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Original Article

Obesity and associated modifiable environmental factors in Iranian adolescents: Isfahan Healthy Heart Program – Heart Health Promotion from Childhood

ROYA KELISHADI,[1] MAHIN HASHEMI POUR,[2] NIZAL SARRAF-ZADEGAN,[3] GHOLAM HOSSEIN SADRY,[4] REZVAN ANSARI,[1] HASSAN ALIKHASSY[5] AND NASROLLAH BASHARDOUST[6]

Departments of [1]Preventive Pediatric Cardiology, [3]Cardiology and [5]Nutrition, Isfahan Cardiovascular Research Center, Departments of [2]Pediatric Endocrinology and [6]Statistics and Epidemiology, Isfahan University of Medical Sciences and [4]Isfahan Provincial Health Office, Isfahan, Iran

Abstract

Objective: To evaluate the prevalence of overweight and obesity among Iranian adolescents and their relationship with modifiable environmental factors.

Methods: The subjects of the present study were 1000 girls and 1000 boys, aged between 11 and 18 years selected by multistage random sampling, their parents ($n = 2000$) and their school staff ($n = 500$ subjects) in urban and rural areas of two provinces in Iran. Data concerning body mass index (BMI), nutrition and the physical activity of the subjects were analyzed by $SPSSV_{10}$/Win software.

Results: The prevalence of 85th percentile ≤ body mass index (BMI) < 95th percentile and BMI > 95th percentile in girls was significantly higher than boys (10.7 ± 1.1 and $2.9 \pm 0.1\%$ *vs* 7.4 ± 0.9 and $1.9 \pm 0.1\%$, respectively; $P < 0.05$). The mean BMI value was significantly different between urban and rural areas (25.4 ± 5.2 *vs* 23.2 ± 7.1 kg/m^2, respectively; $P < 0.05$). A BMI > 85th percentile was more prevalent in families with an average income than in high-income families (9.3 ± 1.7 *vs* $7.2 \pm 1.4\%$, respectively; $P < 0.05$) and in those with lower-educated mothers (9.2 ± 2.1 *vs* 11.5 ± 2.4 years of mothers education, respectively). The mean total energy intake was not different between overweight or obese and normal-weight subjects (1825 ± 90 *vs* 1815 ± 85 kCal, respectively; $P > 0.05$), but the percentage of energy derived from carbohydrates was significantly higher in the former group compared with the latter (69.4 *vs* 63.2%, respectively; $P < 0.05$). Regular extracurricular sports activities were significantly lower and the time spent watching television was significantly higher in overweight or obese than non-obese subjects (time spent watching telelvision: 300 ± 20 *vs* 240 ± 30 min/day, $P < 0.05$). A significant linear association was shown between the frequency of consumption of rice, bread, pasta, fast foods and fat/salty snacks and BMI ($\beta = 0.05$–0.06; $P < 0.05$). A significant correlation was shown between BMI percentiles and serum triglyceride, high-density lipoprotein–cholesterol and systolic blood pressure (Pearson's $r = 0.38$, -0.32 and 0.47, respectively).

Conclusions: Enhanced efforts to prevent and control overweight from childhood is a critical national priority, even in developing countries. To be successful, social, cultural and economic influences should be considered.

Key words adolescents, cardiovascular disease risk factors, nutrition, obesity, physical activity.

Obesity is a major risk factor for atherosclerosis, insulin resistance, diabetes, hypertension, cancer and gallbladder disease. Eighty percent of obese adolescents become obese adults. Overweight in adolescence predicts a broad range of adverse health effects that are independent of adult weight after 55 years of follow up. Although childhood and adolescence obesity is most widespread in countries with the highest economic standards, its prevalence is increasing in developing countries.[1]

Childhood and adolescent obesity is a fast-emerging problem in Iran. The World Health Organization (WHO) monitoring of cardiovascular diseases project (MONICA)

Correspondence: Assistant Professor R Kelishadi, Isfahan Cardiovascular Research Center, Isfahan University of Medical Sciences, PO Box 81465-1148, Isfahan, Iran.
Email: kelishadi@med.mui.ac.ir

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reported, in 1988, that Iran was one of seven countries having the highest prevalence of childhood obesity;[2] in addition, the trend for overweight and obesity in children and adolescents in our community has been shown to have doubled between 1993 and 1999.[3] Regarding these data and the fact that obesity is a complex disease with genetic and environmental causes, the present study was undertaken during 2001 in urban and rural areas of two provinces of Iran to identify the prevalence of overweight and obesity in 2000 students and its exogenous modifiable causes in order to implement efficient integrated community based interventions aimed at preventing and controlling overweight and obesity from early life.

Methods

Subjects

An integrated comprehensive community based program for cardiovascular disease (CVD) prevention and control, called the Isfahan Healthy Heart Program (IHHP) and which consists of eight projects with different target groups, is now being conducted in Iran by the Isfahan Cardiovascular Research Center and Isfahan Provincial Health Office on a population of 20 000. The program methodology has been described elsewhere.[4]

The present study is the first phase (present situation analysis) of one of these projects, the Heart Health Promotion from Childhood (HHPC). Two provinces with very similar socioeconomic circumstances and cultural backgrounds have been selected for this purpose: Isfahan and Arak. During the second phase of the study, different interventions will be performed in Isfahan only on the basis of the results of the first study phase, whereas Arak will remain as the reference area. After 5 years (2005), the postintervention outcomes will be evaluated and compared between the two provinces. The following data show the situation before the interventions (2001). The population studied consisted of 2000 students (1000 girls, 1000 boys) aged between 11 and 18 years, selected by multistage random sampling from 56 guidance and high schools of different urban and rural areas. Regarding the population distribution in the intervention and reference provinces, the urban/rural ratio of subjects studied was 70/30 and 60/40, respectively. In addition to the students, the behavior, attitude, skills and knowledge (BASK) of their parents (n = 2000) and school staff (n = 500) have been investigated. Field examinations were performed by a specially trained team consisting of expert nurses, who were certified after a 1 week training program and evaluation of their inter- and intra-observer variability. All instruments were standardized before the examination and zero was calibrated on the balances and sphygmomanometers.

Standardized percentile curves of body mass index (BMI) for children and adolescents were used.[5] Written informed consent was obtained from parents of pupils after a full explanation of the procedure involved had been provided (it was distributed in schools and was given to the students to be taken home). The cooperation rate in the intervention and reference provinces was 92 and 90%, respectively. Three structured questionnaires (for students, parents and school staff) were prepared and their validity was confirmed after a pilot study. The students and school staff filled out their questionnaires at school under the supervision of the trained nurse. The parents' questionnaire, a 3 day food record form and a food frequency questionnaire, were given to pupils at school to be taken home and completed forms were returned to the schools. Age and the birth date were recorded. Weight was measured to the nearest 200 g with subjects being lightly dressed and barefoot. Standing height was recorded to the nearest 0.2 cm; with feet at an angle of 45°, the back was placed squarely against a wall and the top of the external auditory meatus was level with the external angle of the eye. The BMI was calculated as weight, in kg, divided by height, in m^2.

Subjects with a BMI greater than the 95th percentile for age and sex were considered obese and those with a BMI greater than the 85th percentile but less than the 95th percentile were considered to be overweight.[1] Physical examination and venous blood sampling (after ≥ 12 h fasting) were made from 08.00 am to 09.30 am on school days. After blood sampling, a healthy snack was given to the students. Blood samples were centrifuged for 10 min at 3000 r.p.m., sera were frozen (–20°C) and were transported to Isfahan Cardiovascular Research Center laboratory, which is under the external quality control of St Rafael University, Department of Epidemiology, Leuven, Belgium. Total cholesterol (TChol), High-density lipoprotein–cholesterol (HDL-C) and triglyceride (TG) were measured with enzymatic methods using an Elan 2000 autonalyzer (Ependorf, Hamburg, Germany). Low-density lipoprotein–cholesterol (LDL-C) was calculated (in serum samples with TG ≤ 400 mg/dL) according to the Friedewald formula.[6] A mercury sphygmomanometer with a cuff size suitable for each subject was used for measuring sitting blood pressure twice from the right arm according to WHO criteria. The mean of two measurements of Korotkoff phase I and phase IV was recorded for systolic blood pressure (SBP) and diastolic blood pressure, respectively. The economic status of families was evaluated by questions based on data from the Iranian Plan and Budget Organization.

Nutritional assessment was performed by means of three 24 h food records (once per week; two school days and one weekend) and a food frequency questionnaire. However, quality control measures, including protocols for interviewing and the training of interviewers, as well as the verification of home recipes, have also been undertaken.

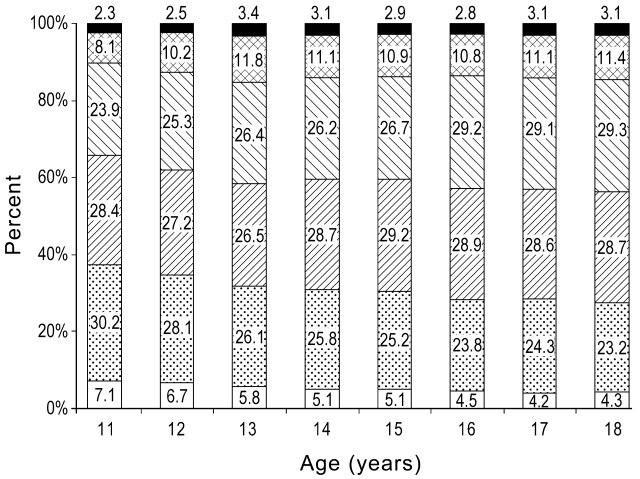

Fig. 1 Prevalence (%) of different body mass index (BMI) categories in girls ($n = 1000$) according to percentiles. (■), BMI > 95th percentile; (▩), 85th percentile < BMI < 95th percentile; (▧), 50th percentile < BMI < 85th percentile; (▨), 25th percentile < BMI < 50th percentile; (⁘), 5th percentile < BMI < 25th percentile; (□), BMI < 5th percentile.

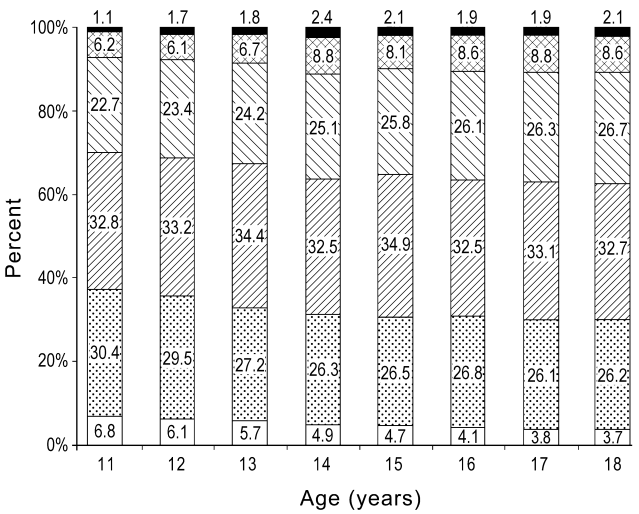

Fig. 2 Prevalence (%) of different body mass index (BMI) categories in boys ($n = 1000$) according to percentiles. (■), BMI > 95th percentile; (▩), 85th percentile < BMI < 95th percentile; (▧), 50th percentile < BMI < 85th percentile; (▨), 25th percentile < BMI < 50th percentile; (⁘), 5th percentile < BMI < 25th percentile; (□), BMI < 5th percentile.

Table 1 Subject characteristics according to body mass index

	Body mass index		95% CI	*P*
	< 85th percentile	≥ 85th percentile		
Duration of breast feeding (months)	18.1 ± 6.2	12.4 ± 6.1	5.7–6.2	0.04
Use of commercial baby food in infancy (%)	37.1 ± 10.2	45.2 ± 7.1	6.1–6.7	0.02
Years of mother's education	9.2 ± 2.1	11.5 ± 2.4	1.1–1.8	0.03
Years of father's education	12.4 ± 2.2	13.8 ± 3.1	1.2–3.5	NS

Data are the mean ± SD. 95% CI, 95% confidence interval.

Information about nutritional status was evaluated and analyzed by a specialized nutritionist using specially designed software for Iranian foods.[7]

Statistical analyses

Data were collected and stored on a computer database. Recorded information was checked for missing values and data entry errors. All missing or doubtful data were rechecked by returning the questionnaire to the respective school. After tidying up the data, statistical analyses were performed using SPSS statistical package version 10 for Windows (SPSS Inc., Chicago, USA). Yates corrected χ^2 test was used to determine differences in physical activity behaviors and the frequency of food consumption, whereas Student's *t*-test was used to compare the mean of variables. Pearson's correlation test was used to determine the relationship between different BMI percentiles and the mean serum lipid and lipoprotein levels and blood pressures. The associations between BMI (as a dependent variable) and eating and exercise behaviors were analyzed by multiple linear regression. Significance of differences was defined as $P < 0.05$.

Results

Analysis of data obtained from 1000 girls and 1000 boys aged between 11 and 18 years of age showed a higher prevalence of overweight and obesity in girls than in boys (10.7 ± 1.1 and $2.9 \pm 0.1\%$ *vs* 7.4 ± 0.9 and $1.9 \pm 0.1\%$, respectively; $P < 0.05$). The prevalence of overweight and obesity according to BMI percentiles in girls and boys are shown in Figs 1,2. The highest prevalence of BMI > 85th percentile was in 13-year-old girls and 14-year-old boys (Figs 1,2). The mean BMI value was significantly higher in urban than rural areas (25.4 ± 5.2 *vs* 23.2 ± 7.1, respectively; $P < 0.05$).

Table 2 Physical activity in subjects with body mass index lower and higher than 85th percentile

	Girls				Boys			
	BMI < 85th percentile	BMI ≥ 85th percentile	95% CI	*P*	BMI < 85th percentile	BMI ≥ 85th percentile	95% CI	*P*
Regular morning exercise in school (%)	58.4 ± 10.1	56.7 ± 11.2	54.1–60.4	NS†	58.2 ± 11.4	57.8 ± 10.8	55.2–62.1	NS†
Regular physical activity								
Extracurricular during the school year (%)	17.1 ± 2.8	14.7 ± 3.1*	14.1–16.8*	0.02†	30.1 ± 2.7*	24.8 ± 3.1*	23.2–29.1	0.03†
During the summer holidays (%)	19.2 ± 5.4*	18.7 ± 4.2*	15.6–21.2*	NS†	32.4 ± 7.8*	31.2 ± 7.1*	29.7 ± 34.1	NS†
Participation on sport teams (%)	21.8 ± 3.1	15.2 ± 2.9*	14.1–18.3*	0.04†	35.8 ± 4.2*	24.2 ± 3.8*	22.7–29.1	0.02†
Mean time watching television (min/day)	235 ± 30	305 ± 25	264.2–291.7	0.03‡	245 ± 35	295 ± 20	241.6–282.7	0.04‡

Data are the mean±SD. **P* < 0.05 between boys and girls. †Chi-squared test; ‡*t*-test.

Regular exercise was defined as exercise ≥ 3 times/week and ≥ 30 min/session.

95% CI, 95% confidence interval; BMI, body mass index.

Some environmental factors that may have influenced BMI are given in Table 1. According to the questionnaires returned by students and parents, regular morning exercise was performed at school, but there was no significant difference between girls and boys and between overweight or obese and other subjects for each sex (Table 2). There was a significant difference with regard to regular physical activity according to the year at school, as well as participation in sports teams between girls and boys and also between subjects with BMI lower or higher than the 85th percentile for each sex (Table 2). The time spent watching television was significantly greater for subjects with BMI > 85th percentile than for other subjects, but was not different between girls and boys (Table 2).

The frequency of food consumption is given in Table 3 and shows significant differences between the frequency of consumption of rice, bread, pasta, fast foods, high fat and salty snacks, and fruits and vegetables in subjects with BMI lower and higher than the 85th percentile.

A significant direct linear association was shown between BMI and the frequency of consumption of rice, bread/pasta, fat/salty snacks and fast foods; this association was inverse regarding fruits and vegetables (Table 4) and also regarding regular physical activity performed throughout the year and not only during summer holidays (Table 4).

As shown in Fig. 3, total energy intake did not differ between overweight or obese and non-obese subjects, but the percentage of energy derived from carbohydrates was significantly higher in the former group compared with the latter ($P < 0.05$).

Table 5 shows the correlation of different BMI percentiles with mean serum lipids, lipoproteins and blood pressures.

The prevalence of overweight and obesity in children of families with a moderate income was significantly higher than for children in families with a high income (9.3 ± 1.7 *vs* 7.2 ± 1.4%, respectively; $P < 0.05$).

Evaluation of BASK showed that 78.4% of parents and 90.2% of school staff had an acceptable level of knowledge concerning the consequences of childhood obesity, but this was in contrast with their practice; only 35.2% of parents and 24.7% of school staff tried to give information to obese adolescents or to change their lifestyle regarding nutrition and physical activity. Analyses of responses to the ideal children body habitus scale and the popular belief that overweight children will outgrow their body fatness revealed that mothers of overweight or obese adolescents preferred an overweight child and adolescent and agreed with the belief that these children would outgrow their obesity or overweight more often than mothers of adolescents with a normal weight (21.8 *vs* 15.2%, respectively; $P < 0.05$). This difference was not significantly different between fathers of these same groups (18.1 *vs* 17.4%, respectively; $P > 0.05$).

Table 3 Frequency of food intake (times/week) in subjects with body mass index lower and higher than 85th percentile

	Body mass index		95% CI	*P* (Chi-squared)
	< 85th percentile	≥ 85th percentile		
Red meat	3.0 ± 1.4	3.2 ± 1.7	1.4–3.1	NS
Chicken	2.1 ± 0.7	2.2 ± 0.8	1.7–2.9	NS
Fish	0.8 ± 0.1	0.9 ± 0.5	0.6–1.8	NS
Soy	0.7 ± 0.4	0.9 ± 0.3	0.6–2.1	NS
Deep fried food	3.3 ± 1.1	3.5 ± 0.9	1.2–2.7	NS
Dairy products	5.7 ± 2.3	6.0 ± 2.7	0.7–1.9	NS
Bread	10.8 ± 4.1	14.4 ± 4.8	2.1–2.7	0.02
Rice	6.8 ± 1.2	11.6 ± 2.1	1.2–1.9	0.04
Potato	3.7 ± 1.1	4.1 ± 1.8	2.1–3.8	NS
Fast foods	1.2 ± 0.3	2.7 ± 0.4	0.6–0.9	0.02
Pasta	2.1 ± 0.4	3.8 ± 0.3	0.4–0.9	0.04
Fat/salty snacks	3.8 ± 1.4	5.1 ± 1.1	0.5–0.9	0.04
Nuts	1.4 ± 0.2	1.1 ± 0.4	0.2–2.1	NS
Vegetables	5.9 ± 1.4	3.8 ± 1.2	0.5–0.8	0.03
Fruits	6.2 ± 1.8	4.2 ± 1.1	1.4–1.9	0.04

Data are the mean ± SD. 95% CI, 95% confidence interval.

Table 4 Linear associations between eating and exercise behaviors and adolescent body mass index

Variable	Body mass index	
	β	*P*
Foods (according to food frequency questionnaire; servings/week)		
Red meat	0.02	0.47
Chicken	0.01	0.51
Fish	0.01	0.42
Soy	0.02	0.48
Deep fried food	0.05	0.02
Dairy products	0.01	0.34
Bread	0.05	0.04
Rice	0.06	0.03
Potato	0.02	0.07
Pasta	0.03	0.04
Fast foods	0.05	0.02
Fat/salty snacks	0.06	0.03
Nuts	0.01	0.57
Fruits	–0.04	0.02
Vegetables	–0.05	0.04
Activity (no. sessions (≥ 30 min)/week)		
Sport only in summer holidays	–0.02	0.4
Sport throughout school year and in summer holidays	–0.05	0.04

β, correlation coefficient (multiple linear regression analysis).

Discussion

Childhood and adolescent obesity has become a global health problem and is no longer limited to industrially developed countries; the implantation of western lifestyles, especially the intake of attractive energy dense food with undesirable composition, increased consumption of animal fats and sugars and reduced consumption of dietary fiber, along with a lack of sufficient physical activity, has resulted in an increasing prevalence of obesity in many countries.[1,2,8–10] In Iran, too, this trend has been increasing in children and adolescents from 1993 to 1999,[3] as well as to the present study; however, the prevalence of BMI between the 85th and 95th percentiles and above the 95th percentile is within the normal distribution of standard BMI percentile curves.[5]

The MONICA project (WHO) has shown that over 30% of the population in the Middle East is overweight.[2] This problem is not limited to adults and overweight has become an important health problem in adolescents of this region. The assessment of BMI in Lebanese adolescent girls showed that the mean percentage of adolescent girls with severe obesity is 11%.[11] Among secondary school students in Bahrain, 15.6% of boys and 17.4% of girls were either overweight or obese according to BMI.[12] The considerable prevalence of adolescent obesity in the Middle East, including in Iran, is suggested to be the result of rapid changes in lifestyle.

The peak age of occurrence of overweight and obesity differs between countries. Observations in Bulgaria showed three peaks of obesity at 3–6, 10–12 and 15–17 years of age;[13] in Austria, these peaks occur at 7–9 and 15–19 years of age.[14] A previous study in Iran showed that the prevalence of overweight and obesity was highest in subjects at 6–9 and 10–14 years of age.[3] In the present study, the highest prevalence of overweight and obesity in adolescents was in 13-year-old girls and 14-year-old boys. The results of the National Heart, Lung and Blood Institute's Growth and Health Study (NGHS) compared with the data of the two National Health and Nutrition Examination Surveys (NHANES I and II) revealed a higher and increasing

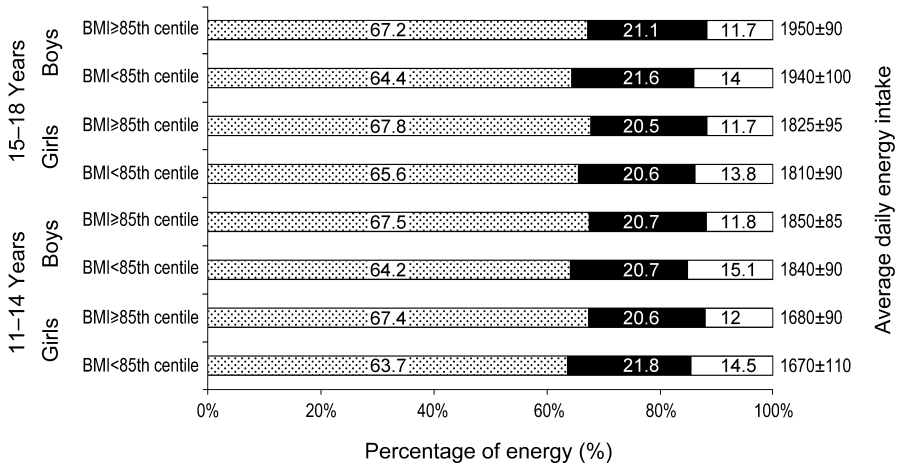

Fig. 3 Comparison of daily energy intake and the percentage of energy derived from fat (■), carbohydrates (⁘) and protein (□) in subjects with body mass index (BMI) lower or higher than the 85th percentile (based on a 3 day food record questionnaire).

Table 5 Correlation between body mass index percentiles and the mean (± SD) of serum lipids and blood pressures

	5th < BMI < 25th	25th < BMI < 50th	50th < BMI < 75th	75th ≤ BMI < 95th	BMI ≥ 95th	*r*
TChol (mg/dL)	145.4 ± 27.1	152.2 ± 28.4	169.1 ± 28.1	171.2 ± 30.4	174.1 ± 31.2	0.01
LDL-C (mg/dL)	87.4 ± 20.8	94.2 ± 21.6	96.1 ± 21.5	98.2 ± 22.3	100.1 ± 22.1	0.02
HDL-C (mg/dL)	42.4 ± 3.7	40.1 ± 4.2	37.3 ± 3.4	36.1 ± 5.2	32.1 ± 4.7	–0.32
TG (mg/dL)	120.8 ± 12.1	128.1 ± 12.1	132.1 ± 14.7	139.8 ± 17.3	146.3 ± 17.1	0.38
SBP (mmHg)	101.7 ± 8.1	104.2 ± 10.1	110.4 ± 11.2	120.2 ± 15.7	125.1 ± 17.1	0.47
DBP (mmHg)	68.2 ± 7.2	70.4 ± 8.1	71.1 ± 10.2	71.4 ± 9.8	71.5 ± 10.4	0.04

r, Pearson product–moment; TChol, total cholesterol; LDL-C, HDL-C, low- and high-density lipoprotein–cholesterol, respectively; TG, triglyceride; SBP, DBP, systolic and diastolic blood pressure, respectively.

prevalence of obesity among girls.[15] Studies performed in different countries in South America and in the Middle East have shown a higher prevalence of obesity in girls.[11,12,16–19] The findings of the present study are consistent with these studies, but not with results of studies performed in other countries in eastern and western Europe.[14,20]

Regarding differences in the prevalence of obesity between urban and rural areas, in the present study obesity was more prevalent in urban areas. This finding is in line with the work of some other groups,[21–23] but not with the results of a study performed in Australia.[24]

Some studies have shown that lower social class position is associated with a higher weight for height score in children.[25] The findings of the present study, too, showed a higher prevalence of overweight and obesity in children of moderate-income families compared with high-income families, which is suggested to be due to the higher intake of carbohydrates, especially rice and bread, among moderate-income families. The finding regarding socioeconomic level is consistent with results of studies performed in Canada,[26] USA[17] and Australia,[24] but not of studies performed in Brazil[18] and Egypt.[27]

Inadequate exposure to and opportunity for physical activity and exercise are important issues for the development of obesity, and the role of the lack of physical activity in the development of obesity has been examined in many studies.[28,29] The rate of acceptable regular exercise and physical activity is not sufficient in adolescents in Iran and evaluation of the trend for regular exercise by adolescents did not show any improvement.[29] In the present study, time spent watching television after school was significantly greater in overweight and obese subjects, a finding that is consistent with the results of many other studies,[30–32] but no significant difference was found between subjects with BMI higher and lower than 85th percentile in relation to the time spent on physical activity at morning exercise in school. Regular extracurricular physical activity during the school year and participation on sport teams was lower in girls than boys and also inversely associated with BMI. Because the range of physical activity of adolescents, especially girls, is low in our community, it is suggested that age- and culturally-appropriate use of school and or other organizational facilities for physical activity programs outside of school hours be encouraged.

In the present study, the education level of mothers with obese and overweight children was lower than that of mothers with normal-weight adolescents; some studies performed in other countries have also shown an effect of parental education level on BMI of children.[11,23,27,33]

Studies on the relationship between infant feeding practices and later obesity have provided inconsistent results.[34–36] In the present study, obese and overweight adolescents had a history of a shorter duration of breast feeding and a higher intake of commercial baby food in the first year of life than other subjects studied. According to these results, which are consistent with those of some other studies,[34,37] recommendations to families, including expectant parents, about healthy nutrition for children in order to prevent obesity should be commenced as soon as possible. Regarding the frequency of food intake, the consumption of high-fat and salty snacks and carbohydrates, particularly bread, rice and pasta, was significantly higher and the frequency of consumption of fruit and vegetables was significantly lower in overweight and obese subjects, which suggests the need to promote healthy dietary patterns, including the consumption of least five servings of fruit and vegetables per day and the provision of healthy snacks.

Overweight and obese adolescents derived a greater proportion of their energy from carbohydrates, although total daily energy intake was not significantly different from that of other adolescents. The latter finding is consistent with that of another study.[38] From these observations, diet composition seems to have greater importance than excessive energy intake with regard to excess weight and families should be encouraged to provide healthy affordable foods.

Analysing the BASK of parents and school staff showed that mothers of overweight and obese adolescents believed that their children would outgrow their body fatness and would have normal weight and be even healthier later in life, and that although school staff had enough knowledge about the possible long-term consequences of childhood obesity, they did not try to educate children or parents about the associated health risks. Emphasis should be placed on families and school staff to better support a healthy lifestyle of children and adolescents.

Many studies performed in children and adolescents have shown a correlation between obesity and other CVD risk factors.[39,40] The present study showed a significant correlation between BMI percentiles and elevated TG levels, low HDL-C concentrations and higher mean SBP, but TChol and LDL-C were weak correlates of overweight and obesity, a finding that is in line with the work of other groups.[39,40]

In general, it can be suggested that the environment can have a decisive positive or negative impact on obesity in early life by introducing and reinforcing good or poor food and physical activity habits. Furthermore, promoting a healthy lifestyle from early life is a national priority, even in developing countries. To be successful, such actions should consider social, cultural and economic influences in order to provide life-long healthy habits from childhood.

On the basis of the findings of this phase of our study, the second phase is now underway in Isfahan in order to improve food and physical activity habits for preschool- and school children and to enhance the practices of parents and school staff in addition to their knowledge. The other province, Arak, remains as the reference area; outcome evaluation by comparison of the two provinces will demonstrate the efficacy of the interventions.

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