = 0.006$) and

Table 1
Comparison of overweight and obesity in both sexes and at different ages in year 2009.

		BMI status			P -value*
		Normal	Overweight	Obese	
Sex	Boy	89(89%)	8(8%)	3(3%)	0.256
	Girl	61(80%)	10(13%)	5(7%)	
Age(year)	10	15(100%)	0(0%)	0(0%)	0.001
	11	35(92%)	3(8%)	0(0%)	
	12	29(85%)	5(15%)	0(0%)	
	13	22(79%)	2(7%)	4(14%)	
	14	35(95%)	2(5%)	0(0%)	
	15	14(58%)	6(25%)	4(17%)	

Chi-square test*.

Table 2
Incidence of overweight and obesity in 2014 compared to 2009.

		BMI in 2014		
		Normal	Overweight	Obese
BMI in 2009	Normal(150)	129(86%)	15(10%)	6(4%)
	Overweight(18)	7(39%)	6(33%)	5(28%)
	Obese(8)	1(13%)	5(63%)	2(25%)

P = 0.020, Marginal homogeneity test.

Table 3
The change in BMI status in 2014 compared to 2009.

		BMI		
		2009	2014	P-value*
BMI status in 2009	Normal	17.2 ± 2.1	21.3 ± 4.0	<0.001
	Overweight	23.6 ± 0.9	26.4 ± 3.9	0.007
	Obese	27.6 ± 1.4	27.4 ± 3.0	0.893
Family history of obesity	Yes(33)	19.8 ± 4.2	24.7 ± 5.3	<0.001
	No(143)	17.9 ± 3.2	21.5 ± 3.9	<0.001

Paired t-test*.

hypertension (P = 0.027), but no significant changes were seen in diastolic hypertension (P = 0.424). In addition, in 2009, a total of 159 (90.3%) had normal blood pressure, with an incidence of hypertension of 5 (3.1%), which had no significant difference between boys and girls (respectively 2 patients, 2.2% and 3 patients, 4.5%, P = 0.651).

In general, FBS, triglyceride, and cholesterol levels decreased significantly in year 2014. HDL levels also decreased significantly, but LDL levels did not significantly differ (Table 5). These changes were more common in people who were in the normal and overweight BMI group in year 2009 but for the obese group, a significant decrease in HDL was found (Table 6).

4. Discussion

The findings of this study showed that in 5 years, the mean BMI significantly increased in individuals aged 15–10 years. The prevalence of overweight and obesity in 2009 was 10.2% and 4.5%, respectively, which increased to 14.8% and 7.4%, respectively in 2014. The incidence of overweight and obesity over 5 years in subjects with normal BMI was 10% and 4%, respectively, and the incidence of obesity in overweight people was 28%. Increased BMI was found in people with normal or overweight BMI and in both groups with and without family history of obesity. Also, the mean systolic and diastolic blood pressure increased significantly over the 5 years. Diastolic blood pressure significantly increased in both groups with and without a family history of hypertension, while systolic blood pressure increased significantly only in subjects without a family history of hypertension. The prevalence of systolic hypertension, diastolic hypertension, and hypertension in general was 6.3%, 5.7%, and 9.7%, respectively, in 2009 which decreased respectively in 2014 to 0.6%, 3.4% % and 3.4%, which was significant for systolic hypertension and hypertension in general. The incidence of hypertension over the 5 years in subjects with normal blood pressure at the beginning of the study was 3.1%. Our study showed that in 5 years, the prevalence of overweight increased from 10.2% to 14.8% and the prevalence of obesity increased from 4.5% to 7.4%. The incidence of overweight and obesity was also 10% and 8% respectively. Prevalence of overweight and obesity increased significantly with age, and the highest prevalence was at age 15. According to Assar and Asghari, the prevalence of obesity and overweight in students aged 7–14 years

Table 5
Changes in fasting blood glucose and lipid profiles in year 2014 compared to 2009.

	2009	2014	P-value*
FBS, mg/dL	93 ± 34	90 ± 6	0.006
Triglyceride, mg/dL	97 ± 42	88 ± 43	0.011
Cholesterol, mg/dL	160 ± 32	148 ± 28	<0.001
HDL, mg/dL	57 ± 14	45 ± 10	<0.001
LDL, mg/dL	85 ± 25	85 ± 22	0.716

Paired t-test*.

Table 6
Status of changes in fasting blood glucose and lipid profiles in year 2014 compared to year 2009 based on BMI in year 2009.

		2009	2014	P-value*
Normal	FBS(mg/dL)	93 ± 37	91 ± 28	0.038
	Triglyceride(mg/dL)	94 ± 40	86 ± 41	0.044
	Cholesterol(mg/dL)	158 ± 32	147 ± 28	<0.001
	HDL(mg/dL)	58 ± 14	45 ± 10	<0.001
	LDL(mg/dL)	83 ± 25	85 ± 22	0.301
Overweight	FBS(mg/dL)	90 ± 9	85 ± 9	0.259
	Triglyceride(mg/dL)	112 ± 49	94 ± 42	0.032
	Cholesterol(mg/dL)	166 ± 33	149 ± 29	0.002
	HDL(mg/dL)	54 ± 9	44 ± 7	<0.001
	LDL(mg/dL)	89 ± 28	86 ± 24	0.379
Obese	FBS(mg/dL)	89 ± 7	78 ± 13	0.070
	Triglycerid(mg/dL)	115 ± 63	108 ± 69	0.648
	Cholesterol(mg/dL)	177 ± 30	150 ± 32	0.161
	HDL(mg/dL)	48 ± 10	38 ± 7	0.006
	LDL(mg/dL)	90 ± 22	106 ± 21	0.251

Paired t-test*.

Table 4
Systolic and diastolic blood pressure changes in year 2014 compared to 2009.

			Blood pressure		
			2009	2014	P-value*
Systolic blood pressure, mmHg			103 ± 11	105 ± 12	0.042
Diastolic blood pressure, mmHg			61 ± 10	66 ± 9	<0.001
Systolic blood pressure	BMI status in 2009	Normal	103 ± 11	105 ± 12	0.092
		Overweight	103 ± 11	104 ± 10	0.573
		Obese	105 ± 8	113 ± 10	0.197
	Family history of hypertension	Yes	102 ± 10	102 ± 19	0.986
		No	103 ± 11	106 ± 9	0.012
Diastolic blood pressure	BMI status in 2009	Normal	61 ± 10	65 ± 9	<0.001
		Overweight	64 ± 9	64 ± 9	0.917
		Obese	64 ± 11	75 ± 11	0.095
	Family history of hypertension	Yes	62 ± 8	66 ± 11	0.028
		No	61 ± 10	66 ± 9	<0.001

Paired t-test*.

old in Ahvaz was 2.2% and 6.09% respectively in 2001, with the highest prevalence being in the age range of 12–14 years [13]. Compared to that study, the prevalence of overweight and obesity seems to have increased significantly in both phases of our study. However, there has not been any significant change in the age of developing these conditions. One year later, Tabatabai et al reported an overall prevalence of obesity in 6-12-year-old Ahvaz children based on three criteria including Iranian, CDC and IOTF to be 10.9%, 5.2%, and 3.6% respectively [14]. The Iranian reference was based on the study of Hosseini et al. [19] in determining the BMI percentiles in Tehran teens aged 2-18. Although Tabatabai et al studied younger children than those in our study, our results are consistent with theirs. However, Aminzadeh et al. reported the prevalence of obesity and overweight in 6-10-year-old students in Ahvaz to be 18.8% and 17.7%, respectively, and an increase of nearly 100% compared with Assar et al [13] was reported [15]. However, the results of the first phase of our study, one year earlier than Aminzadeh's study, show a lower prevalence. Even in the second phase, despite the increasing prevalence and incidence of overweight and obesity in our study, our figures are still smaller than those of Aminzadeh et al. Considering that the study method is the same in both studies, differences in age groups might have led to differences in results. Also, because our study focused on people who came to health centers, the preventive advice or the use of brochures in these centers that highlight the importance of noncommunicable diseases might have partly improved the lifestyles of our subjects.

Many studies have been carried out in other Iranian cities, with more recent studies pointing to an increase in the prevalence of overweight and obesity in children and adolescents. In some Iranian cities, the prevalence of overweight and obesity is as follows: Bandar Abbas, 11.4% and 8.5% [20]; Tehran 15.2% and 26.7% [21]; Semnan, 18.8% and 14.3% [22]; Gorgan, 14.7% and 6.3% [23]. Also, based on a systematic review, 129 outbreaks of overweight in Iranian children and adolescents at different ages and in both sexes were reported to be from 4.4% to 42.3% and the prevalence of obesity was 1% to 16.1% [24]. In a prospective three-year study in Western Azerbaijan, Nouri Saeedlou et al. also described the increasing prevalence of overweight and obesity among 12-year-old students [25]. According to the above figures, the prevalence of overweight and obesity in Ahvaz during the 5 years of the study seems to be close to that of other Iranian cities. However, compared to other countries, the prevalence of overweight and obesity in Ahvaz and other Iranian cities is still lower than that in some developed and western countries. In another study in Canada in 2004, the prevalence of overweight and obesity was reported to be 25.6% [26]. The prevalence of overweight and obesity in the 2-19-year-olds in the United States in 2010 was reported to be 31.7% and 16.9%, respectively [27]. Also, a seminal overview study on 2416 studies from 1975 to 2016 (containing 31.5 million children and teenagers aged 5–19 years) has reported that BMI changes over the years vary by region, with Western Europe remaining virtually unchanged and central Latin America having the highest increase of 1.00 kg / m2 per decade [28].

Overall, the results of our study indicated a decrease in the prevalence of hypertension although its average has increased. However, the incidence of hypertension over a 5-year period was 3.1% in those who had normal blood pressure in the first phase. There was also no significant relationship between BMI and hypertension. Aleali et al. reported high prevalence of hypertension in children and adolescents aged 10–17 in Ahvaz (1.7%) (2.5% in boys and 0.8% in girls). Also, the mean systolic and diastolic blood pressure increased with an increase in BMI [16]. The difference between their results and ours can be because of the small sample size. It could also be due to the type of samples that were selected from health centers where preventive brochures and advice were offered during initial referrals or subsequent referrals. This calls for further studies.

Other studies have shown that the prevalence of hypertension in children aged 7–11 in Ilam girls was 9.1% and 8.7% in boys [29] and in 7–11-year-olds in Tehran, it was 24% [30]. The prevalence of systolic hypertension among primary school children in Rafsanjan was 11.8% and in children aged 11–18 years in Birjand, the figures were 7.78% and 0.9%, respectively [31]. Also, the prevalence of hypertension in a population representative of 6–18-year-old children and adolescents in Iran was 6.88% and the prevalence of systolic hypertension was 4.17%, and of diastolic hypertension was 4.33% [32,33]. An overview of the above studies and other studies in this area suggests a large difference in the prevalence of hypertension among different cities and also the difference between the results of our study and the above results, which can have different causes. In general, in other countries, the prevalence of hypertension in children and adolescents in various studies has been reported to be from 4.5% to 4.9% [34,35]. In spite of this, blood pressure measurements are often removed from routine children's examinations. Hence, the new guidelines have introduced hypertension and its prior stages as a health problem in children and the American Academy of Pediatrics recommends measuring blood pressure for all children over the age of 3 in a care visit (45).

There are many differences in the prevalence of overweight, obesity, and hypertension in different parts of Iran, which can be due to differences in dietary habits, physical activity, the use of gadgets and advanced technology, climate and socioeconomic conditions, the measure of obesity, etc. Today, the use of digital technologies such as television, mobile phones, tablets and such devices has become increasingly popular among children and adolescents, and computer games have supplanted physical activity and exercise in many cases, which can create overweight and obesity, and hence their complications during childhood and adolescence. Although not bringing about any current visible medical condition, in the following decades, overweight and obesity can be increasingly associated with mental and behavioral disorders, cardiovascular disease, skeletal malformations, etc., reducing the social efficacy of the individual to a large extent and imposing a financial burden upon future families and health systems in each region. Therefore, it is imperative to inform students and families, especially the affluent, and warn them about the predisposing factors of obesity and hypertension. Also, periodic studies in the coming years to examine the possible changes in the prevalence and incidence of obesity and hypertension in children and adolescents can examine the effectiveness of educational, cultural, preventive and therapeutic interventions in this area.

Although a small sample size was one of the main limitations of this study, which prevented its results from being generalized, its two-phase study design and the determination of overweight, obesity and hypertension were among the strengths of this study because most of the previous studies were cross-sectional and only investigated the prevalence of these cases. Also, considering that the prevalence of the above-mentioned conditions was measured in the same population at two time intervals and that the gap between the two phases of the study is small, the impact of some confounding factors such as the economic status, diet, physical activity, etc. is eliminated to a large extent and the results are more generalizable.

5. Conclusion

The findings of this study showed that there was a significant increase in mean BMI in 5-10-year-old individuals, and the incidence of overweight and obesity in subjects with normal BMI at the beginning of the study was 10% and 4%, respectively

while the incidence of obesity in overweight individuals was 28%. Also, the mean systolic and diastolic blood pressure increased during this period. Therefore, the underlying causes of increased obesity and overweight and hypertension in young people should be investigated and interventions to prevent it with the aim of preventing further complications in adulthood need to be implemented.

Conflict of interest

The authors declare that they have no conflict of interest.

Ethical approval

All procedures performed in this study involving human participants were in accordance with the ethical standards of Ethics committee of Ahvaz Jundishapur University of Medical Sciences and approval number was IR.AJUMS.REC.1395.762.

Informed consent

Informed consent was obtained from all individual participants included in the study.

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