

Anthropometric measurements illustrating the socio-economic effects on growth and development in a subadult sample population in Romania

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Abstract: In Romania, the age estimation protocol for children consists of anthropometric measurements, odontostomatology, Rx imaging and the assessment of secondary sexual characteristics. The present study compares certain anthropometric measurements (height, weight, body mass index), part of the age estimation protocol, obtained during the medico-legal expertise undertaken at “Mina Minovici” National Institute of Legal Medicine with the international standards of World Health Organization. Anthropometric expertises of 804 subadult subjects were retrieved from the “Mina Minovici” National Institute of Legal Medicine archive, data being recorded between 2002 and 2011. In a retrospective observational study we followed the anthropometric measurements for subadult subjects, ages between 1 year and 18 years, investigating the growth pattern and development of children depending on age and gender. At the time of the examination, date of birth was not recorded in the national registry office, but in most cases the chronological age was known from the medical birth certificate issued in the maternity hospital. Therefore, anthropometric measurements in these cases and the age estimation could be compared with the presumed age that had a high degree of probability. We systemized the data for different stages of childhood and by gender, demonstrating that the growth pattern in our study population followed a lower growth curve than the international standards, thus confirming the influence of the socio-economic status.

Key Words: anthropometry, age estimation, subadult, socio-economic status.

INTRODUCTION

Anthropometry (from greek “Anthropos” and “metron” meaning human and “measurement”) represents the branch of anthropology that studies measurements and proportion determinations of the human body [1]. In Romania, the age estimation protocol for children consists of anthropometric measurements, odontostomatology [2], Rx imaging [3-5] (especially radiography of the left hand) and the assessment of secondary sexual characteristics. The advantages of the anthropometric measurements are seen and used in many medical fields, such as: legal medicine, paediatrics, orthopaedics, endocrinology, diabetes and sports medicine. In paediatrics, growth and development

of children are monitored by various ratios and body indices [6], as body mass index (BMI), subsequently these measurements are further used to develop national measurements standards known as “growth charts” [7]. The standard in anthropometric measurements is elaborated based on age and gender. The estimation of the children's age is made by quantification of different anthropometric criteria, represented by: height, weight, cranial, thoracic and abdominal diameter, the thickness of the skin folds, the circumference of the arm (8). Our study compares certain anthropometric measurements (height, weight, BMI), part of the age estimation protocol, obtained during the medico-legal expertise undertaken at “Mina Minovici” National Institute of Legal Medicine with the international standards of World Health Organization

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[9,10]. Our aim was to determine the influence of the socio-economic level on the children's growth pattern. We systemized the data for different stages of childhood and by the gender, demonstrating that the growth pattern from our study population followed a lower growth curve than the international standards, thus confirming the influence of the socio-economic status.

MATERIAL AND METHOD

As required by the national legislation [11], medico-legal expertise was performed in the "Mina Minovici" National Institute of Legal Medicine, the archives were the source for the anthropometric measurements in case of 804 subadult subjects, data that was recorded between 2002 and 2011. The chronological age was presumed with a high degree of probability as all of our subjects had a medical birth certificate issued by the maternity hospital, even if the birth had not been declared at the national registry office. We did not include in our study the individuals that had a presumed age of over 18 years at the time of the medico-legal examination. All children included in our study were eligible for measurements. We conducted a retrospective observational study and we included the anthropometric measurements for subadult subjects, ages between 1 year to 18 years, investigating the growth pattern and development of children depending of age and gender.

In these types of expertises there are some basic requirements needed to ensure the physical and psychical comfort of the individual [12] as well as the accuracy of the anthropometric measurements, such as: the room where the measurements are carried out must be properly equipped in order to obtain results as accurate as possible; the equipment required for the measurements is represented by: the scales and the calibration weights of the scales (used at the beginning, at the middle and at the end of each measurement), the digital/portable scale, the stadiometer, the infantometer, the Holtain instrument used for the measurement of the fold of the skin at the subscapular and tricipital level, head circumference measurement band, height correction ruler [13,14].

The following instruments and measurement methods were of interest for our study:

- children are weighed using Fazzini scales and the result is displayed in kilograms. At the time of the measurements, they wore light clothing for an accurate result. The measurement is done in the upright position of the body with hands on the side.
- the length was measured from birth until the age of 47 months, according to the protocol, horizontally, using the Infantometer, a measuring instrument that should be fixed among the head and feet of the examined children.
- the height was measured in children from the age of 2 years using the Stadiometer. The measurement

would be made from the upright posture with hands on sides. The head, the scapula, the gluteal muscles and the calcaneus will reach the measurement surface and the lower limbs will be directed outward in such way as to create a 60 degree angle [14,15].

RESULTS

Our study included 804 subadult subjects, 423 were boys and 381 girls (Fig. 1), thus a superior ratio in favour of the male subjects, all divided into age groups. The data collected for this study was statistically processed and depicted in graphics as follows, comparing the results with the international standards [9,10].

The maximum number of the surveyed children was 64 in the age group of 3 to 4 years, of which 34 boys and 32 girls, while the minimum number, 22, was encountered in the 12 to 13 age category, of which 7 boys and 15 girls. The largest proportion of male subjects has been recorded in the age group of 2 to 3 years, a total of 40, and the smallest, 7, encountered in the 12-13 age category and for the female subjects, the highest ratio, 34, was registered in the 3-4 years age range, while the lowest ratio, 14, was observed in the 16-17 age category.

For all subadult subjects we have analyzed specific characteristics of growth and development stages. The average weight of the boys, measured in kg is showed in Figure 2, the lot is divided into age groups, from 1 to 18 years and the results were compared with those in the literature [9, 10, 14]. The biggest difference compared to the ideal weight for age was recorded within the 16-17 age group, the difference being of 5.36 kg, while in the age group of 5-6 years the lowest difference of 0.27

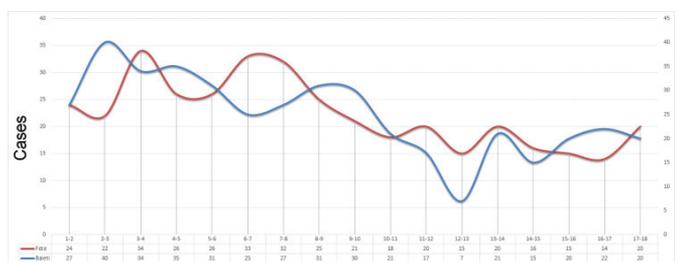


Figure 1. Graphic representation of the number of boys (blue) and girls (red).

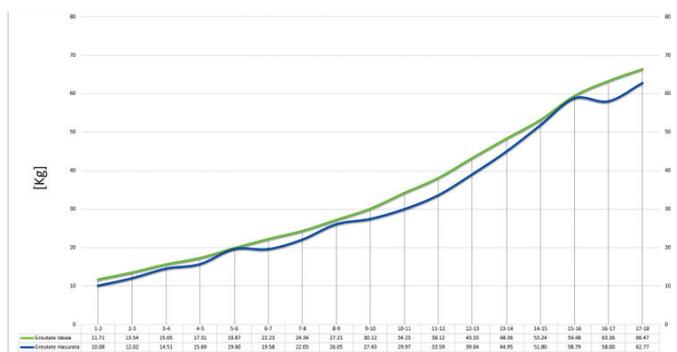


Figure 2. Graphic representation of the number of boys (blue) and girls (red).

kg was noticed. Analyzing the chart we can easily observe the fact that the average weight of our subjects was below the ideal weight for age displayed in the literature within all age groups analyzed.

The average weight of the girls, measured in kilograms (kg), is depicted in Figure 3, the population being divided in categories of age, from 1 to 18 years and the results were compared with those in the literature [9, 10, 14]. The biggest difference in weight compared to the ideal weight for age, was recorded within the 12-13 age group, the difference being of 3.85 kg, while the lowest difference between these two values can be noticed in the 1-2 years category of age, the difference being of 0.43 kg. Analyzing the chart we can easily observe the fact that the average weight of our subjects is minor within all age groups analyzed compared to the ideal weight for age displayed in the literature. We registered one exception, in the 13-14 age group where the measured average weight was of 48.09 kg, compared to the appropriate values for age, which according to the standards are 47.57 kg, the difference being of 0.52 kg.

Figure 4 indicates the average height of the boys, measured in centimeters (cm), the lot being divided by categories of age, from 1 to 18 years and the results were compared with those in the literature [9, 10, 14]. As a result of our measurements compared to the ideal height standards of boys for different ages, we found the biggest difference in the 15-16 age range and it counts for about 6.84 cm, while the slightest difference was in the 3-4 years age group, 1.01 cm.

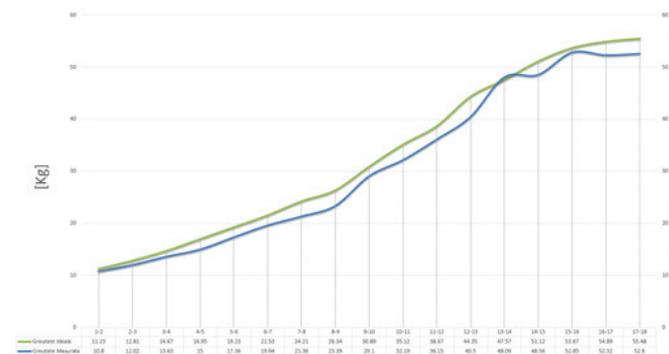


Figure 3. The girls average weight (blue) in this study and standard weight for age (green).

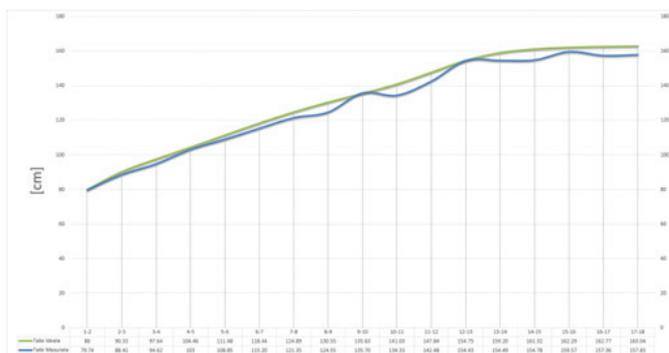


Figure 5. The average height of the girls in this study (blue) and the standard height for age (green).

We found that the average height of our male subjects within all age groups is below the ideal height, these fluctuations of height generally depending on the age group.

Figure 5 indicates the average height of the female subjects, measured in centimeters (cm), the lot being divided by age categories, and data compared with those in the literature [9, 10, 14]. We found that the biggest difference between the average height of the girls in our study population and the one from the specific literature is within the 10-11 age range and is about 6.70 cm, while the minimal difference was encountered in the 9-10 years age range and is about 0.07 cm. It is clear that the average height of our female subjects is below within all age groups analyzed compared to the ideal height displayed in the literature.

Figure 6 represents the average body mass index (BMI) in the male subjects that is stated by the ratio between weight, measured in kilograms and height in square meters. The average body mass indexes were compared with standard results in the specific literature [9, 10, 14]. After comparing the results, we could see that the largest difference between the BMI in our lot and the ideal is found in the age range of 1-2 years, being 1.47 kg/m², and the smallest difference is found in the age category 9-10 years, of 0.01 kg/m². The average body mass index of our male subjects has a lower value compared to the ideal body mass index presented in the specific literature except for the following groups of age: 5-6,8-9, 9-10,14-15 and 15-16 as well.

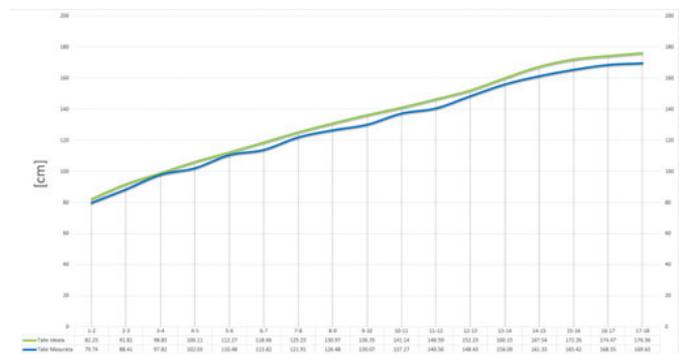


Figure 4. The boys average height (blue) in this study and standard height for age (green).

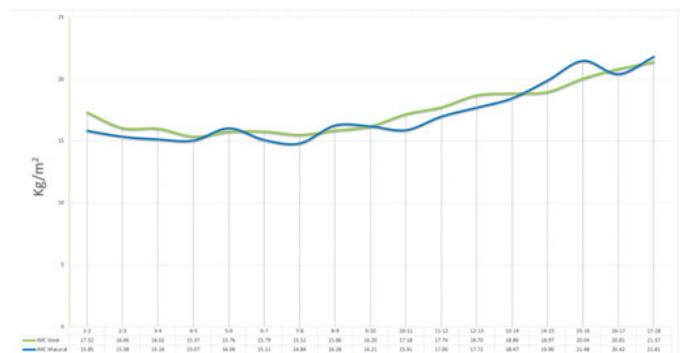


Figure 6. The average body mass index in our study (blue) and the standard body mass index for boys (green).

Figure 7 presents the average body mass index in our study population compared to standard results from the literature. We observed that the largest difference between the BMI in our female subjects and the ideal average is found in the age range of 12-13 years, of 1.54 kg/m², and the smallest difference is found in the age category 11-12 years, of 0.12 kg/m². Our results show that the average body mass index of our female subjects has a lower value compared to the ideal body mass index presented in the literature except for the following age ranges: 10-12, 14-18, where the average body mass index is superior to the ideal one.

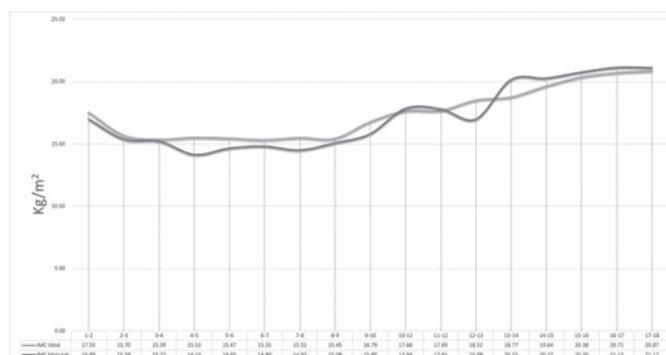


Figure 7. The average body mass index in our study (blue) and the standard body mass index for girls (green).

DISCUSSION

According to the legislation in Romania a medico-legal expertise for age estimation is required for all individuals without a birth certificate, meaning that they are not recorded in the national registry office database [10]. In our study population the including criterion was the availability of a medical birth certificate issued by the maternity hospital in the medico-legal examination for age assessment performed at the Institute.

A child's growing pattern is influenced by multiple factors like: genetic factors, environment, nutrition, socioeconomic status, hormones, geographical influences [16-18].

The present study provides age and gender specific statistical results based on anthropometric measurements (including height, weight and BMI), obtained from a lot of 804 subadult subjects from Romania, from a low socioeconomic family status, following a retrospective observational study. Additional non-medical data recorded at the time of the age assessment expertise brought new insight concerning concurrent situations; the cases selected had at least one of the following characteristics: young parents, homelessness, social welfare, unknown father, low income families, consequently exemplifying the low socioeconomic status.

We have analyzed specific characteristics of growth and development stages on male and female

subjects, studying a number of 423 cases of male children and 381 female children. There are several techniques that allow the assessment of body composition, however, anthropometric measurements are the most widely used methods for the age determination in children, mostly because they are non-invasive [12] and use portable equipment [19].

The results of our study show that the average weight of our male subjects was below the paediatric growth standards for age within all age groups, while, in the female subjects, the average weight is also below bellow the paediatric growth standards for age within all age groups, except for the 13-14 years age, where the measured average weight is 48.09 kg, 0.52 kg above the standards (47.57 kg).

Our study results show regarding height that the average measures of our male and female children subjects are below the paediatric standards for age, within all age groups, with the mention that these fluctuations of height are dependent on age.

The socioeconomic environment is a confirmed factor impacting the growth pattern and health of an infant, with long-term effects and the results of our study indicate that low socioeconomic status influences children's growth and development by lowering the growth curve (for height and weight) in both genders at all age groups. Therefore, in the attempt to emphasise these findings, we compared our results with those communicated by other researchers in this area of interest.

Several studies reported similar findings. In 2014, Patel and co-authors also found that in a middle income country, socioeconomic differences start their impact in pre-natal period and early childhood, factors like baby feeding, maternal smoking and overcrowding can generate up to approximately 2 cm difference in height at pre-scholars [20].

The studies by R. Hakeem conducted in the department of food and nutrition in Karachi, Pakistan and P. M. Casey and collaborators have encountered that general height and weight were both affected by socioeconomic status, a height deficit was evident in the lower income level groups, in all age-gender groups [21, 22], socioeconomic differences in weight are not uniform among all gender and age groups, reporting also deficit and excess weight among low-income classes.

Our study did not confirm the pattern of modifications regarding weight for age, previously stated and retrieved by other studies, values above the appropriate weight for age, by analyzing the influence of socioeconomic status on children's development and growth [23, 24]. This fact was attributed to endocrine disrupters with changes in the functioning of the endocrine system in the period of development that lead to child obesity, also associated with low socioeconomic status [17, 21, 22].

Metabolic programming became of great interest for recent studies focusing on the developmental origin of health and disease and have identified links between early nutrition, epigenetic processes, and long-term growth and illness [25, 26]. The importance of epigenetic factors in normal development of humans has been proven without doubt, thus sustaining that a child can be influenced of the lifestyle and living condition of his parents [27-29]. Recent studies revealed children suffering of obvious sexual dimorphism in response to environmental insult [30, 31].

In conclusion, the results of our study illustrate, using anthropometric measurements, that the subadult sample population in Romania with a low socioeconomic

status has a growth curve below the international standard for age for both genders in all age groups. The exception found in female subadult group, 13-14 years, could be explained by malfunctions of the endocrine system also attributable to low socioeconomic factors. Further research is required to determine the mechanism for children's growth pattern and development as a consequence of the socioeconomic status taking into consideration the discrepancies of our results and the recent literature regarding weight for age.

Conflict of interest. The authors declare that there is no conflict of interest.

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