Construction of National Standards of Weight and Height and Growth Charts of Iranian Children: A Review Article

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ABSTRACT

Objectives: Growth charts are the most important evaluation tools for the assessment of growth and development of children which could be further used to develop preventive interventions. This study was undertaken with the aim of reviewing different current growth curves, their advantages and disadvantages, and performing a review of the studies conducted in Iran and other countries on determination of weight and height standards.

Methods: In order to collect materials for this review, a detailed search of Scientific Information Database (SID), Iran Medex, MEDLINE, PubMed, and Web of Science was carried out for the time period 2005-2010.

Results: The results of performed studies in European and Asian countries showed that the height and weight curves of these children were different from WHO and NCHS growth standards. The finding of growth trend study of Iranian children showed that the mean height and weight of girls and boys were increased. In spite of these increases, the median height and weight of Iranian girls and boys under 15 years was under 20th percentile of the United States National Center for the Health Statistics.

Conclusions: Considering the epidemiological changes and existing genetic differences and different children's weight and height growth patterns, it seems that the global standard for the children's growth, including the WHO standards, are not applicable to all the populations and each country should construct a separate national standard.

Keywords: National standard, Height, Weight, Children, Growth chart.

INTRODUCTION

The word "growth" refers to the increase in height and weight over time which can be demonstrated by a curve. The only way of evaluation is reference or standard curves prepared based on weight, height, and Body Mass Index (BMI) of healthy and well nourished children. Standard height and weight charts are the most important evaluation tools for the assessment of growth and development of children which could be further used to develop preventive interventions both in individual and epidemiologic assessments in the community.[1-2] Children of different populations differ a lot in size and shape, resulting from differences in their genetic pattern, their needs and interaction of these two. Considering the fact that current standards have prepared based on the data of American children and also the point that standard references from a country may not be applicable to another country, it can be said that not only each country needs to have its especial national standards for itself, but also the national standards of any country should be updated.[3-4]

In fact, if each country could prepare growth curves from the data of the children of its society, the clinical and epidemiological comparisons using these curves will not only provide a

more accurate estimation of children growth, but also it would be possible to functionally update the curves in suitable time intervals based on socio-economical developments and their effects on growth and development of children.[5] Regarding the existence of different standards, it seems that a national standard can provide a more accurate functional individual and social evaluation tool and many problems will be solved in case of availability of an Iranian standard for comparison of children's height, weight, and their growth follow-ups. One of these problems is the abnormal results regarding malnourishment, overweight, or obesity in Iranian children. Considerable rate of childhood malnutrition in Iran and other countries necessitates the implementation of interventional programs including development of local growth charts to prevent and manage malnutrition in the community.[6-7] This is because the current standards do not match the current situation of the children of our society. This article aimed at studying the different current growth curves, their advantages and disadvantages, and performing a review of the studies conducted in Iran and other countries on determination of weight and height standards.

METHODS

In order to collect materials for this review, a detailed search of Scientific Information Database (SID), Iran Medex, MEDLINE, and PubMed was carried out for the time period 2005-2010 using the keywords: national standard, height, weight, children, and growth chart. Initially, we reviewed international standards of weight and height.

- National Center for Health Statistics (NCHS):

Hamil et al. constructed the growth curves based on the data of 1975 using 4 different resources. Those resources were the second National Health Examination Surveys (NHESII) conducted between 1963 and 1965 for children aged between 6-11 years old and the third National Health Examination Surveys (NHESIII) conducted between 1966 and 1970 for children aged between 12-17 years old. They also used the data of the first National Health and Nutrition Surveys (NHANESI) conducted between 1971 and 974 on people between 1-17 years old to correct and update the previous curves. The mentioned study did not include the data of infants between 0-1. So they completed their

study with the data from the Fels longitudinal study (1929-1975) conducted in spring research center in Ohio. The reference was based on a restricted sample of American children and regarding technical and biological aspects it had some weaknesses that did not completely make it suitable for monitoring of fast changing growth of early childhood. Most of the children were formula fed children. It should be mentioned that those children who were breastfed were healthier; however, they had a slower physical growth and smaller body. Comparing these children using the curves based on formula fed children will result in an abnormal growth interpretation. Another weakness was the absence of especial curves for body mass index.[8]

- Centers for Disease Control and Prevention (CDC) curves:

The reference was constructed based on the national data gathered from 5 surveys between 1963 and 1994. The infant part of the curve was from Fels longitudinal study (NCHS, 1997) and two national surveys: NHANESII (1976-1980) and NHANESIII (1988-1994). Data from NHANESII did not include children aged less than 6 months and the data from NHANESIII did not have the data regarding weight of children aged less than 2 months and height of children aged less than 3 months. For this reason, CDC used the supplementary data to cover the weakness. The reference provided separate curves for growth control of girls and boys. Some studies have mentioned some weak points of this reference. For example, the curves of the reference are not based on disease rate index. The data of this reference is also from American children that may not be applicable to other populations. Another problem is that considering the population growth, the malnourishment percentiles will also change.[5,9]

- World Health Organization (WHO) growth curves:

Between 1997 and 2003, WHO generated this reference for children between 0-5 years old in two component forms of cross-sectional and longitudinal. In the longitudinal component, cohorts of 882 newborns were measured from birth through 2 months.

Based on the recommendations of WHO, the reference included exclusive breastfeeding for at least 4 months, and continued breastfeeding for at least 12 months. Complementary feeding

started from month 6. In the cross-sectional component 6669 children aged between 18-71 months with a minimum duration of 3 months exclusive breastfeeding were included. The standard was prepared as weight-for-age, weight-for-height, height-for-age, and BMI.

Rising some question about the previous standards and to prevent the limitations of previous standards that were limited to a certain location, WHO with the participation of the United Nations university started a study from 1997 with the aim of formulating a new international standard for assessing the growth and development of infants and young children worldwide with an age between birth through 5 years. This was actually a Multicenter Growth Reference Study (MGRS) and its data was gathered from several countries. To compare the growth pattern of all children worldwide, more than 8,000 healthy children from 6 different countries (Brazil, Ghana, India, Norway, Oman, and the United Sates) were surveyed. The children were selected in optimal life and environment conditions provided with good healthcare and did not have any acute diseases. Their mothers were not smokers before or after pregnancy and followed WHO feeding criteria such as:

1. Exclusive or dominant breastfeeding at least for 4 months

2. Introduction of complementary foods at the age of 6 months.

3. Still on breastfeeding at 12 months

For the first time, the standard created a harmony between breastfeeding instructions and assessment of child growth. It helps an easier and more accurate assessment of breastfeeding and complementary feeding with the help of new standards. In other words, child growth standards of WHO is a new tool to provide the best healthcare and nourishment for the children worldwide.[10]

There are also some speculations that these standards are not applicable to Asian countries and separate standards should be generated reflecting lower growth rate and poorer socio-economic status.

Countries like the United Kingdom, The Netherlands, France, Norway, India, China, and Saudi Arabia have created standards for their countries. What follow is a review of some studies in Iran and other countries of the world with the aim of determination of growth curves and standards for weight and height.

A Review of Performed Studies in Constructing Growth Charts:

- Performed studies in Iran:

Between 1990 and 1991, Hosseini et al. undertook a survey among children aged 2-18 years old. They measured weight and height of 3301 children resident in Tehran. Using statistical methods, BMI percentiles based on age (years) and sex were calculated.[11] Their reference had the following weak points:

1. They measured the age based on years; so a child aged 4 years and one day was in the same category with a child aged 4 yeas, 11 months, or 29 days.

2. Children resident in Tehran cannot represent the children of Iran.

3. Healthy children, thin, obese, and even short ones were all put in one category.

- Studies in other countries:

- To construct a national standard and growth chart for children under 5 years old, Al-Mazrou et al. randomly selected 24000 Children in Saudi Arabia (12000 girls and 12000 boys) from 5 different regions of the country with 200 children in each monthly age group. Demographic data as well as the anthropometric measurements were recorded by well-trained personnel using pretested and new well calibrated equipment. The study showed that Saudi boys (0-5 years old) were heavier and taller than Saudi girls in the same age group, and that the median weights and heights of Saudi boys and girls (0-5 years old) were more than those of Harvard standards. A growth chart suitable for growth monitoring was also constructed.[3]

- In 1980, Cole and Roede studied 41000 Dutch girls and boys (0-20 years old). BMI was calculated based on height and weight and percentiles were calculated using LMS method. The LMS parameters are L (Lambda, λ), the Box-Cox power, M (Mu, μ), the mean, and S (Sigma, σ), the coefficient of variation. In resulted growth curves, BMI had an increase in the first year of life and then declined. A second rise was seen at the age of 6 years. Rates of overweight in Dutch children were less than American, French and Norwegian children.[12]

To determine the growth pattern of Indian children, Agarwal et al. measured the weight, height, head circumference, chest, and mid-arm circumference of children aged between birth and 6 years from affluent families in 7 different

centers. On each age and sex point, 200 children were observed. The resulted data showed growth curve values lower than European national center for the health statistics. The differences in growth seem to be possibly due to lower velocity in Indian children, especially in the first 18 months as compared to American children.[13]

- Rolland-Cachera et al. in 1991 prepared weight per height in square meters percentile curves from birth through the age of 87 years for the French population. The curve showed a rising trend in the first year and reversed toward the age of 6 years old. There was a second rise then to the age of 65 years in which the trend declined a second time.[14]

-To update the growth curves prepared in Norway in 1980s and 1970s, Juliusson et al. used the data from Bergen gathered between 2003 and 2006 and constructed new growth curves for children (0-19 years old) in Norway. They compared these new curves with the old references and WHO standards (published in 2006). The results showed that the height and weight curves for children between 0-4 years old had a marginal difference with previous curves. In older children, however, the 50th percentile for height showed an increase of 3.4 cm in boys and 2.5 cm in girls. The weight-for-height curve, especially in higher percentiles for these children, also showed an increase. The comparison of these new curves with WHO standards also showed that percentile curves of weight at birth, height, weight, and head circumference of children aged 6 months to 5 years old was higher as compared to WHO standards. The mentioned differences for the Norwegian children may reflect the demographic differences in relation to the environment and the differences in growth potential in different populations.[15]

- To construct the growth curves of height, weight, and head circumference for the Chinese children (0-7 years old), Li undertook a study in 2009. He gathered the anthropometric data (weight-for-age, height-for-age, and head circumference) from 69760 healthy girls and boys from the forth national survey on the children younger than 7 years old in nine cities in China in 2005. The standard values of each percentile were calculated using SML parameters. The sample volume was large and was at the national level. The data quality was high. The international smoothing method was acceptable. The results showed that the height curves of Chinese children (0-7 years old) were slightly higher than WHO children's growth standards.

Using the new growth curve, the growth level of Chinese healthy children was calculated and the use of China's growth curves for the determination of Chinese children nutritional status in the 21st century was suggested.[16]

CONCLUSION

From the studies undertaken in other countries with the aim of construction of the height, weight, and growth curves it can be concluded that considering epidemiological changes and genetic differences and weight and height growth patterns for children in each country, the global growth standards for the growth of children, including WHO standards, are not applicable for all the populations and each country should generate its separate national standards.[17] In some studies conducted in the country, the comparison between BMI percentiles of Iranian children and the percentiles of the control center for diseases and other foreign references showed a considerable difference which emphasizes the necessity of creating a national standard.[11,18-20]

The result of a study about growth trend of Iranian children and teenagers showed that the mean height and weight of girls and boys have increased. In spite of these increases, the median height and weight of Iranian girls and boys aged less than 15 years was under 20th percentile of the US. National Center for the Health Statistics. This shows the necessity of cultural education along with the economic development in order to eliminate the gaps in growth and development of infants and children.[21] Hence, it is suggested that, as one of the major decision-makers, the Iranian Ministry of Health and Medical Education with the cooperation of educational and research centers makes an effort for determination of locally height and weight standards.

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