Short Communication

Parental body mass index is associated with adolescent overweight and obesity in Mashhad, Iran

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Objective: This cross-sectional study was carried out to determine the prevalence of overweight and obesity among secondary school children aged 12 to 14 years in the city of Mashhad, Iran and its association with parental body mass index. Methods: A total of 1189 secondary school children (579 males and 610 females) aged 12-14 years old were selected through a stratified multistage random sampling. All adolescents were measured for weight and height. Household socio-demographic information and parental weight and height were self-reported by parents. Adolescents were classified as overweight or obese based on BMI-for age Z-score. Multivariable logistic Regression (MLR) determined the relationship between parental BMI and adolescent overweight and obesity. Results: The overall prevalence of overweight and obesity among secondary school children in Mashhad was 17.2% and 11.9%, respectively. A higher proportion of male (30.7%) than female (27.4%) children were overweight or obese. BMI of the children was significantly related to parental BMI (p<0.001), gender (p= 0.02), birth order (p<0.01), parents' education level (p<0.001), father's employment status (p<0.001), and family income (p<0.001). MLR showed that the father's BMI was significantly associated with male BMI (OR: 2.02) and female BMI (OR: 1.59), whereas the mother's BMI was significantly associated with female BMI only (OR: 0.514). Conclusion: The high prevalence of overweight/obesity among the research population compared with previous studies in Iran could be related to the changing lifestyle of the population. The strong relationship with parental BMI was probably related to a combination of genetic and lifestyle factors. Strategies to address childhood obesity should consider the interaction of these factors.

Key Words: obesity, overweight, adolescents, body mass index, parental BMI

INTRODUCTION

Obesity in childhood causes a wide range of serious complications, and increases the risk of premature illness and death later in life, raising public-health concerns,[1] and its prevalence is increasing in both developed and developing nations.[2] In USA, the prevalence of overweight/obesity has doubled and tripled among preschool and primary school children, respectively.[3] In addition, the prevalence has increased 2-2.8-fold in England,[4] 2-fold in Sweden,[5] and 2.5-fold in Finland[6] during the past two decades. In the developing world, the highest prevalence of childhood overweight was found in Eastern Europe and the Middle East.[7] Several countries such as Thailand,[8] Japan,[9] China,[10] Iran,[11] and Russia[12] have experienced high prevalence of adolescents' overweight and obesity. In the Middle East, a high prevalence of overweight/obesity was found among adolescents in Kuwait[13] and Quatar.[14] In Iran, the prevalence of obesity among junior high school students in a district of Tehran was 10%,[15] while the prevalence was 7.1% among secondary students in Tehran.[16] Prevalence of overweight and obesity in high school girls was 11.1% and 3.6%, respectively in the city of Tabriz,[19] and it was 11.3% and 2.9%, respectively, in 13-18-year-old adolescents in the city of Shiraz, Central Iran.[18]

Obesity is multi-factorial disorder, with key genetic and environmental drivers. But it is not clear how much of childhood overweight/obesity can be attributed to genetic susceptibility and how much to environmental factors.[19] Genome-wide association studies have identified more than 50 loci associated with body mass index.[20] The re-

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cent rise in obesity appears to be related to gene-environment interactions.[21] The obesity gene map shows 244 genes that influence body weight when expressed through transgenes in the mouse.[22] An evidence-based research project showed an association between DNA methylation at IGF2 and H19 genes and parental obesity.[23] The study of Reed et al[24] in mice revealed that more than 6000 genes could influence body weight.[25]

In the last decade, a number of studies showed associations between parental BMI and offspring's birth weight.[26] The impact of parental BMI on the severity of obesity in children is strengthened as the child grows into adolescence.[27] Parental weight status has been shown to be an important predictor for the development of obesity in children and adolescents.[28] Having an obese parent is a principal determinant for becoming overweight/obese during childhood and adolescence.[29] Maternal adiposity is one of the strongest predictors of childhood adiposity.[30] Having an obese mother doubles the risk of obesity in 2- to 4-year old children, whereas, the risk is increased 10-fold when both parents are obese.[31] The relationship between mothers' and children's BMI is not consistent. Evidence based research showed that mothers' BMI was related to daughter's BMI as well as son's BMI,[32] While in the study of Whitaker examining the correlation between children's body fat percentage and parent's BMI, there was a significant relationship only between mothers and daughters.[33] On the other hand, an association between father's and children's weight status was reported.[34] The aim of this study was to determine the prevalence of overweight and obesity among secondary school children aged 12 to 14 in Mashhad city, Iran. The present study also examined the association between parental BMI with adolescent overweight and obesity.

MATERIALS AND METHODS

Subjects

This cross-sectional study was conducted in Mashhad city, the capital of Khorasan Razavi province, located in north-east of Iran. In total, 1189 students (579 males and 610 females) aged 12-14 were assessed during the 2010-2011 school year. Using a stratified multistage random sampling method, 10 schools were selected in seven Departments of Education and Training in Mashhad city. The number of students selected in strata (Northern/Southern) was based on the total population and sex ratio of strata. In the schools, children were selected randomly.

Measurement

Anthropometric

Body weight was measured to the nearest 0.1 kg using Healthometer (Seca Corporation) professional floor scale. Children were required to remove their coats, shoes and to empty their pockets before measurement. Height was measured and recorded to the nearest 0.5 cm using a flexible non-stretchable tape (range 0-1.5 m × 0.1 cm; CMS Weighing Equipment Ltd) fixed to a flat vertical wall. Children were required to take off their shoes and any head garments before measurement. Body mass index (BMI) was calculated as BMI= Body Weight (kg)/Height (m^2) and then, categorized according to the World Health Organization cut-off points[35] using WHO AnthroPlus software. Based on the criteria, overweight and obesity in adolescents are defined as Overweight: >1 Standard Deviation (SD), and Obese: >2SD.

Parents' weight and height measurement were self-reported and classified according to the new revised WHO classification for BMI cut-off pints.[36] Several studies have reported using self-reported anthropometry measurement for parental weight and height data to assess parental overweight and obesity.[34,37]

Dietary intake

Diet was assessed with a single 24-hour dietary recall. Because of the large sample size, only a single 24-hour recall was collected. The 24-hour dietary recall was assisted by a food record. Data from the 24-hour recall and the food record were analyzed with a computerized food analyzer (Diet Plan 6.60).

Socio-demographic

Socio-demographic background of the children including age, sex, and birth order were determined through a face-to face interview. The education and occupation of their parents, family size, and family monthly income were obtained through parents' self administered questionnaire.

Data analysis

Statistical analyses were performed using the Statistical Package for Social Sciences (SPSS 18) for windows. All variables were tested for normality by Kolmogorov-Smirnov. The level of significance for all statistics was set at $p<0.05$ and all analyses were two-tailed. Descriptive statistics was used to summarize continuous variables using mean, standard deviations and frequencies. Chi square test was used to indicate differences in the prevalence of overweight/obesity between males and females, and to indicate the impact of separately overweight/obesity of father, mother, both, or non- of them on adolescent's overweight/obesity. Relationship between several factors and adolescents' BMI was tested using Crude odds ratio (OR). Then Multiple regression (adjusted OR) was used to focus on the relationship between parents' BMI and adolescents' BMI. Multiple regression (adjusted for socio-demographic factors; age, sex, birth order, family member, parents' age, parents' education, parents' employment status, and parents' BMI) was used to show variables were strongly associated with adolescents' overweight/obesity. 95% confidence intervals (CIs) were calculated for adjusted OR.

RESULTS

The overall prevalence of overweight and obesity among secondary school children in Mashhad city was 17.2% and 11.9%, respectively. The comparison of overweight/obesity among male and female subjects, showed that a higher proportion of male (30.7%) than female (27.4%) adolescents were overweight/obese (Figure 1). The mean BMI of male and female adolescents was 20.0±4.24 and 19.9±4.08 kg/m^2, respectively (Table 1). Chi square test revealed that the prevalence of overweight/obesity of samples was 21.3% for neither parent, 28.4% for father only, 24.8% for mother only, and 43.3% when both parents were overweight/obese.

There was a statistically significant relationship between father's educational attainment (<high school, high school, diploma, >diploma, p<0.001), father's employment status (government employment, private employee, employer, worker/farmer, retired, and jobless, p=0.007) and mother's educational attainment (<high school, high school, diploma, >diploma, p<0.001) with BMI. But, no relationship with the mother's employment status (government employment, private employee, employer, worker/farmer, housewife, and retired, p=0.4) was found. The relationship between family monthly income levels (low, middle, and high income) with BMI was statistically significant (p=0.001).

Crude OR showed that, the risk of overweight/obesity among adolescents decreased with mother's education (OR 0.378, 95% CI 0.248-0.577, p<0.001), family size (OR 0.811, 95% CI 0.674-0.976, p=0.02), father's BMI (OR 0.470, 95% CI 0.320-0.690, p<0.001), and mother's BMI (OR 0.492, 95% CI 0.329-0.736, p=0.001). While other factors such as father's education, parent's age, parent's employment, family monthly income, birth order, and dietary energy intake did not show significant relationships with the risk of overweight/obesity. Crude OR model 1 (including only overweight/obese fathers) showed a statistically significant association with males' and females' BMI and higher risk in males than females (OR: 2.02 vs. 1.59). OR model 2 (including only overweight/obese mothers) showed a statistically significant association only with females' BMI and lower risk in females than males (OR: 0.514 vs. 0.970). OR model 3 (including both overweight/obese fathers and mothers) showed no statistically significant association with adolescents' overweight/obesity. Parents' BMI increased the risk of overweight/obesity in males, and decreased the risk in females (OR: 1.87 vs. 0.767) (Table 2).

Multiple regression (adjusted OR) of parents' BMI with adolescents' BMI, while controlling for the factors which were significant in crude OR (age and height of

Table 1. Study sample characteristics

Characteristics	Male (n=579)	Female (n=610)	Total (n=1189)	p value
Father's Body Mass Index (kg/m^2) n (%)				
<18.5	16 (3.2)	21 (4.3)	37 (3.7)	
18.5-24.9	242 (48.0)	227 (46.7)	469 (47.4)	
25.0-29.9	206 (40.9)	187 (38.5)	393 (39.7)	
≥30.0	40 (7.9)	51 (10.5)	91 (9.2)	0.38
Mother's Body Mass Index (kg/m^2) n (%)				
<18.5	14 (2.8)	13 (2.6)	27 (2.7)	
18.5-24.9	213 (42)	201 (40.2)	414 (41.1)	
25.0-29.9	184 (36.3)	180 (36)	364 (36.1)	
≥30.0	96 (18.9)	106 (21.2)	202 (20.1)	0.83
Adolescents				
Age	13.4±0.92	12.8±1.07	13.1±1.03	0.1
Birth order($\bar{x}$ ±SD) *	2.04±1.14	2.04±1.09	2.06±1.1	0.05
Weight (kg) ($\bar{x}$ ±SD) *	50.7±14.0	47.4±12.1	49±13.2	0.001
Height (cm) ($\bar{x}$ ±SD) *	158±9.50	154±7.30	156±8.72	0.001
Total energy intake (kcal) ($\bar{x}$ ±SD) *	2470±873	2268±611	2350±741	0.001
Energy per body weight (kcal/kg) ($\bar{x}$ ±SD) *	49.3±22.4	51.5±17.7	50.6±19.7	0.001
Body mass index (kg/m^2) n (%) **				
≤-2SD	120 (20.7)	121 (19.8)	241 (20.3)	
-2SD-1SD	282 (48.7)	322 (52.8)	604 (50.8)	
1SD-2SD	94 (16.2)	112 (18.4)	206 (17.3)	
≥2SD	83 (14.4)	55 (9)	138 (11.6)	0.02

Significant at p<0.05.
** World Health Organization BMI-Z score cut points (WHO, 2007).

Table 2. Adjusted odd ratios* of parental BMI with overweight and obesity in adolescents

Factor	Male	Female	Total	p value
	OR (95% CI)	OR (95% CI)	OR (95% CI)	
Father's BMI				
Overweight/obese	2.02 (1.24-3.28)	1.59 (1.04-2.45)	1.80 (1.04-2.48)	0.001
Non-overweight/obese	1			
Mother's BMI				
Overweight/obese	0.970 (0.562-1.46)	1.59 (1.04-2.45)	0.67 (0.488-0.930)	0.01
Non-overweight/obese	1			
Parental BMI status				
Non-overweight/obese	1			
Father overweight/obese	2.41 (1.23-4.69)	2.01 (1.16-3.49)	2.17 (1.42-3.32)	
Mother overweight/obese	1.13 (0.54-2.39)	0.71 (0.37-1.35)	0.860 (0.530-1.39)	
Both overweight/obese	1.87 (0.904-3.85)	0.767 (0.38-1.53)	1.20 (0.737-1.96)	<0.001

* Model controlling for factors that were significant in crude OR (except parental BMI)

adolescent, family income, and father employment) showed that, father's BMI had more impact on adolescent's BMI (OR: 1.80, 95% CI 1.04-2.48), compared with mother's BMI (OR: 0.674, 95% CI 0.488-0.930), and combined father's and mother's BMI (OR: 1.20, 95% CI 0.737-1.96) (Table 2).

DISCUSSION

The current study and other recent studies[16,38] confirms that childhood obesity is a growing national concern and has become a major public health challenge in urban areas of Iran. The trend for obesity in Iranian children has doubled during the period between 1993 and 1999.[39] The national survey entitled ''Childhood and Adolescence Surveillance and Prevention of Adult Non-Communicable Disease'' (CASPIAN), which was performed among 21,111 school students aged 6-18 years living in urban and rural areas of 23 (out of 28) provinces in Iran in 2003-2004 showed the prevalence of overweight and obesity was 11.3 percent, and 2.9 percent, respectively, according to IOTF criteria.[40] The highest prevalence were observed in Rasht (18.8 percent overweight and 7.4 percent obesity) and Qom (18.4 percent overweight and 7.3 percent obesity).[41]

Our findings demonstrated that almost 1 in every 3 of secondary school children was either overweight or obese, with a higher proportion of males (30.7%) than females (27.4%). Iranian lifestyles have been affected by the rapid urbanization and modernization processes that have taken place over several decades.[42] These rapid changes have resulted in a significant decrease in physical activity and changes in food consumption patterns.[42] Besides, the nutrition transition in Iran is taking place in the context of rapid demographic change, urbanization and social development.[42]

The study showed that father's BMI, and mother's BMI separately were associated with adolescent's BMI. The higher BMI in the father increased the risk of overweight/obesity among male and female. While, higher BMI in the mother decreases the risk of overweight/obesity among females. Power et al[43] showed an important biological role of fathers in obesity of their offspring. Our result is similar to Ohlund et al[44] which found a stronger association between a child's BMI and paternal BMI compared with maternal BMI. As Vogels et al[45] explained, dieting, fruit and vegetable consumption is more common in young women than young men. Another possible reason for the association between father's and child's BMI is that the mean BMI was higher in fathers than mothers. Besides, some alleles of obesity are inherited only from father.[44] On the other hand, higher BMI in both father and mother is not significant with adolescent's BMI, a finding that is the opposite of Magarey et al.[46] They reported the relative risk of overweight increased if one parent was overweight and increased further if both parents were overweight.[46] In the present research, most impacts on adolescent's overweight/obesity occurs, when only father is overweight/obese. The extent of obese fathers compared with obese mothers is not definitely clear, particularly the role of non-genetic factors. Ng et al[47] showed that paternal high-fat-diet exposure programs beta-cell "dysfunction" in rat F_1 female offspring.

Perez Pastor et al[48] showed that the effect of mother's BMI was independent of the effect of the father's BMI and vice versa. They also suggested a gender assortative relationship between parental BMI and weight gain in their children. Overweight parents are considered as risk factors for childhood obesity.[1,37,55] The association between overweight children and parental overweight reflects both genetic and environmental influences.[49] Families can be characterized as obesigenic based on obesity-promoting dietary and activity patterns, and parental weight status may moderate children's responses to the environmental contexts of eating.[50] Children with a genetic predisposition for overweight may have additional risk factors for overweight, including a heightened responsiveness to food cues.[51] The relative importance of genetic influences and environmental influences are still not clearly defined.[52]

In present study, overweight and obese children belonged more frequently to families with well educated and affluent parents. The finding is similar to studies carried out in Germany,[51] South Africa,[52] and Guilan province in Iran.[53] Findings revealed that the family monthly income was significantly associated with adolescents' BMI (p value= 0.001). The number of overweight/obese adolescents among those with a high family income was almost double compared with those with a low family income (22.4% vs. 12.8%). The finding confirms previous studies.[54,55] The causal linkages that explain our findings according to the associations between BMI, and parental characteristics may be complex. On the other hand, parental factors such as the levels of education, monthly income, and employment status may also reflect their ability to supply a lot of food and drinks; especially those that are energy-dense.

Limitations

Some limitations need to be considered in the interpretation of our findings. The first limitation is its cross-sectional nature. Thus, the association between parental BMI and the adolescents overweight and obesity remains to be confirmed in prospective studies. Other limitations are the self-reported heights and weights of the parents, which may have resulted in some inaccuracies. Also, considering the cultural aspect of study population, we could not include the ascertainment of puberty among the subjects, as this may affect the prevalence rate of overweight and obesity.

Conclusion

In Iran, few data are available on the prevalence of overweight and obesity among children and adolescents, thus there is a need to confirm the findings through up-to date studies. Childhood/adolescent overweight and obesity seem to be increasing at an alarming rate in Iran. Rapid progress of nutrition transition, urbanization, and demographic trends is associated with unhealthy diets, like imbalance in food consumption, and overconsumption of low nutrient, high energy density diets. Our data showed high prevalence of childhood overweight and obesity among secondary school children in Mashhad, northeast of Iran, and its association with father's BMI and mother's BMI. The association reflects both, genetic and envi-

ronment effects. Although, parental BMI was associated with adolescent overweight/obesity, but fathers' BMI was a more powerful predictor in comparison to mother's BMI. The present study highlights the importance of childhood overweight and obesity as a public health problem in this population in Iran, and indicates that it is necessary to adopt preventive strategies. Specifically, health professionals and policy-makers should focus on primary prevention of childhood obesity via children and their parents.

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ETHICAL CONSIDERATIONS

The study protocol was approved by the medical research ethics committee (Faculty of Medicine and Health Sciences, UPM). Written informed consent was obtained from the parents on behalf of the children involved.

AUTHOR DISCLOSURES

The authors declare that they have no conflict of interests.

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Short Communication

Parental body mass index is associated with adolescent overweight and obesity in Mashhad, Iran

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伊朗马什哈德市父母身高体重指数与青少年超重和肥胖相关

目的：本横横断面研究调查了伊朗马什哈德市年龄在 12-14 岁的中学生超重和肥胖情况，并分析与其父母身高体重指数的相关性。方法：采用分层多级随机抽样 1189 名年龄在 12-14 岁的中学生(599 名男性，610 名女性)作为调查对象。所有青少年均测量身高体重。父母提供家庭社会相关信息及自己的身高体重。青少年们的超重和肥胖是根据年龄相关 BMI 的 Z-Score 区分的，采用多变量 logistic 回归法(MLR)分析父母 BMI 与孩子超重或肥胖的关系。结果：在马什哈德市中学生中，总的超重或肥胖率分别为 17.2%和 11.9%。其中男孩的超重或肥胖率(30.7%)高于女孩(27.4%)。孩子的 BMI 与父母 BMI (p<0.001)、性别(p=0.02)、出生时体重(p<0.01)、父母受教育程度(p<0.01)、父亲的职业地位(p<0.001)、以及家庭收入(p<0.001)都呈显著相关。MLR 分析还提示父亲的 BMI 与男孩 BMI (OR：2.02)及女孩 BMI (OR：1.59)具有显著相关性，而母亲的 BMI 则只与女孩 BMI (OR：0.514)相关。结论：与之前的对伊朗人群的研究相比，本研究结果显示超重/肥胖率有所升高，提示人们生活方式的改变。与父母 BMI 的显著相关性可能是由于遗传和生活方式的共同作用结果。在制定控制儿童肥胖计划时，应当将这些因素的相互作用考虑进去。

关键词：肥胖、超重、青少年、身高体重指数、父母的身高体重指数