Review Article
DOI: 10.5455/amaj.2021.01.005

Azerbaijan National Growth Charts for Children and Adolescents from Birth to 16 Years

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Objective: Establish Azerbaijan national growth charts for children and adolescents, and conduct a comparative analysis of local growth references with the growth standards of the World Health Organization (WHO), The Centers for Disease Control and Prevention (CDC), and Turkish children growth references.

Material & methods: This study included the collection of anthropometric measurements from birth to 16 years based on a mixed longitudinal and cross-sectional study. Cole's LMS statistical method was used to smooth growth curves and create age percentiles.

Results: A total of 19280 weight and height data (47.8% of which were girls), and 12246 were head circumference data (46.8% of which were girls) were analyzed; and national percentiles diagrams for weight-for-age and height-for-age from birth to 16 years, head circumference-for-age from birth to 3 years, and BMI-for-age from 2 to 16 years were composed. As a result, a comparative analysis was carried out.

Conclusion: The revealed high BMI from local children and adolescents is an alarming sign, as being overweight in childhood can have serious consequences in adulthood.

Keywords: Body Mass Index, growth charts, head circumference, height, weight.

Introduction

Growth charts are an important tool for assessing and monitoring the growth of children, both in pediatric practice and in public health organizations [1,2]. Growth charts are presented in the form of curves and tables to help visualize anthropometric data [3]. They provide an opportunity to assess the state of health and nutrition at both the individual and population levels [4]. Growth charts have come a long way in 200 years, and they represent an impressive synthesis of anthropometry, statistical summary, and chart design [5]. Growth charts are the standard accepted way to monitor growth, diagnose disease, and monitor improvement [6]. Using these, specialists can compare the anthropometric parameters of one child with the parameters of a large group of children of the same age and gender [7]. Early diagnosis of deviations from the norm makes it possible for specialists to timely identify the presence of diseases, problems with food, lifestyle, or care; predisposition to pathological conditions [8]. Since there are no national growth charts in Azerbaijan, local specialists use Turkish growth charts in their practice [9], given the proximity of peoples and WHO growth standards [2,10]. WHO growth standards (Multicenter Team, WHO Growth Survey 2006) for children between 0 and 5 years, based on measurements of children from six countries, were developed under the assumption that children who are raised under good conditions grow similarly in the first years of their lives irrespective of their genetic predisposition [11]. These standards were recommended for international use [2]. Also, they had endorsed by over 150 countries of the world and became an integral part of their growth assessment [5].

The reference values proposed for use in children older than 5 years are based on the revised version of the National Center for Health Statistics (NCHS) that has been in use in the United States since 1977. These latter charts are known as the 2000 Centers for Disease Control (CDC) Growth Charts [2,7]. Thus the WHO references for older children were developed by the merging and smooth transition of these data [7]. However, some countries have their national growth charts [9,12,13,14,15,16,17,18,19,20]. As there still may be differences in healthy growth among populations that are explained by genetic, ecological, nutritional, or other differences between populations. The Azerbaijan National Growth Study was held to provide comprehensive data on the growth pattern of local children and to compare them with currently used in the country the Turkish/WHO/CDC reference values.

Materials and methods

The study was conducted based on the pediatric department of the Baku Medical Plaza from 2015 to 2020. The study has used a combination of longitudinal with cross-sectional research sampling methods based on age and gender. Were collected anthropometric measurements from children aged 0-16 years. A total of 19280 weight and height data analyzed, of which 9221 were girls (47.8%) and 10059 were boys (52.2%); and 12246 were head circumference data analyzed, of which 5731were girls (46.8%) and 6515 were boys (53.2%). The selection criteria for the participants in this study was close to the criteria of the MGRS [21]. Healthy full-term babies (born to an Azerbaijani father) were included in the research, from singleton pregnancy, without chronic and congenital health abnormalities that could affect their growth. Children grew up in a social-economic and ecological supportive environment where factors that negatively affect growth were minimized, including poor nutrition and infections. Mothers adhered to a healthy lifestyle, for example, there was no smoking. All criteria of the MGRS also were adhered to regarding breastfeeding [22], because it was considered as a physiological norm: 1) exclusive or predominant breastfeeding for at least 4month; 2) introduction of complementary foods between 4 and 6month; and 3) partial breastfeeding to be continued up to at least 12month.

Although the study was based on one clinic, not only all 12 districts (raion) of Baku were covered: Binagadi, Garadagh, Khatai, Khazar, Narimanov, Nasimi, Nizami, Pirallahy, Sabail, Sabunchu, Surakhany, Yasamal; also other cities and districts of Azerbaijan: Shirvan, Ganja, Lankaran, Mingachevir, Naftalan, Neftchala, Shaki, Sumqayit, Yevlakh, Nakhchivan, Khirdalan, Masally, Barda, Beylagan, Balakan, Hajiqabul, Imishli, Ismayilli, Kurdamir, Qabala, Qakh, Qazakh, Quba, Qusar, Saatly, Sabirabad, Salyan, Shamakhi, Shamkir , Shabran, Tovuz, Ujar, Khachmaz, Zaqatala, Agstafa, Agsu, Aghjabadi, Gadabay, Yardimli. This did possible because our medical center popular among the local population and accepts pregnant women and women in labor from as all over the city and also from all parts of Azerbaijan. Infant data were taken from the neonatal unit (weight, length, head circumference). A larger part of the children born in our center continued to undergo scheduled pediatric examinations with vaccinations according to the calendar in the children's department of our center. Mentioned above created an opportunity for our team to conduct a longitudinal examination of these children. Healthy children with the appropriate criteria, which were born in other clinics. However, who passed the examination at our center one or more times, also participated in the study. In the pediatric unit, at each visit, anthropometric measurements were collected from each child.

5 trained nurses performed all measurements, using standard equipment and methods [21,23,24]. The instruments used for the measurements were checked at the beginning of each day as the equipment required precise calibration. Electronic measuring devices were checked once a month for serviceability and accuracy. The medical personnel received training every six months. Differences within and between observers were also assessed by calculating the technical measurement uncertainty.

Weighing of infants was carried out without clothes on electronic scales with a Seca-232 height rod with restraints for the head and legs. With this kit, you can quickly and accurately determine the weight and height of the baby at the same time. Children from 1.5-2 years old were measured standing without shoes and outerwear, without jewelry on their heads, using medical electronic scales with a Tcs-200-Rt height rod or Wolf electronic floor scales and a wall height rod, installed at right angles to the level floor and leaning against a straight vertical plane. When measuring growth, the back of the head, shoulder blades, buttocks, calves, and heels should have touched a vertical plane. The child's body weight was recorded with an accuracy of 0.1 kg, the child's body length in centimeters with an accuracy of 0.1 cm. When measuring the height of a child under 2 years old in a standing position, 0.7 cm was added to the result obtained to obtain the length body (according to the WHO recommendation, the height in the standing position is less than the length of the body in the lying position by about 0.7 cm).

Head circumference was measured with a flexible, non-stretching centimeter measuring tape. For maximum accuracy when measuring, children had to look straight ahead. A measuring tape was applied to the patient's head along with the landmarks: behind the occipital protuberance, in front of the super ciliary arches. The measurements were carried out twice taking into account the average value.

This study has fulfilled all the ethical approach from every stage of the research and was has been approved by the local ethical committee. Collection of anthropometric in both younger and older age groups was a part of medical examination.

Data for the first year of birth were collected monthly (0 (data obtained from hospitals), 0.5 to <1.5, ≥1.5 to <2.5, and so on.), from a year to three years every three months (eg.14.5 to <15.5, 17.5 to <18,5 and so on.), from three to six years every 6 months (eg.35.5 to <36.5, 41.5 to <42.5 and so on.), from 6 to 16 years, once a year. The age intervals in older group were ≥5.5 to <6.5, ≥6.5 to <7.5, ≥7.5 to <8.5, ≥8.5 to <9.5, ≥9.5 to <10.5, ≥10.5 to <11.5, ≥11.5 to <12.5, ≥12.5 to <13.5, ≥13.5 to <14.5, ≥14.5 to <15.5, ≥15.5 to <16.5. Measurements were presented by rounding. For example, for the age of 2 months and <15 days was expressed as 2 months; 2 months and >15 days was expressed as

3month; a height of 60.52 cm as 60,5 cm. Age was determined to the nearest month using the date of birth shown on the birth certificates before the date of measurement. In case of early interruption of breastfeeding or diagnosis of any chronic or congenital diseases and any disorders in the examined children, they were excluded from the study. Children from multiple pregnancies, children born before 37 weeks of pregnancy also were excluded. Children could participate in study 1 or more times, on average 8 +/-5 children under 5 years old and 3 +/-2 in older children. So how, about 80% of the examined children in our clinic were children of preschool age, for the study of the older group, it was decided to connect secondary schools and collect anthropometric measurements for children and adolescents 6 to 16 years. In the older group, from each examined was collected 3 + _2 data. Children underwent a questionnaire survey: about passport data, a short family history, the presence or absence of chronic health problems. The study participants were from socially well to do families, whose parents mostly had higher education. The physical assessment of secondary school students was carried out in the school doctor's office. Each student had a health card, and anthropometric measurements were entered there. Personal data, health status, presence or absence of chronic health problems were also recorded in this card. The weighing was carried out without shoes and outerwear on an electronic scale, height was measured while standing. Although the younger group (children until five years) covered most of the cities and regions of Azerbaijan, the older group (children from 6 to 16 years) included generally children and adolescents, who live in Baku. Considering that the capital has received immigrants from all over the country for many years, the mixed composition population of this city can be considered quite representative for this research. The collected values of anthropometric data were grouped by gender and age. Statistical reporting was carried out using the Microsoft Office Excel (2010) software package by the method of variation statistics. Data was cross-analyzed. The LMS method was used to smooth growth curves with estimates of L, M, and S parameters [25,26]. The growth model LMS by Cole &Green was used to help create the growth charts [27]. This method assumes that the measurement at each age can be transformed to a normal distribution using a Box-Cox transformation [28], and just three parameters, the Box-Cox power λ, the median μ, and the coefficient of variation σ, summaries the distribution. For the construction of LMS scores for our study was used LMS Chart Maker Pro version 2.54 (Harlow Healthcare, Tyne and Wear, United Kingdom). The resulting models were checked for the goodness of fit using the detrended Q-Q plot, Q Tests, and worm plots.

Results

We present national percentiles diagrams for weight-for-age, height-for-age from birth to 16 years old, head circumference-for-age from birth to 3 years and BMI-for-age from 2 to 16 years. Percentile values of growth charts were calculated at the 3rd, 10th, 25th, 50th, 75th, 90th and 97th percentiles as in the standard growth charts [1]. BMI-for-age charts were integrated from age 2 to 16 years because they are recommended to screen children two years or older. The BMI-for-age charts additionally included the 85th percentile line, which was a cutoff point for the diagnosis of overweight children, also there are 5th and 95th percentile lines that indicate malnutrition and obesity cut-offs [29]. For comparative analysis, curves were compiled with mean values weight, height, HC, and values BMI for 50th,75th,85th percentiles for some ages for each gender.

Growth curves are shown in curves 1-8.

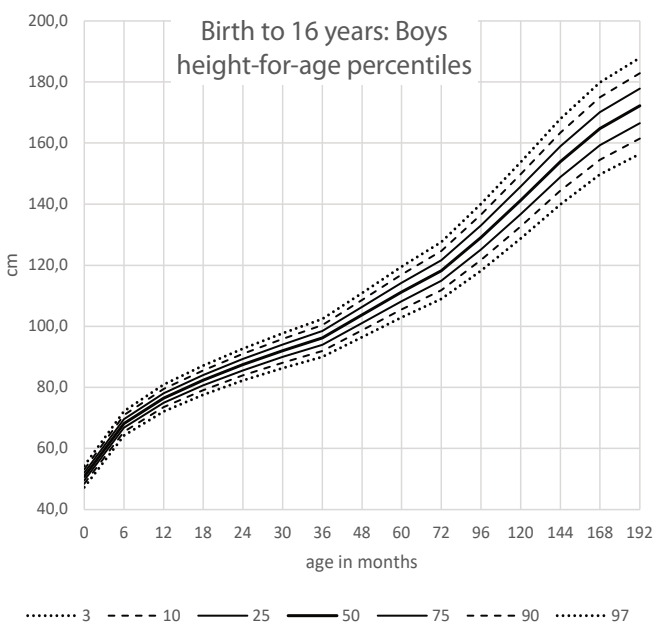

Figure 1. Birth to 16 years: Boys height-for-age percentiles.

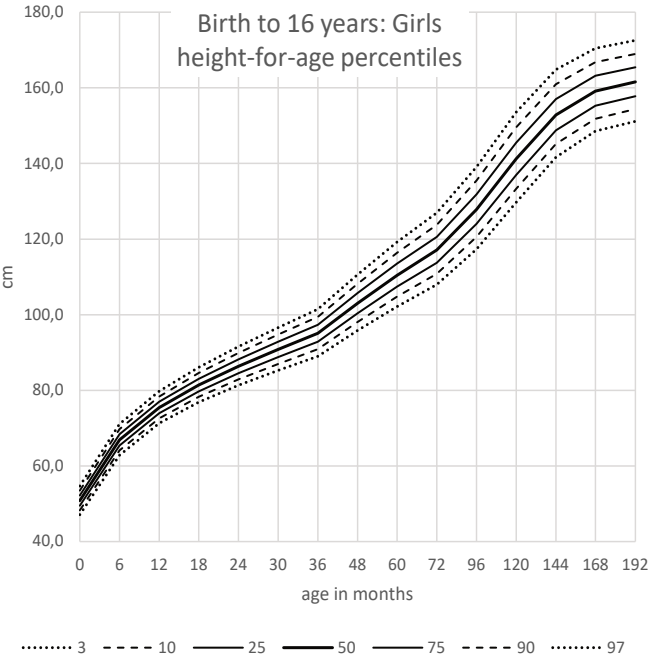

Figure 2. Birth to 16 years: Girls height-for-age percentiles.

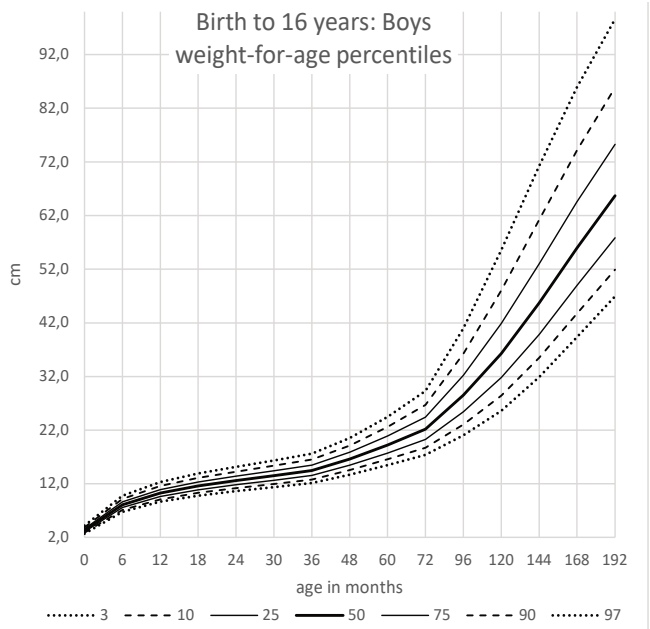

Figure 3. Birth to 16 years: Boys weight-for-age percentiles.

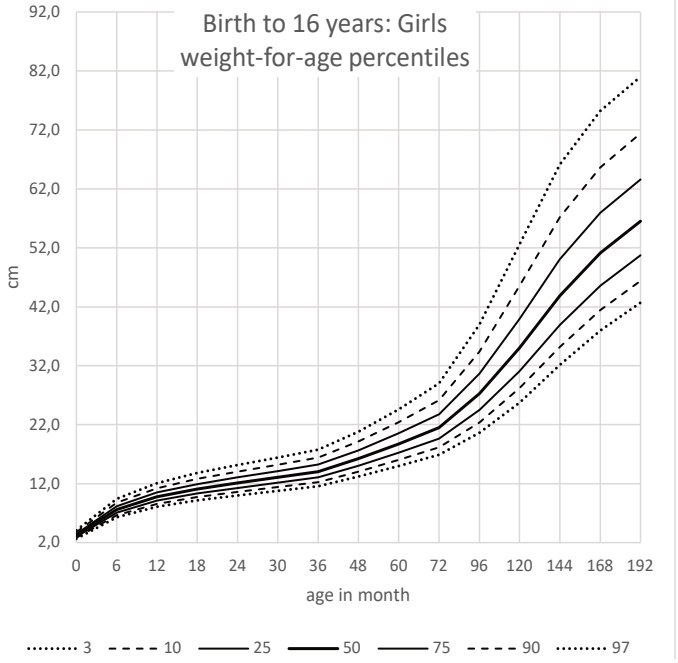

Figure 4. Birth to 16 years: Girls weight-for-age percentiles.

Discussion

Interpretation. The main aim of this study was to collect reference data to be used as a basis for the development of clinically relevant and up-to-date growth charts for local children. In our study, we used the same diagnostic criteria, which was described in the MGRS research [11], that is the study population was a selective one and consisted of children exclusively from well to do families. Since the goal was to display the growth potential of the child population in a favorable environment, to exclude

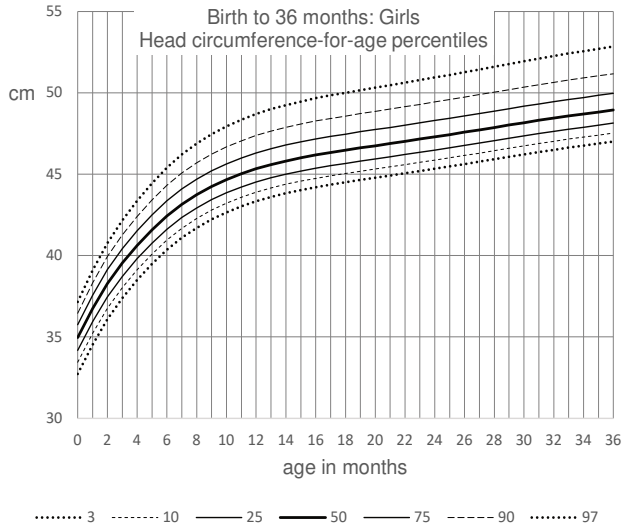

Figure 5. Birth to 36 months: Girls.
Head circumference-for-age percentiles.

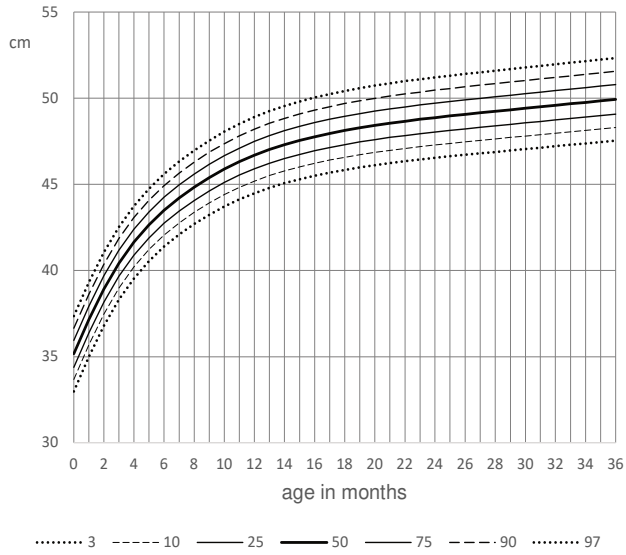

Figure 6. Birth to 36 months: Boys.
Head circumference-for-age percentiles.

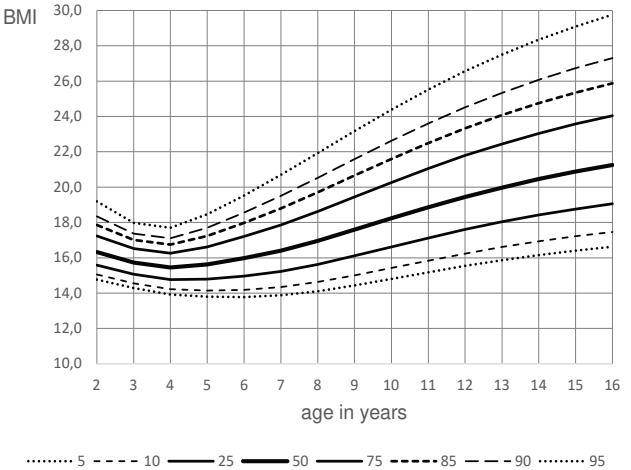

Figure 7. 2 to 16 years: Girls. BMI-for-age percentiles.

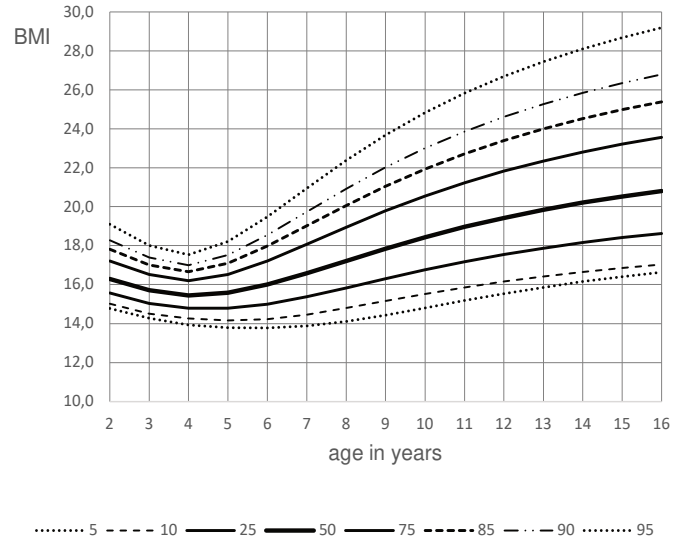

Figure 8. 2 to 16 years: Boys. BMI-for-age percentiles.

adverse effects on the growth of both social-economic and environmental conditions which could have taken place, in the representative sample of the population in Azerbaijan.

Comparison. Length/height and Weight: Values of length/height and weight for local children aged 0 – 4 years we can say not much different from Turkish growth charts and from WHO/CDC growth standards. However, in children older than 5 years of both gender, we observe mean values for height and weight are relatively higher. Although in adolescence, both sexes show a decrease in height compared to both Turkish indicators and WHO/CDC, however, weight indicators remain high. A growth spurt in local girls starts at the age of 9 and slows down significantly already at 15 years old, in boys the jump begins at the age of 10 and after 15 there is a slight slowdown. this can be explained by the predisposition of this population to early puberty. The relatively low growth in adolescents is most likely due to the ethnic and geographic characteristics of the respondents. Head circumference: Mean percentile values head circumference from local boys are not positioned above the WHO/CDC standards for children until 2 years and stay less than Turkish, although by the age of 3 years they become higher than WHO/CDC values, and are closer to Turkish indicators. Mean percentile values of head circumference from local girls are less than Turkish values, close to indicators CDC, but higher than WHO. Body mass index: Of particular concern was the high BMIs in both boys and girls, starting at the age of 6 years. High indicators of weight and BMI are noted both in average indicators and in high percentile indicators. In girls, BMI is higher on average by 1.0, in boys by 2.0 units. Boys in the 75th percentile in our study had a BMI of 23.6 and girls had a mean BMI of 24 at 16 years, these indicators are high and only are just under the adult cut-off for overweight. The 85th percentile in this study shows the index has higher levels than 25 in both gender: of boys-25.4, of girls-25.9. Weight measurements and BMI results indicate that Azerbaijan children, like children in other countries, are prone to become overweight from an early age and that obesity reaches significant proportions starting in pre-pubertal years. The rising trend of BMI rings alarm bells in terms of associated adverse health consequences in adulthood. Similar to other countries, the Azerbaijan population is threatened by an epidemic of obesity starting at young ages. Child or pediatric obesity is now an important public health problem worldwide, especially in developed countries [30]. Comparison curves show in figures 9-16.

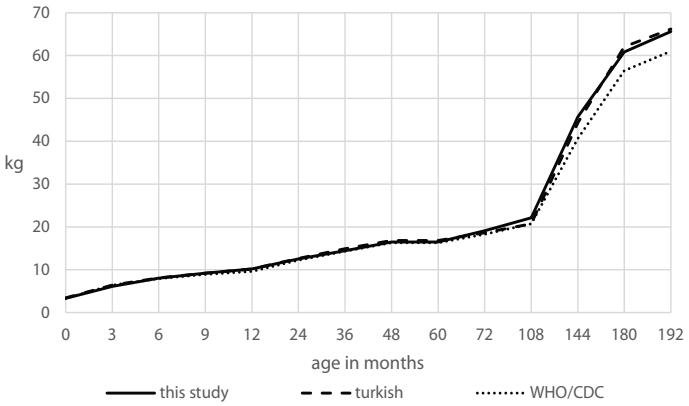

Figure 9. Comparison weight of boys (mean values) from this study, Turkish and WHO/CDC data

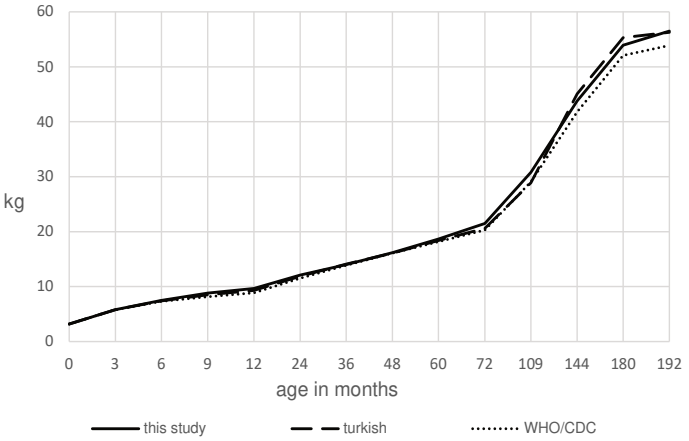

Figure 10. Comparison weight of girls (mean values) from this study, Turkish and WHO/CDC data

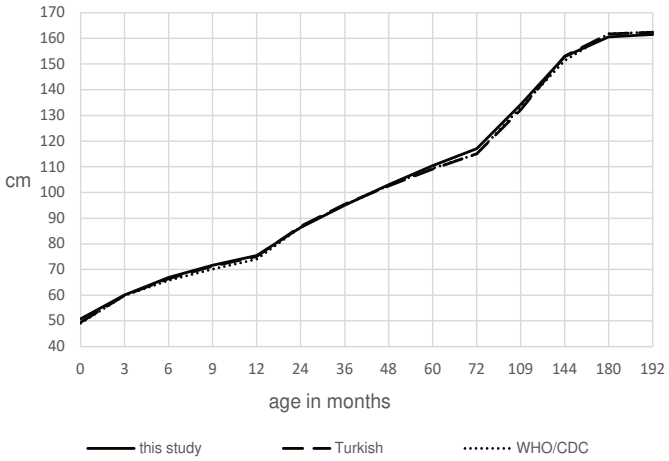

Figure 11. Comparison height of girls (mean values) from this study, Turkish and WHO/CDC data

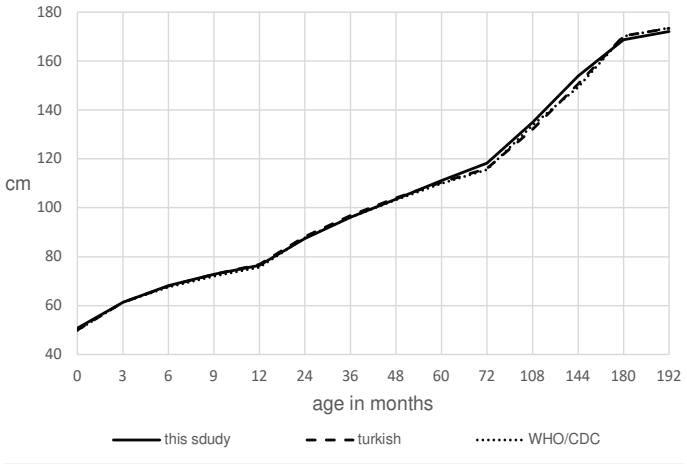

Figure 12. Comparison height of boys (mean values) from this study, Turkish and WHO/CDC data

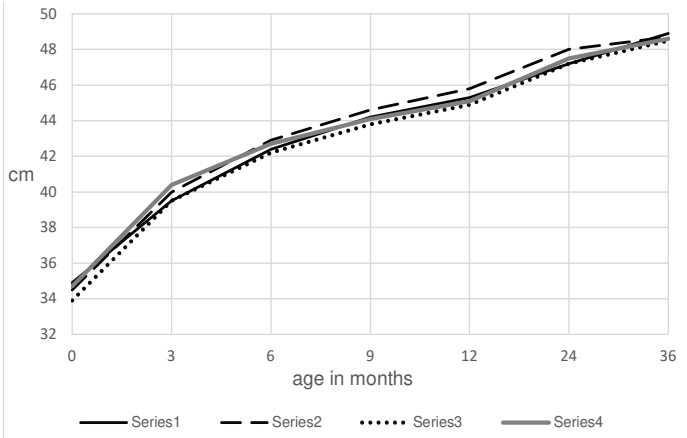

Figure 13. Comparison head curcumference of girls (mean values) this study, Turkish, WHO and CDC data

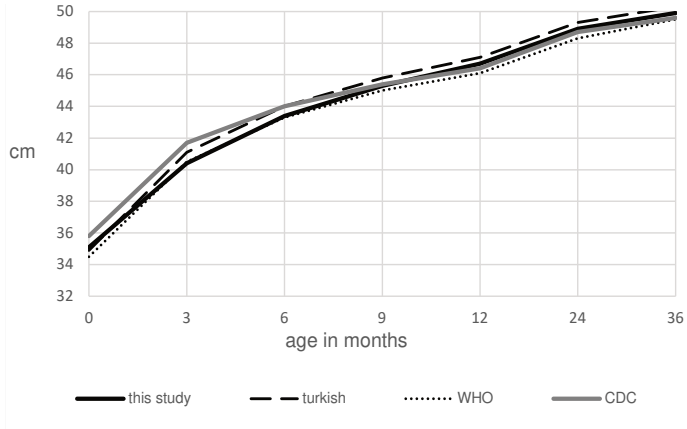

Figure 14. Comparison weight of boys (mean values) from this study, Turkish and WHO/CDC data

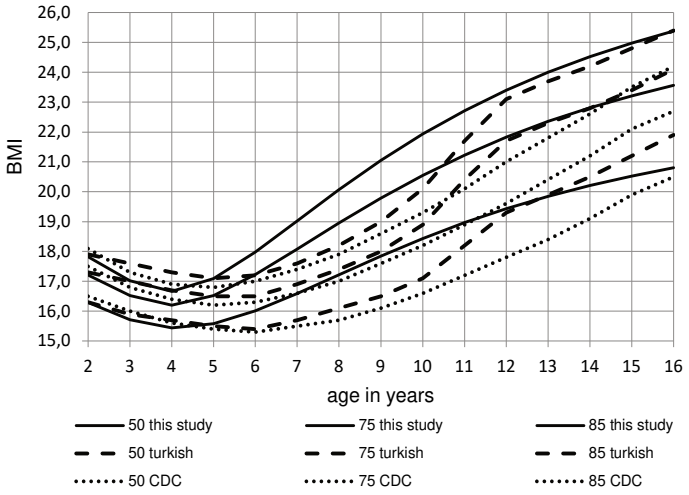

Figure 15. Comparison BMI of boys (50th, 75th, 85th persentiles) from this study, Turkish and CDC data.

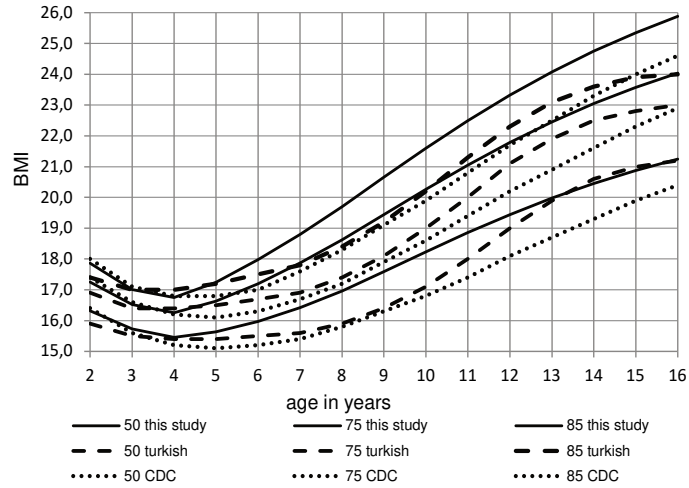

Figure 16. Comparison BMI of girls (50th, 75th, 85th persentiles) from this study, Turkish and CDC data.

Conclusion

We present Azerbaijan national growth charts for children and adolescents, and recommend them for screening and monitoring growth. Growth is one of the best markers of health status both individually and for the population. However, recommended that growth references should be updated regularly [1], because the pattern of growth of children can change with time. Updated references give more exactly informed health to children in the research population currently. This study showed, that local children and adolescents predisposed to overweight. It is an alarm sign that requires the intervention of both medical representatives and nutritionists to promote a more active lifestyle and healthy diet.

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