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Original article

Investigating the association between underlying factors, eating habits, and obesity in girls aged 9-11: a case control study

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Summary. *Aims:* Over the past few years, the prevalence of childhood obesity has been increasing. This study aimed to assess the factors leading to obesity in female children in Iran. *Methods:* This is a case-control study of 9-11 year old school girls conducted in 2013 using stratified random sampling. The participants had not experienced menstruation and had not received any multivitamin or supplements at the time of the study. Seventy five students, with a Body Mass Index (BMI) ≥95th percentile, were considered as obese while another group of 75 students, with BMI percentiles 15≤BMI≤85, were selected as control group. The data on underlying factors were collected through interviews while the data associated with eating habits, including dietary intake, were gathered using 24-hour dietary recall questionnaire. *Results:* Daily caloric intakes observed in the obese and normal children were 1881±755 and 1609±529 kcal, respectively (p=0.01). Daily caloric intake was significantly correlated to weight (p=0.03) and BMI (p=0.01). History of obesity among first-degree relatives (p<0.001) and TV watching habits (p<0.001) showed significantly higher levels in obese children than the levels found in the control group. Using t-Test analysis, a statistically significant association was found between BMI in the obese adolescents and intake of vitamin B1 (p=0.02), B2 (p=0.011), and B6 (p=0.05). *Conclusions:* Our findings suggest that food intake pattern and sedentary behaviours in obese girls are major risk factors leading to metabolic disorders in the future.

Key words: young female students, obesity, childhood obesity, underlying factors, eating habits

Introduction

Obesity is a major health problem in all age groups including children, and its prevalence continues to increase sharply in developed and developing countries (1-2). According to a survey carried out by Hyattsville at National Centre for Health Statistics, almost one-third of American children and adolescents aged 2-19 years are suffering from overweight and/or obesity (3). Systematic studies conducted over the past decades showed that obesity has escalated to epidemic proportions among children and adolescents (4). A nationwide study conducted in 23 provinces of Iran from 2003 to 2004 among 21,111 children aged 6-18 years showed the prevalence of overweight and obesity, as assessed according to international standards, were 8.82% and 4.5%, respectively (5).

Studies have shown that childhood obesity is a strong predictor of adulthood obesity, and it has been found that obese children are 2-3 times more likely to become obese during adulthood compared to none obese children (6). Obesity also increases the risk of

cardiovascular diseases, diabetes, hyperlipidaemia, hypertension, orthopaedic problems, deleterious effects on maturity process, respiratory problems, and depression (7-9). Many factors have been found to contribute to childhood obesity including genetic, and /or behavioural and environmental factors such as physical inactivity, watching TV or playing video games, poor eating habits, and etc. (10-11). Several studies have investigated the importance of adequate vitamins and minerals like iron, calcium, and phosphorus on the health and function of the different organs of the body. The main function of vitamins and minerals and their possible impact on obesity during childhood has been the subject of many recent studies (12-14). The present study was designed to examine factors leading to female childhood obesity in order to provide evidences for practitioners and health policymakers to intervene overweight and promote health in pre puberty girls.

Methods

This study used a case-control design to investigate eating habits and other lifestyle-related behaviours of young female students attending selected schools during 22nd November to 22nd December in 2013 A group of students was selected through stratified random sampling. Of the elementary girl schools in Kermanshah city, five schools were chosen, and a random list of obese and normal students was prepared for each school (Body Mass Index (BMI) greater than or equal to 95th percentile on the 2007 World Health Organization diagram and BMI percentiles 15≤BMI≤85 were considered obese and normal weight, respectively). All the participants met the inclusion criteria being a female student aged 9-11 years, had not yet had their first menstruation (because dietary pattern may change during menstrual period), and had not taken any dietary supplements containing vitamins and drugs. Social and economic conditions were taken into consideration in selecting the participants. Seventy five obese students as case group and 75 students with normal weight were randomly selected as control group and since the data gathering conducted in their school, they all participated in the study. All student were in the same grade and school. Prior to data collections, the participants' mothers were asked for their informed consents. Data on underlying factors such as height, weight, body mass index, age, parental job and education, history of obesity among immediate and extended family, excessive television (TV) watching and playing video game (totally more than 2 hours a day), collected using general questionnaires while data on dietary habits were gathered using a 24-hour dietary recall questionnaire completed by a dietician (15). Assuming that foods eaten by children of this age are usually prepared at home or at least the mother has paid for it. Mothers were invited to participate through either oral or written consent. These mothers were asked, in the presence of the children, to recall their children's past diets within the last 24-hours; trying to minimize the recall bias by asking from children. At the end of the interview, they were awarded a booklet of childhood nutrition tips. The records of dietary intakes for the students were coded into a computer program, and daily intakes of micronutrients, including vitamins and minerals, were calculated using Dorosty Food Processor for Windows (DFPW-2.1) (16). Statistical methods, including independent sample t-test, logistic regression, and Pearson correlation test, were used to develop the classification criteria and the data were analysed using SPSS (version19) and DFPW-2.1. Ethical approval was granted by the ethical committee of the university. This manuscript has been checked with STROBE statement and the checklist is submitted as a separate file.

Results

In this case control study, the association between obesity and dietary micronutrient intake was investigated. The participants were 150 pre-pubertal elementary school girls aged 9-11 years in the city of [removed for blind peer review] in the 2013-2014 academic years (The response rate was 100% because of free medical visit and an incentive). Weight was measured by a digital scale with 0.1 Kg sensitivity and height by centimetre. Fathers of the participants were unemployed, workers, employees, or self-employed. The highest rate of obesity was observed in children with self-employed fathers (46.6%), while 53.4% of

Table 1. The demographic characteristics of the children

Variables	Obese (n=75) (Mean±SD)	Normal (n=75) (Mean±SD)	P. value
Age (years)	9.73±0.81	9.67±0.73	0.404
Weight (Kg)	50.95±7.47	34.16±5.85	<0.001
Height (cm)	143.25±7.65	139.12±9.28	0.004
BMI	24.71±2.04	17.52±1.33	<0.001

children with normal weight had fathers who were employed by organizations. The difference between the case and control group in terms of employment status was not significant. Our findings also revealed that nearly 80% of the mothers of obese children and 65.3% of the mothers of normal children were housewives, with no statistical difference found between the two groups. Although the percentage of fathers with a degree higher than a high school diploma (40.5% for obese and 49.3% for normal group) and the percentage of mothers with a high school diploma (29.6% in obese and 43.2% in normal group) were higher in the normal group, this difference was not significant. Table 1 compares the mean age, weight, height, and BMI values for the two groups. As seen in this table, a significant difference was found between the children in the case and those in the control group in terms of weight, height, and BMI.

Table 2 presents a comparison of the underlying factors and dietary habits between the two groups. As shown in this table, history of obesity among first-degree relatives, and excessive watching of TV or playing computer games are at significantly higher levels for obese children compared to the children in the control group. The daily caloric intakes observed in obese and normal children were about 1881±755 kcal and 1609±529 kcal, respectively, showing a significant difference (p=0.01) between the two groups.

In the second phase of the study, the findings of the 24-hour dietary recall questionnaire were analysed using DFP. The results are summarised in Table 3. The results found through Pearson product correlation showed that for the 75 obese children whose macronutrient intake was studied here. Results of DFP analysis also suggested that the only significant difference between the two groups was observed between BMI and protein intake (p=0.05) which was negative.

The amount of calories, zinc and total fat daily intake was significantly higher in obese children (p <0.01). Similarly it happened about the levels of vitamin B3 and B6 intake in both case and control groups (p <0.001 and p <0.02 respectively) (table 4).

As illustrated in Table 4 there was no significant difference between minerals intake in obese children and normal weight group.

Table 3. Comparison between nutrients and minerals intake in two study groups, based on a 24-hour dietary recall

Variables	B	p-value	exponential (B)	Confidence Interval 95%	
				Lower	Upper
Calorie	.000	.551	1.000	.999	1.002
Protein	-.034	.049	.780	.759	.975
Fat total	-.010	.250	.990	.972	1.007
Zinc	.000	1.000	1.000	.874	1.144
Constant	.911	.092	2.488		

Table 2. Underlying factors and dietary habits of case and control groups

Variables	B	p-value	exponential (B)	Confidence Interval 95%	
				Lower	Upper
History of obesity among first-degree relatives	1.393	<0.001	.248	.116	.533
Snack consumption≥ 3times a day	.572	.084	.565	.295	1.080
Daily consumption of dairy products	-.309	.332	.735	.394	1.369
Daily consumption of fruit & vegetables	-.213	.271	.808	.554	1.181
Watching TV or playing computer games≥ 2hours a day	1.078	<0.001	2.939	1.746	4.947
Constant	.862	.294	2.367		

Table 4. Comparison of the average dietary intake in two study groups of children (case and control groups)

Variables	Normal (N=75)	Obese (N=75)	*P. value
Celeries Intake (mean±SD)	1609±529	1881±755	0.01
Nutrient Intake (mean±SD)			
Protein	64.2±25	79.8±45	0.01
Carbohydrate	205±70	223±75	N. S
Fiber	14±5	15±6	N. S
Total Lipid	63±32	80±50	0.01
Fe (mg)	11.23±8	13.03±10	NS
I (µg)	16.0±0.1	15.4±1.2	NS
Cu (mg)	1.56±1.1	2.16±0.3	NS
Na (mg)	2.20±0.35	2.15±0.21	NS
Ca(mg)	933.2±48.1	854.9±56.6	NS
P (mg)	1265±58.1	1360.7±72.3	NS
Cl (gr)	3.04±0.52	3.08±0.31	NS
K (gr)	2.75±0.13	2.82±0.17	NS
Mg (mg)	1.94±0.1	2.21±1.1	NS
Mn (mg)	2.7±1.7	2.84±1.9	NS
Sn (mg)	0.50±0.27	0.58±0.38	NS
Zn (mg)	8.60±4.2	10.75±6.1	0.01
Vitamin (mg/day) (mean±SD)			
B3	9.82±5.5	15.51±11	0.001
B6	1.08±0.38	1.27±0.61	0.02

A statistically significant association was also found between body mass index in obese adolescents and the vitamins B1 (p=0.02), B2 (p=0.011), B6 (p=0.05), and pantothenic acid (p=0.014). Among the vitamins studied in children with normal weight, only vitamin B1 had a significant positive correlation with body mass index (r=0.26, p=0.02).

Discussion

The association between underling factors (*i.e.* age, number of family members, father's education, father's occupation, mother's education, mother's occupation, history of obesity in immediate and extended family, and television watching habits), and dietary habits, overweight, and obesity were examined. Our findings showed a history of obesity in first degree relatives of obese students, confirming the findings of Bayeghi et al. in a study conducted on 1471 students aged 6-12 years (16). Our results also indicate that a larger proportion of the children in the control group, compared to the obese children, eat breakfast. Missing breakfast has been found to have a negative impact on cognitive function and increased appetite at subsequent meals. In a recent study conducted on over 6 thousand children aged 10-12 years in 8 European countries, a negative correlation between frequency of breakfast consumption and body mass index has been reported (17). The results of the food frequency questionnaire used in that study showed that the rate of soda and industrial juice consumption is higher in obese children. Another study showed that excessive consumption of such beverages can increase the risk of obesity, diabetes, metabolic syndrome, and cardiovascular disease both in adults and in children (18). Several other studies have demonstrated that regular consumption of fruit and vegetables are important factors in the prevention of overweight and obesity (19-20). The results of this survey also confirmed that fruit and vegetable consumption in obese children were lower than in children with normal weight. In the present study, it was observed that obese children spend a greater amount of time watching TV and/or playing video games, and physical inactivity is known to increase the risk of obesity and overweight. One of the factors known to reduce physical activity, particularly among children, is the length of time spend on watching TV and playing computer games (21). In a study conducted on 300 students by Dorosti et al., a significant positive correlation was found between the lengths of time spent on watching TV and other sedentary pursuits (*e.g.* playing computer games and using other electronic devices) and BMI of obese students which is consistent with our results (22). Analysis of the data obtained from the 24-hour dietary recall showed that the total caloric and macronutrients (protein and fat) intake in obese children were significantly higher than in the normal weight children. This is consistent with the fact that

the amount of food intake in obese children is much higher than in normal children. In other words, the obese children studied here were found to have binge eating habits compared with the normal weight children. This is referred to as portion size in scientific literature (21). It should be noted that since the body has no mechanism to store protein, consumption of excess protein can lead to its conversion into fat, potentially contributing to weight gain and obesity (23).

Meat is a good source of zinc and the difference in zinc intake between the two groups was not unexpected given that protein intake in obese children was higher than in normal ones. We also found a positive correlation between body mass index and intake of such minerals as iron, iodine, calcium, phosphorus, potassium, magnesium, and zinc. This can be explained based on the fact that obese children consume more foods containing these nutrients.

In this study, body mass index in obese girls was found to be significantly associated with vitamins B3 and B6 intake. It has recently been shown that a high intake of vitamins, especially B-group vitamins, can be a risk factor for obesity (19). The underlying mechanism involved is that vitamins may activate obesity through multiple paths including increasing fat synthesis, causing insulin resistance, and disrupting neurotransmitter metabolism (23).

Inadequate accuracy of recording nutrition frequency in children was one of the limitations of the present study. To mitigate the effects of this limitation, we asked a dietician, who was well acquainted with the principles of paediatric psychology, to fill out the questionnaire. Another limitation of this study was persuading mothers to cooperate and to provide as accurate answers as possible to the questions they were asked. Furthermore, as another limitation, it should be noted that the authors of this paper acknowledge that the sample used in this study was a biased sample which may not represent the whole population, as the sample was taken from a number of selected schools.

In general, the findings of this study suggest that food intake pattern and sedentary behaviours in obese girls are major risk factors, and that undesirable eating behaviours in children may lead to metabolic disorders in future. In addition to these underlying factors, the relationship between the overall set of micronutrients, including vitamins and minerals, and weights of children was also investigated. For a more detailed analysis and review, further studies should be carried out to, for example, investigate the association between serum markers of these minerals and weight, or to closely study the mechanism linking the intake and metabolism of micronutrients to obesity and overweight.

Conclusion

Based on this study, the most accompanying factors for obesity were history of it among first-degree relatives, and excessive watching of TV or playing computer games. Results also suggested that there is negative significant difference between the two groups in terms of protein intake.

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