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Original Article

Geographical Distribution of Growth Disorders in Iranian Children and Adolescents: The CASPIAN-IV Study

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Abstract

Background: Iran is a vast country with great variability in ethnicity and geographical regions as well as higher diversity in socioeconomic and demographic factors in different provinces. All these differences could influence the growth indicators of children and may result in a substantial inequality in the distribution of growth indexes across Iranian provinces. This study aimed to determine the distribution of growth disorders of Iranian children according to the geographical and climatic conditions.

Methods: In this nationwide cross-sectional study, students aged 6-18 years, living in urban and rural areas of 30 provinces in Iran, were studied. The prevalence of underweight, overweight, obesity, abdominal obesity and short stature were determined in different geographical regions of Iran using the geographic information system (GIS) and ArcGIS software.

Results: Overall, 13486 children with mean age of 12.5 (CI: 12.3 - 12.6) years were studied. The prevalence of overweight and obesity as well as underweight ranged between 5-15%, in most provinces. Underweight was more prevalent in very hot and hot regions than in cold regions. The prevalence of overweight and obesity was higher in regions with cold and rainy weather. The prevalence of short stature in most of the provinces ranged between 5-15%.

Conclusion: The findings provide geographic disparities of growth disorders among Iranian pediatrics population. They could be used as baseline information for planning further studies to determine the causal pathway for reported wide range of reported growth disorders and their association with different geographical and climatic regions.

Keywords: Obesity, Overweight, Underweight, Short stature, Children, Adolescents, Iran

Introduction

Child growth is considered as an important health concern as well as good indicator of nutritional status in a community. Normal growth is representative of good health in pediatric population. Growth disorders including overweight, underweight and short stature are of concern in various populations (1, 2).

Underweight is one of the largest contributors to global burden of disease with higher rate of morbidity and mortality (3). On the other hand, overweight and obesity are a global epidemic, with increasing rate notably in developing countries, and facing them with double burden of disease (4, 5).
Short stature is another growth disorder that is associated with underlying medical conditions and its proper management could help to achieve good health and normal adult height (6). Moreover, some cases of overweight and obesity are because of short stature and making abnormal weight-to-height ratio (7, 8).
Though some influencing factors as genetic and underlying medical disorders should be considered for growth disorders, but environmental and lifestyle factors have a crucial role in this regard (9, 10).
Geographical and climatic changes are considered as possible environmental factors influencing the occurrence of growth disorders. There are few studies in this field, which indicated the association of growth disorders with different climatic conditions (11-13).
Low-and middle-income countries are facing "epidemiologic transition" and "double burden of disease" (14) and dual burden of nutritional and growth disorders (15) .Similar to other developing countries, Iran is experiencing this paradox among children and adolescents (16, 17).
Iran is a vast country with great variability in ethnicity and geographical regions as well as higher diversity in socioeconomic and demographic factors in different provinces. All these differences could influence the growth indicators in the pediatric age group, and may result in a substantial inequality in the distribution of growth indexes across Iranian provinces.
This study aimed to determine the distribution of growth disorders of Iranian children and adolescents according to the geographical and climatic conditions by using Geographical Information System (GIS).

Methods

This nationwide cross-sectional study was conducted in 2011-2012 in the framework of the fourth survey of a national school-based surveillance program entitled Childhood and Adolescence Surveillance and Prevention of Adult Non-communicable disease (CASPIAN-IV) study. Protocols of the study were reviewed and approved by regional and Ethical Committees of other relevant national regulatory organizations. After explanation of the study objectives and protocols, verbal assent and written informed consent were obtained from students and their parents, respectively.
This survey was conducted among 14880 students, aged 6-18 years, living in urban and rural areas of 30 provinces in Iran. Detailed methodology of the study has been reported previously (18). Herein, the methods are described in brief.
The study population consisted of school students, who were recruited by multistage random cluster sampling method.
A team of trained health care professionals measured height and weight according to standard protocols and by using calibrated instruments, which were rechecked regularly during the study. The Data and Safety Monitoring Board of the study closely supervised the quality control and quality assurance of the survey at the national level.
Weight was measured to the nearest 0.1 kg in in light outdoor clothing and height were measured without shoes to the nearest 0.1 cm. Waist circumference (WC) measured to the nearest 0.1 cm, at midway between the lowest rib and the iliac crest. Body mass index (BMI) was calculated as weight (kg) divided by the height squared (m^2). Waist to hip ratio (W/HtR) was calculated as the ratio between waist and height and a cut-off point of 0.5 was considered as abdominal obesity (19).
BMI was categorized to four parts: underweight (less than or equal to 5^{th} percentile), normal weight (between 5^{th} and 85^{th} percentiles), overweight (between 85^{th} and 95^{th} percentiles), and obese (equal to or more than 95^{th} percentile). Short stature was considered as height values of

less than 3rd percentile, values between 3rd and 97th percentiles were considered as normal. To categorize BMI and height levels, the growth charts of the World Health Organization (WHO) were used (20), which are in close agreement with Iranian growth charts (21).

Geographical distribution

The geographic information system (GIS) and ArcGIS software were used after entering data in the mapping information table; A GIS is a computer system designed to capture, store, manipulate, analyze, manage, and present all types of geographical data and lets us visualize, question, analyze, and interpret data to understand relationships, patterns, and trends. we mapped spatial distribution of underweight, obesity and overweight. This study aimed at mapping the distribution of underweight, obesity and overweight and its relationship with geographical and climatic conditions in Iran (Appendix I).

Statistical analysis

Descriptive analysis was used to determine the prevalence of weight disorders and short stature. To draw the figures, ArcGIS software has been used. The differences between various provinces were examined by Chi Square test. Data were analyzed using the Statistical Package for Social Sciences (SPSS) software package version 18.0 (SPSS Inc., Chicago, IL, USA).

Results

Overall, 13486 children and adolescents out of 14880 invited students (participation rate of 90.6%) completed the study. They consisted of 6640 (49.2%) girls and 6846 (50.8%) boys; 75.6% urban and 24.4% rural inhabitants, and had a mean age of 12.5 (95% CI: 12.3 -12.6) years.

Table 1 presents the mean of anthropometrics measurements and the prevalence of growth disorders in the study population.

Table1: Mean of anthropometrics measurements and prevalence of growth disorders as overweight, underweight and short stature in studied children and adolescents: the CASPIAN-IV study

Variables	Total
[1]Weight (kg)[1]	42.40 (41.64-43.15)
Height (cm) [1]	146.99 (146.10-147.88)
BMI (Kg/m²)[1]	18.85 (18.70-18.99)
WC (cm)[1]	67.02 (66.57-67.48)
WHtR [1]	0.45 (0.45-0.45)
Hip (cm)[1]	80.78 (80.16-81.40)
Abdominal obesity (%)	19.12 (18.22-20.06)
BMI categories (%)	
Underweight	12.17 (11.5-12.87)
Normal	66.28 (65.31-67.24)
Overweight	9.66 (9.14-10.21)
Obesity	11.89 (11.22-12.59)
Short stature (%)	2.6 (2.19-3.05)

[1]Mean (95% CI)

The distribution of BMI percentiles (underweight and overweight) across different provinces is shown in Fig. 1.

In most regions, the prevalence rate of underweight ranged between 5-15%.The higher rate of underweight was seen in the Southern part of the country, i.e. Hormozgan, Sistan and Kerman, as well as in Zanjan and Ilam (15-30%). Northern and northwestern provinces, Boushehr, Lorestan and Kohkilouyeh had the lower rate of underweight (5-10%). In general, the prevalence of underweight was higher in very hot and hot regions than in cold regions.

In most provinces, the prevalence of overweight and obesity ranged between 5-15%.The lowest rate was documented in Southeastern provinces, Kerman and Hormozgan with a prevalence rate of 0-5%.Whereas, the highest rate was observed in Northern provinces, East Azarbayejan, Tehran, Ghom, and Boushehr with a prevalence rate of 15-20%. Overall, the prevalence of overweight and obesity was higher in regions with cold and rainy weather.

In Fig. 2, the distribution of abdominal obesity in different provinces of Iran is depicted. In most provinces this prevalence ranged between 20-30%. Tehran, the capital of Iran had the highest rate of

abdominal obesity. The lowest rate was documented in Hormozgan and Sistan followed by Kerman (10-15%), Ghom, Ilam, and Kohkilouyeh (15-20%). Prevalence of abdominal obesity was higher in Northern provinces (30-35%). Abdominal obesity was lower in very hot regions.

The distribution of short stature across different provinces of Iran is presented in Fig.3. The prevalence of short stature in most of the provinces ranged between 5-15%. The highest rate was seen in Sistan (very hot and dry) and Ardebil (cold and rainy) (20-25%) followed by Hormozgan and Kohkilouyeh (very hot and dry) (15-20%). The lowest rate was seen in Yazd and Ghom (hot and dry).

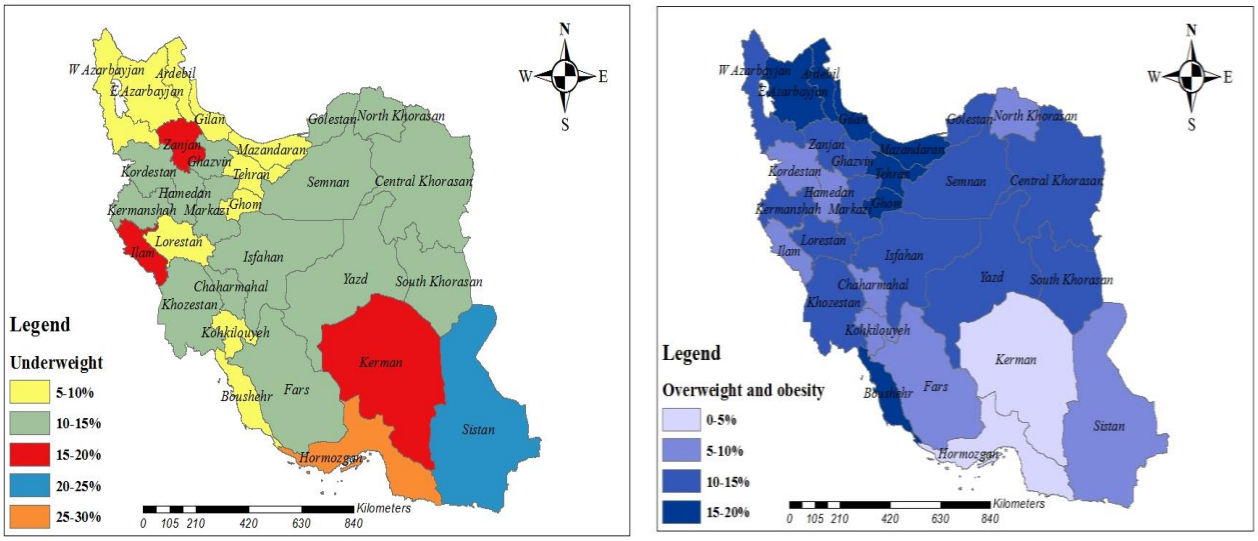


Fig.1: Distribution of underweight and overweight in Iranian children and adolescents**:** the CASPIAN-IV Study

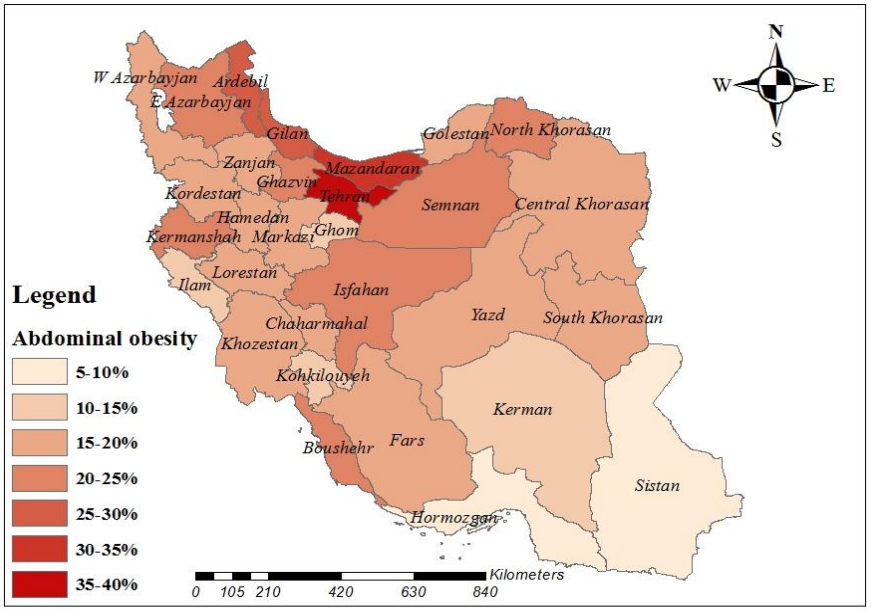


Fig. 2: Distribution of abdominal obesity in different provinces of Iran: the CASPIAN-IV Study

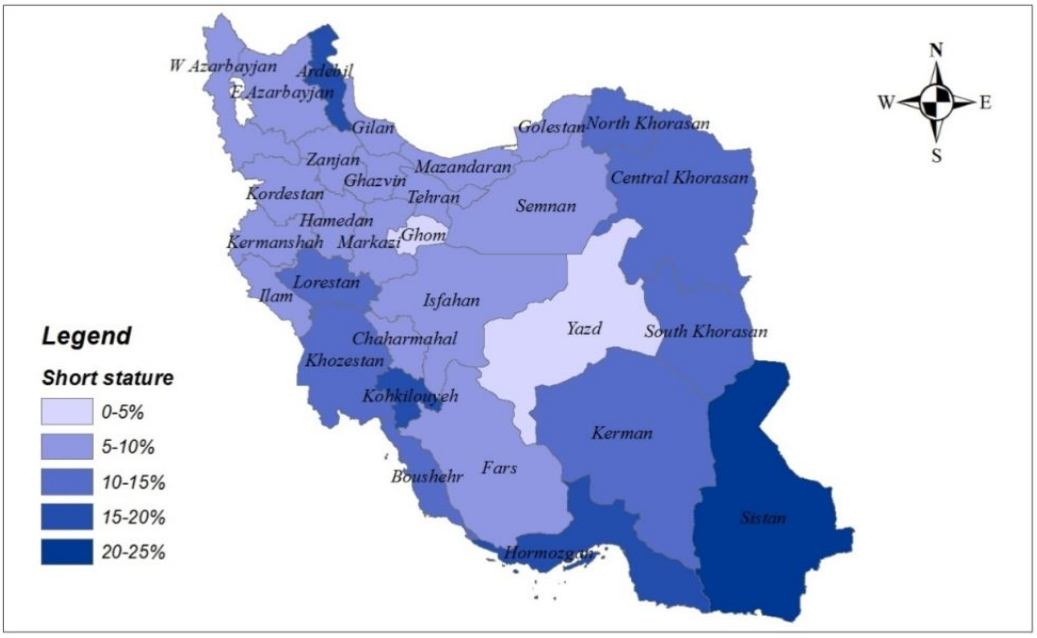


Fig.3: The distribution of short stature across different provinces of Iran: the CASPIAN-IV Study

Discussion

In this study, the geographical distribution of growth disorders in different provinces of Iran was investigated. The findings of our study indicated that the distribution of growth disorders had large variations across different provinces, and we have regions in both ends of the disorders spectrum.

Though studying the distribution of disease according to the geographical areas in Iran may be considered as a regional survey, but our findings regarding the association of the disorders with different climatic regions provide us new insight for some factors influencing growth disorders, and may be generalizable to other populations.

Several studies showed the multifactorial origin of growth disorders (21, 22). One or more of genetic, behavioral, and environmental factors could cause the disorders (23, 24). Identification of the role of each component in the pathophysiology of different growth disorders could have an important role in preventing strategies of the disorders. Environmental factors are those that surround the children and influence their food intake and physical activity (24). Geographic regions and various climatic conditions possibly could have role in the development or occurrence of growth disorders.

The role of climate on growth disorders specially obesity and adipose tissue have been investigated in some studies (11-13, 25-27). Evidences regarding the effectiveness of climate and weather on fat tissue mostly were from animal studies (25-27). There were few studies regarding the role of climate and different geographical regions on obesity, underweight and short stature among children and adolescents (13, 28). Animal studies demonstrated that cold acclimation could increase the synthesis of both white and brown adipose tissue (25-27). Heat exposure during pregnancy is related to lower birth weight (29).

In a study in two areas of the Amazon, the anthropometrics measurements of adolescents aged 10-19 years were compared. They indicated that during the wet season, the prevalence of overweight among girls was higher in the forest (42%) than in the floodplain (9%) (28).

El Mouzan and colleagues in Saudi Arabia have reported the regional variation of growth disorders among Saudi children and adolescents. They

demonstrated lower growth in children living in southwest regions and suggested that the possible cause of the findings is higher altitude of the region (10).

In the current study, overweight was more prevalent in Northern provinces of Iran, which classified as cold and rainy regions. It was also higher in Tehran and Ghom. Similar feature was observed for abdominal obesity except for Ghom.

Higher rate of underweight was reported in very hot regions.

Considering the findings mentioned in animal studies our results could be explained (25-27). Overweight and obesity were higher in cold and rainy regions. Our results also were similar to that reported in Amazon (28). However, regarding the fact that, climatic conditions are in linked with or could be affected by other factors such as infectious diseases food and energy intake (micro and macronutrients deficiencies) and physical activity. Other explanations should be considered also.

It seems that the higher rate of overweight /obesity in Tehran, the capital of Iran, is due to the lifestyle of its population (less physical activity or unhealthy diet).This lifestyle could influences Ghom the neighboring province of Tehran. Urbanization and household poverty were the most important risk factor for overweight/obesity and underweight, respectively (30).

Regarding Northern provinces, it seems that due to weather the outdoor physical activity is unavailable in most of the times of the year for children. However, the role of other environmental and ethnic factors in this field should be evaluated also.

Regarding the higher rate of underweight in very hot regions, it is supposed that the main factor could be under nutrition and low intake of essential micro and macronutrients, which should be investigated in our future studies.

Our findings indicated that the prevalence short stature was higher in Eastern provinces with hot and very hot climate. It was in its highest rate in Sistan Province, which had also the higher rate of underweight. Stunting was higher in Hormozgan, the province with higher rate of underweight and Ardebil and Kohkilouye also.

In one study in China, the district differences of height among Chinese children aged 7 to 18 years, was evaluated. They indicated that Chinese children and adolescents were taller in the northern and shorter in the southern areas. The highest and lowest levels of heights were in the Northern and the Southwest areas respectively. They reported that the levels of height in the coastal areas were higher than that of the inland (13).

Our results were not similar to that reported in China. However, Ardebil and Kohkilouye have not coastal areas but Hormozgan and the southern part of Sistan are coastal areas.

Nearly 45%–85.5% of diagnosed short statures in Iran have non-pathologic causes and the micronutrient insufficiencies commonly zinc deficiency was suggested one of the important etiologic factors of SS (31). Considering the possible relation between micronutrient deficiencies in the etiology of idiopathic SS in Iran, it is recommended to evaluate the correlation between different geographic regions with micro and macro nutrient deficiencies and their role in growth disorders.

SS were more prevalent in provinces with higher rate of under nutrition in our study. Observed association between SS and underweight in current study could strength the possible role of micro and macro nutrient deficiencies in growth disorders.

Though some previous reports showed that there was a significant relationship between SS and obesity (32, 33), but our results could be explained by that the history of under nutrition during childhood is coexisting with overweight as well as stunting in adulthood not childhood (34).

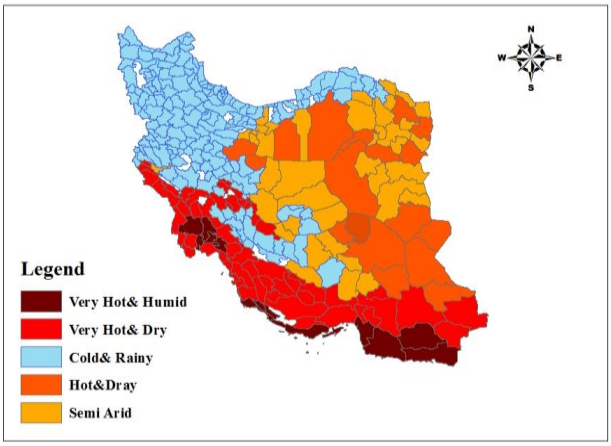
Another explanation for both weight disorders and SS, which could support the role of micronutrients deficiencies, is the predominance of rural settlements in regions with higher rate of underweight, and SS. However, evidences showed that prevalence of mentioned disorders is higher in urban population comparing with rural ones (10).

However, in spite of the fact that growth disorders are multifactorial, but our findings provide us baseline information regarding the association of different climatic conditions with growth disorder.

The limitations of this study were cross sectional design of the study, lack of more complementary both anthropometrics and laboratory measurements, However performing mentioned data in such a large sample size would be time consuming .It is recommended to design further studies according to the findings of current study to find out the etiologic bases of the disorders.
The strength of current study was nationwide form of the study and similar methods of evaluating growth disorder in all provinces of Iran.

Conclusion

The findings of this nationwide and epidemiologic study provide us geographic disparities on anthropometric measurements including weight, height and fat distribution among Iranian children and adolescents. They could be used as baseline information for planning further studies to determine the causal pathway for reported wide range of children and adolescents growth disorders and their association with different geographical and climatic regions.



Appendix I: Climatic conditions of Iran

Ethical considerations

Ethical issues (Including plagiarism, Informed Consent, misconduct, and/or falsification, double publication) have been considered carefully.

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Authors declared that there is no conflict of interest.

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