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The Prevalence of Weight Disorders in Children and Adolescents in Lorestan Province: Comparison of Three Different Criteria in A Cross-sectional Study

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ABSTRACT

Background: Anthropometric studies in children and adolescents are important to screen changes in growth and puberty. Hence, standard percentiles and cutoffs are set by the World Health Organization (WHO), Centers for Disease Control and Prevention (CDC), and Iranian national criteria. This study aimed to examine and compare the prevalence of weight disorders in children and adolescents in Lorestan province according to different criteria. **Methods:** Children and adolescents (6–18 years) were randomly selected from the urban and rural areas by the multistage stratified cluster sampling method. All Iranian citizens aged who resided in Lorestan province for at least one year were eligible to participate in this study. After obtaining consent forms, researchers gathered the accurate anthropometrics and body mass index (BMI) measurements. **Results:** A total of 866 children and adolescents took part in the study, 447(51.6%) of whom were girls and 419 (48.4%) were boys. The overall prevalence of overweight and obesity was 17% in boys and 12.5% in girls. The prevalence of underweight in girls was 5.8%; while in boys it was 4.5%. The total prevalence rate of underweight according to the national criteria was 5.2%. However, this rate increased to 12% and 12.6% by using WHO and CDC cut-off points, respectively. The highest prevalence of overweight was obtained by CDC (15.8%), followed by WHO (13%); while national cut-off points resulted in 9.7%. Furthermore, 9.2% of the studied population was found to be obese by WHO; while this rate was 4.2%, and 5% by CDC and national cut-off points. **Conclusion:** This study indicated the coexisting prevalence of underweight and obesity and high prevalence of overweight among children and adolescents in Lorestan province. Furthermore, using the WHO and CDC criteria leads to overestimating the prevalence of weight disorder compared to the national cut-off points in Iran.

Keywords: *Weight disorders; Children and adolescents; Body mass index.*

Introduction

Anthropometric studies in children and adolescents are important; since they enable us to screen changes in growth and puberty. In addition, given growth may be affected by

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nutritional disorders, adolescents anthropometric also reflects nutritional status and health risks (Sodaei *et al.*, 2013). In this regard, the most common index used to assess weight disorders, including underweight, overweight, and obesity, is the body mass index (BMI), which is obtained by dividing weight in kilograms by height squared in meters (Güngör, 2014, Kumar and Kelly, 2017).

Statistics from previous literature have shown that world has witnessed over the past three decades a shift from the high prevalence of underweight to the high prevalence of overweight and obesity in low and middle-income countries (Bentham *et al.*, 2017, Greydanus *et al.*, 2018).The decline in the prevalence of underweight compared to overweight and obesity may be due to urbanization, industrialization, lifestyle changes, food security, and health education (Heidari-Beni and Kelishadi, 2019, Weihrauch-Blüher and Wiegand, 2018). Evidence from the data have shown a significant increase in the prevalence of obesity in each country from 1975 to 2016 (Greydanus *et al.*, 2018). In fact, overweight and obesity has been mentioned as one of the most important health challenges of the 21st century (World Health Organization, 2018).

Obesity is indeed a multi factorial disease in which genetic and environmental factors, such as physiological, biochemical, metabolic, psychological, and social factors are involved (Khazaei *et al.*, 2017a, Sanyaolu *et al.*, 2019). Increased intake of high-calorie foods, decreased physical activity, and increased sitting activities are the main factors associated with increasing the prevalence of obesity in children and adolescents (Sahoo *et al.*, 2015). On the other hand, it should be noted that children are significantly more likely to be malnourished due to their special nutritional needs for growth (gholami *et al.*, 2014). Underweight also has very negative effects on quality of life and health status. It can be said that obesity it is an important problem , especially in growing children (Heidari-Beni and Kelishadi, 2019).

Many studies have shown that childhood obesity and its associated metabolic effects are transmitted to adulthood (Simmonds *et al.*, 2016) Therefore, identification of children who are at high risk for obesity, reduce the risk of obesity in adulthood if combined with weight loss and improved lifestyle.

Based on epidemiological evidence, obesity in childhood and adolescence increases the risk of some diseases, such as metabolic syndrome (MetS), cardiovascular disease (CVD), hypertension (HTN), type-2 diabetes mellitus (T2DM), dyslipidemia (DL), and arteriosclerosis in adulthood. It also increases the risk of CVD in childhood and adolescence (Weihrauch-Blüher *et al.*, 2019).

Considering the role of childhood and adolescence obesity in adulthood, the consequences of obesity on the growth and development of children in the following years of life, the heavy burden of this disorder for health care systems, as well as having an insight on the prevalence and trend of childhood and adolescents underweight, overweight, and obesity can provide evidence-based information for health policymakers at national levels in order to plan and implement programs for primary prevention.

Despite previously mentioned evidence which has examined the prevalence of obesity or malnutrition in children and adolescents in different cities of Iran, no study has yet indicated the prevalence of weight disorders in urban and rural areas of Lorestan province. Also, most studies have reported results based on one criterion. However, the present study considered three different criteria for estimating the prevalence. Therefore, this cross sectional study was designed to investigate the prevalence of weight disorders in children and adolescents in Lorestan province based on different cutoffs related to the World Health Organization (WHO), Centers for Disease Control and Prevention (CDC), and National Growth Charts for BMI among Iranian children and adolescents to assist policy-makers in developing preventive strategies and guide further research.

Materials and Methods

Study design and participants: This population-based cross-sectional study was done on 30532

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children and adolescents aged 6-18 years in the framework of the national survey of Iranian children and adolescents' psychiatric disorders (IRCAP project) in all provinces of Iran using a multistage cluster sampling method.

This project was designed by the Department of Nutrition and Psychiatry and performed by the Psychiatric Research Center of Tehran University of Medical Sciences and funded by the National Institute for the Development of Medical Research (NIMAD).

In this study, children and adolescents aged 6-18 years were selected by multi-stage cluster sampling (cluster sampling and random classification) from urban and rural areas of Lorestan province. Based on the sampling method, 150 clusters of houses were randomly selected based on postal codes in both rural and urban areas. In each cluster, 6 children and adolescents were randomly selected within equal blocks of gender and age groups (6-9 years, 10-14 years, and 15-18 years). If the selected family did not have a child in the age range of 6-18 or no one was at home, the next license plate was referred. The clusters were selected randomly according to the postal code received from the post office. All Iranian citizens aged 6-18 years who resided in Lorestan province for at least one year were eligible to participate in this study. The exclusion criterion included non-Iranian citizens and immigrants. Furthermore, those who did not consent to participate were excluded.

Finally, a total of 866 children and adolescents living in urban and rural areas of Lorestan province were evaluated for BMI and entered the epidemiological and analysis stage.

Measurements: Sociodemographic information was collected by a questionnaire developed particularly for this study. Demographic and familial characteristics included gender, age, residential area, parental education levels, parental job, and a history of parental physical or mental illness, the data about which were gathered via self-report using a semi-structured questionnaire. Moreover, accurate measurements of anthropometric indices were collected by the researchers. More detailed information about the study design, participants, and data collection method have been published previously (Mohammadi *et al.*, 2019).

Data collection was done by 6 trained interviewers referring to houses and explained the study process to the interviewees. Parents were invited to take part their children in the study and then written consent form was received from parents and adolescents.

In addition to the main questions of the IRCAP study, the interviewers also collected demographic and anthropometric data, including accurate measurements of height and weight of children and adolescents. BMI was then calculated using the weight (kg)/height $(m)^2$ formula.

In the age group of children and adolescents, gender-specific BMI-for-age percentile curves were used to define abnormalities in BMI. Hence, standard percentiles and cutoffs were set by WHO and CDC. Based on these percentages, children and adolescents were classified into different groups, including underweight, normal weight, overweight, and obese. Standard percentages of BMI also depend on other factors, such as genetics (ethnicity), environmental, and demographic-social factors (Albrecht and Gordon-Larsen, 2013, Veghari, 2012). Therefore, national percentiles determined in previous studies in Iran are of great importance.

Ethical considerations: Written consent was obtained from parents of participants aged less than 15 years and from the participants and their parents of adolescents aged 15-18 years. All information about the participants and their families were kept confidential. The Ethics Committee Board of the National Institute for Medical Research Development (NIMAD) approved this study (the ethics code: IR.NIMAD.REC.1395.001).

Data analysis: The collected data were analyzed using SPSS software version 19 (IBM SPSS Statistics for Windows version 19.0, Armonk, NY: IBM Corp) and Chi-square test was used to compare the genders and age groups. In this study,

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BMI classification was performed according to National Growth Charts for BMI among Iranian children and adolescents in comparison with the WHO and CDC curves as follows (Mohammadi *et al.*, 2020).

Underweight: BMI less than the 5th percentile of the country.

Normal weight: 5th to 85th percentile of the country.

Overweight: 85th percentile to less than 95th percentile of the country.

Obesity: more than 95th percentile of the country.

Therefore, the prevalence of underweight, overweight, and obesity were reported and compared using the cut point of Iran, WHO, and CDC.

Results

Study population characteristics: A total of 866 children and adolescents aged 6-18 years took part in the study, 447(51.6%) of whom were girls and 419 (48.4%) were boys. Moreover, 75.8% of the participants lived in urban areas and others (24.2%) lived in rural areas. **Table 1** shows that the total prevalence of overweight and obesity among boys was 17%, while was 12.5 % among girls. The prevalence of underweight in girls was 5.8% (n=26), while it was 4.5% (n=19) in boys. Finally, the results indicated that among three considered status (underweight, overweight, and obesity), the highest rate is primarily related to overweight with a prevalence of 9.7%, then underweight 5.2%, and finally obesity with a prevalence of 5%. There were no significant differences in the prevalence of underweight, overweight, and obesity between urban and rural areas.

Comparison of BMI percentile: **Table 2** shows BMI of Iranian children and adolescent percentiles in comparison to CDC and WHO reference data. It shows that the prevalence of underweight, overweight, and obesity according to the WHO criteria are 12%, 13%, and 9.2%, respectively, and based on the CDC reference the prevalence are12.6%, 15.8%, and 4.2%; however, both of these statistics are very different from Iranian criteria. According to Iranian cutoff points, the prevalence of underweight, overweight, and obesity are 5.2%, 9.7%, and 5%, respectively. This shows that Iranian children and adolescents are genetically lower in BMI compared to the American children and adolescents and the fifth BMI percentile was lower in Iranian children and adolescents compared to WHO and CDC fifth percentile. **Figure 1** also shows the BMI distribution of children and adolescents in Lorestan province according to Iranian cutoff points, CDC, and WHO and comparisons between them.

Discussion

According to the findings of this study, the prevalence of underweight, overweight, and obesity among children and adolescents were 5.2%, 9.7%, and 5%, respectively. It was also found that boys were more likely to be overweight and obese than girls.

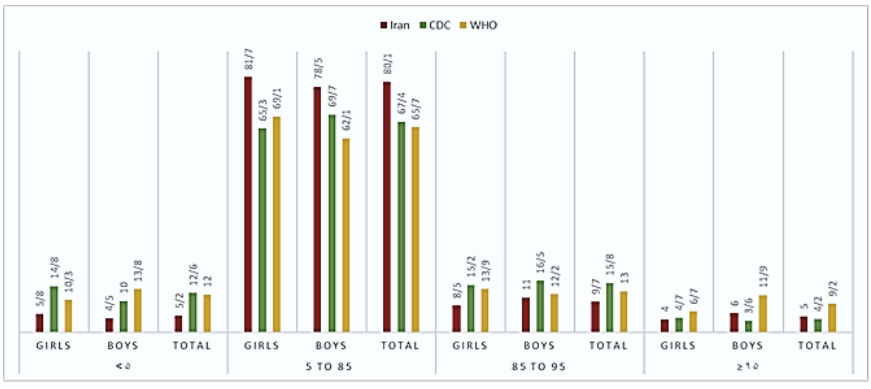

Figure 1. The graph of BMI distribution in children and adolescents in Lorestan province

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Table 1. Baseline characteristics and Prevalence of underweight, overweight and obesity in children and adolescents in Lorestan province

Demographic variables	Total	*Body mass index percentiles*				*P-value*[a]
		< 5	5-85	85-95	95 ≤	
Gender						
Boy	419 (48.4)[b]	19 (4.5)	329 (78.5)	46 (11.0)	25 (6.0)	0.26
Girl	447 (51.6)	26 (5.8)	365 (81.7)	38(8.5)	18 (4.0)	
Age (y)						
6-9	272 (31.4)	17 (6.3)	227 (83.5)	17 (6.3)	11 (4.0)	0.03
10-14	309 (35.7)	8 (2.6)	246 (79.6)	38 (12.3)	17 (5.5)	
15-18	285 (32.9)	20 (7)	221 (77.5)	29 (10.2)	15 (5.3)	
Residential area						
Urban	656 (75.8)	34 (5.2)	524 (79.9)	64 (9.8)	34(5.2)	0.96
Rural	210 (24.2)	11 (5.2)	170 (81.0)	20 (9.5)	9(4.3)	
Total	866 (100)	45 (5.2)	694 (80.1)	84 (9.7)	43(5.0)	-

[a]: Chi-square *test*; [b]: N (%)

Table 2. Comparison of body mass index percentiles for Iranian children and adolescent with CDC and WHO reference data

Reference data	Gender	*Body mass index percentiles*				P-value[a]
		< 5	*5-85*	*85-95*	*95 ≤*	
Iran	Boy	19 (4.5)[b]	329 (78.5)	46 (11.0)	25 (6.0)	0.59
	Girl	26 (5.8)	365 (81.7)	38 (8.5)	18 (4.0)	0.76
	Total	45 (5.2)	694 (80.1)	84 (9.7)	43 (5.0)	0.96
CDC	Boy	43 (10.0)	292 (69.7)	69 (16.5)	15 (3.6)	<0.001
	Girl	66 (14.8)	292 (65.3)	68 (15.2)	21 (4.7)	<0.001
	Total	109 (12.6)	584 (67.4)	137 (15.8)	36 (4.2)	<0.001
WHO	Boy	58 (13.8)	260 (62.1)	51 (12.2)	50 (11.9)	<0.001
	Girl	46 (10.3)	309 (69.1)	62 (13.9)	30 (6.7)	<0.001
	Total	104 (12.0)	569 (65.7)	113 (13.0)	80 (9.2)	<0.001

[a]: Chi-square test; [b]: N (%)

This result is similar to the findings of a study conducted in Khorramabad city in 2011-2012. It showed that the prevalence of overweight and obesity among students was 16% and 5% and also the prevalence of overweight and obesity was higher in boys (17% and 6%) compared to girls (16.4% and 3.6%) (Khorramabadi *et al.*, 2017).

Previous studies have not indicated any specific reason for this sex difference in the prevalence of obesity and overweight. In this regard, cultural differences of mental image of the body can be considered in boys and girls, including the tendency of boys to computer and computer games leading to reduced physical activity and obesity, high consumption of outdoor foods in boys which increases calorie intake, girls' physical differences, and the effect of some hormones (Khazaei *et al.*, 2017b, Sodaei *et al.*, 2013).

In a systematic review study in 2014 with the aim of examining the prevalence of obesity and overweight among Iranian children and adolescents, it was stated that girls had a lower prevalence of obesity and a higher prevalence of overweight compared to boys. This might be due

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the fact that girls pay more attention to their body image than boys (Kelishadi *et al.*, 2014).

A systematic review by Kelishadi et al. in 2019 was conducted with the aim of determining the prevalence of weight disorders in Iranian children and adolescents. They showed the increasing trend of childhood obesity and overweight, but it was not significant. Furthermore, underweight is still one of the main nutritional problems in children of some areas, including Sistan-va Baluchistan and Kerman provinces (Heidari-Beni and Kelishadi, 2019).

In Iran, the prevalence of underweight in children was reported at 15.5% (Cl 95%: 12%-19.7%) based on a meta-analysis conducted in 2018 and this amount was higher in Birjand and Zahedan cities and the lowest prevalence of underweight was found in Jahrom city (Mohammadi *et al.*, 2018). It is noteworthy that underweight is a reflection of acute, chronic, or both malnutrition and is caused by partial, continuous, or periodic deprivation of proper nutrition, alternating health and illness, persistent debilitating and chronic illness, and lack of health care (Mohammadi *et al.*, 2018).

Based on previous studies, it can be said that the prevalence of weight gain in children and adolescents in the Middle East is higher than in developing countries (Khorramabadi *et al.*, 2017). Some reasons lead to this increase, such as lifestyle changes with consumption of high-calorie density foods, sedentary lifestyle, excessive screen time, i.e. watching television and playing computer games, as well as globalization, epidemiologic transition, and the problem of stunting (Heidari-Beni and Kelishadi, 2019).

Another meta-analysis study in 2017 reported that the prevalence of obesity is 5.82% in Iranian students, which was higher in boys than in girls (6.85% compared to 5.13%) (Khazaei *et al.*, 2017b).

There is no consensus on the definition of overweight and obesity in childhood and adolescence, and the lack of a universal definition has led to an inability to compare data between studies. The findings also revealed that underweight was respectively prevalent among almost 12% and 12.6% of children and adolescents by the use of WHO and CDC cut-off points. The prevalence reached 5.2% according to Iranian national criteria. The highest prevalence of overweight was obtained by CDC (15.8%) followed by WHO criteria (13%), while the prevalence was 9.7% according to national cut-off points in Iran. Furthermore, 9.2% of the studied population was obese by WHO definition, while this rate was 4.2% and 5% by CDC and national cut-off points in Iran, respectively. In fact, estimates of underweight obtained from national cut-off points in Iran were lower than those obtained according to CDC or WHO.

Bahraini et al. also compared national cut-off points in Iran with those of The International Obesity Task Force (IOTF), CDC 2000 and WHO 2007, but this was done on Isfahan students aged 11-18 years (Bahreini *et al.*, 2013). In their study, the prevalence of underweight according to WHO, Iranian national criteria, CDC, and IOTF were 38.5%, 25.5%, 45.8%, and 39.5% respectively. The highest prevalence of overweight was obtained by IOTF cut-off points (30.5%), while CDC 2000 criteria, WHO 2007, and national cut-off points in Iran gave similar prevalence results (4.7%, 4.0%, and 4.4%). According to WHO 2007 definition, 2.4% of the studied population were found to be obese, while this rate was 0.8%, 0.5%, and 0.8% by IOTF, CDC 2000, and national cut-off points in Iran (Bahreini *et al.*, 2013).

One of the strengths of the study was using a representative sample of children and adolescents in Lorestan province to find the coexisting prevalence of underweight and obesity in the population. The limited number of studies in which the prevalence of weight disorder was estimated based on several different criteria, made the study findings interesting. One of the limitations of this study was the lack of information about causes and factors leading to weight disorders. Moreover, the interviewer bias

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may be involved in the results, and finally the statistical analyses were limited. Therefore, more accurate statistical analyses should be considered in future studies.

Conclusion

This study indicated the coexisting prevalence of underweight and obesity and high prevalence of overweight among children and adolescents in Lorestan province. Therefore, BMI assessment and its appropriate interpretation based on proper reference curve should be part of the routine clinical assessment of all children and adolescents. Furthermore, using the WHO and CDC criteria leads to overestimating the prevalence of weight disorder compared to the national cut-off points in Iran.

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Authors' contributions

Mohammadi M, Mostafavi SA, Khaleghi A, and Ahmadi N designed the research; Nazari H, Parsamehr H, Abbasi motlagh F, Tajipoor A, Godarzi Z, Shokri moghadam S, Kumasi jodaki S, Salehi kia H, Veyskarami M, and Beyranvand S conducted the research; Mostafavi SA analyzed the data; Hatami M wrote the manuscript. Hatami M had primary responsibility for final content. All authors read and approved the final manuscript.

Conflict of interest

The authors declared there is no conflict of interest.

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