

The Incidence of Developmental Disorders Linked to Stature and Weight in the Case of Secondary School Pupils

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Abstract

Introduction. The development of stature and weight during puberty represents the results of complex interactions between a series of intrinsic and extrinsic factors which determine the accelerated change of the anthropometric parameters and indexes. *The purpose* of this study is to determine the quality of physical development in the case of secondary school pupils (in puberty) and to identify the ways in which one can intervene to improve it. *Material and method.* The study group consisted of a representative lot from a school in Timisoara who underwent a questionnaire with questions oriented mostly towards lifestyle, level of physical activities conducted and nutritional habits, as well as a complex protocol of somatoscopic and somatometric evaluation. *Results:* the values of the anthropometric parameters and indexes are situated as average values within the normal limits according to the age and gender of those investigated; still, there is a relatively high percentage of deviations from these values (concerning both dimensions), both in regard to nutritional state and in regard to the stature's development; even though these deviations can be partially explained by the fact that the evaluated pupils were in various stages of puberty, still the presence of some unfavourable influences due to nutritional habits, a low level of physical activity and passive resting in the case of many of the pupils questioned is remarkable. *Conclusions:* an important part of the study group is aware of the existence of some negative aspects related to physical aspect, nutritional habits, physical activity conducted, and is willing to be counselled by specialists in these areas; there is also a small percentage of pupils who have acknowledged their problems upon being questioned for this study and is willing to address them.

Rezumat

Introducere. Dezvoltarea staturo-ponderală la pubertate reprezintă rezultatul unei interacțiuni complexe dintre o serie de factori intrinseci și extrinseci care determină modificarea accelerată a parametrilor și indicilor antropometrici. *Scopul* acestui studiu este reprezentat de aprecierea calității dezvoltării fizice la elevii ciclului gimnazial aflați la pubertate și de identificarea modalităților de intervenție asupra acesteia. *Material și metodă.* Grupul de studiu a fost un lot reprezentativ al unei școli timișorene căruia i s-a aplicat un chestionar cu întrebări orientate cu precădere spre stilul de viață, nivelul activității fizice realizate și obiceiurile nutriționale, precum și un protocol complex de evaluare somatoscopică și somatometrică. *Rezultatele* au arătat că valorile parametrilor și indicilor antropometrici sunt situați ca, valori medii, în limitele normale corespunzătoare vârstei și sexului celor investigați; totuși, există într-o proporție relativ crescută abateri semnificative de la aceste valori (în

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ambele sensuri), atât în ceea ce privește starea de nutriție cât și în cea a dezvoltării staturale; deși aceste abateri se explică parțial prin faptul că elevii evaluați se aflau în diferite etape ale pubertății, totuși, este remarcabilă și prezența (la mulți dintre elevii chestionați) a unor influențe nefavorabile datorate alimentației, nivelului scăzut al activității fizice și al odihnei pasive. *Concluzii:* o parte importantă din grupul de studiu este conștientă de existența unor aspecte negative ale dezvoltării saturo-ponderale, ale stilului de viață și este dispusă să fie consiliată de specialiști în aceste direcții; există și o mai mică proporție de elevi care și-au conștientizat problemele cu ocazia realizării studiului, dar sunt și aceștia dispuși să le remedieze.

Cuvinte cheie: pubertate, dezvoltare fizică, parametri și indici antropometrici

Introduction

Normal growth is defined by progression in weight and height, in accordance with the standards established for age and gender, in relation to the individual genetic potential and hormonal, environmental, socio-economic and cultural factors. Progress in the fields of common interest such as genetics, paediatrics, family medicine, nutrition, socio-economic development, together with other numerous medical or non-medical specialties that directly or indirectly target this aspect of human development, engage in numerous efforts to know the progress of growth to the finest detail. There is a series of factors which contribute in variable and many times unknown proportions to the completion of this complex process of development; together with genetic baggage and physiological hormonal activity, the onset and development of the pubertal psychosomatic changes are also influenced by: physical activity, nutritional habits, duration and quality of sleep, social status, the pupil's entourage (school, family etc.), climate.

Purpose

Taking into account the socio-economic transformations occurred in the last few decades, the nutritional revolution, geographic differences, as well as the lack of recent data collected at a national level, we aimed to conduct a study which would monitor the stature and weight of secondary school

pupils. We aim to highlight, with the help of the data we have processed and interpreted, the main aspects of physical development – the growth process, harmonious physical development, nutritional state – but also to be guided by the data in regards to the measures and methods that we might use in order to improve the aforementioned aspects.

Characteristics of stature and weight development during puberty

Set against the entire lifespan, the growth process in humans occupies the longest period than in the case of all the other mammals; this phenomenon is due to the high level of development (differentiating, qualitative development, functional perfecting). Still, during childhood and puberty, this rhythm is much more accelerated as opposed to other periods.

Puberty is a unique event when physical appearance and hormones go from those of a child to full adult maturity. Puberty is a dynamic period of development marked by rapid changes in body size, shape and composition; it is also characterized by the greatest sexual differentiation since foetal life and the most rapid rate of linear growth since infancy [4]. The transition from childhood to adolescence is a complex gradual process, as there is a parallelism between the growth and maturing of the various systems of the organism, which in the end lead to a harmonious physical development and to gaining adult-specific traits, differentiated according to gender. The main players in this period

are "the puberty hormones" - testosterone from the testicles, oestradiol from the ovaries and growth hormone from the pituitary [1].

During this period, profound changes take place in the case of the entire organism through somatic development, sexual maturing and neuropsychological development. The age when puberty starts presents great individual, familial, racial variations, while climate, luminosity and the socio-economic factors are those which have a major influence on puberty's onset. A cold climate delays the onset of puberty for about 2-3 years, while a warm climate hastens it, in conditions of normal nourishment. Furthermore, the environment also has its influences: in an urban setting, puberty appears earlier in the case of both genders than in a rural setting.

The pubertal period lasts an average of 4-5 years. This period consists of three stages [4, 8]:

1. *The prepubertal stage (prepuberty)*, which begins on average at the age of 10 in the case of girls, and 12 in the case of boys; it is dominated by the growth hormone (STH), which stimulates the organism's overall growth and determines the prepubertal jump in stature. This period is the one in which the organism begins to secrete ovarian and testicular hormones, respectively. On average, girls enter and complete each stage of puberty earlier than boys, but there is significant individual variation in the timing and tempo of puberty, even among children of the same gender and ethnic background [4].

2. *The pubertal stage (puberty)* is dominated by processes of sexual maturation, following the increased secretion of gonadotropic and sex hormones. A morphological and functional development of the genital organs takes place; thus, after a period of quantitative accumulations, the qualitative jump occurs in the form of the first occurrence of menstruation in the case of girls and the first

ejaculations in the form of pollutions in the case of boys. During the pubertal state, weight increases with an average of 3.5 kg/year, and height with an average of 6 cm/year. Thus, in the case of girls aged between 10 and 13, the growth rate is accelerated, with peak velocity being at an average of 8,4-9 cm/year; this is the period of maximum growth, totalling up to 25 cm during the entire pubertal stage [4,7,8]; subsequently, the growth rate slows down, so that at the age of 14-15 it is significantly slower, and the definitive stature is reached around the age of 16-17. In the case of boys, the maximum growth occurs between the ages of 12 to 15, the peak velocity being at an average of 9.4-10.3 cm/year. After they reach the age of 15, the growth rate slows down progressively; the definitive stature is reached at the age of 19-20, when the cartilages have finished growing. . The longer duration of prepubertal growth in combination with a greater peak height velocity results in the average adult height difference of 13 cm between men and women [4, 8].

At the beginning of puberty, a lengthening of the lower limbs occurs, which predominates in the ratio between the length of the torso and that of the limbs. The cranial perimeter grows from 51 to 53-54 cm between the ages of 6-12 so that, at the end of puberty, the brain reaches its adult size.

Furthermore, the vertebral column is exposed to deformity, which in some cases can be quite severe, while differences occur between genders: in the case of boys, the skeleton is much more vigorous, the bony prominences are more evident, the biacromial diameter is larger, while in the case of girls the bitrohanterian diameter is more significant. From the age of 12 in the case of girls and 14 in the case of boys, the lengthening of the lower limbs begins to slow down, while the torso keeps on

growing. This is the period in which lateral growth begins to prevail over linear growth.

Puberty is also a time of significant weight gain, being preceded, with an average of 6-18 months, by an increase in height. Up to the age of 13-14, the girls overtake the boys in terms of height and weight; the differences cease to be significant when the boys reach the age of 14-15 and at the age of 16 they overtake the girls of the same age both in height and weight. In the case of boys, the peak weight velocity occurs at the age of 14 with an average of 9kg/year; in the case of girls, the peak weight reaches 8.3kg/year around the age of 12.5 [4].

In regard to the development of certain systems, heart development is inconsistent with the body's development during puberty. While the overall muscle volume increases twice, the heart mass increases only one and half times and the increase of the arterial diameter is inferior to heart development. Moreover, the respiratory system does not develop at the same pace as the body, although the vital capacity is on the rise. The respiratory rate is 18-22/minute. The type of breathing changes during puberty, as it changes from an abdominal type (in the case of children) to a lower rib type. Together with the stature-weight growth, a modelling of the body proportions also occurs, gradually reaching an adult configuration.

3. *The postpubertal stage (adolescence)* coincides with the appearance of the third molar and lasts until the closure of the growth cartilages. During this stage, sexual maturation and neuropsychological maturation are complete. This stage is dominated by the secretion of thyroid hormones, which take part in the growth processes and the body tissue differentiation.

Scientists are able to accurately describe the physical and hormone changes in puberty, but we do not understand how the body decides "It's time".

In Romania, the onset of puberty in the case of girls occurs in the urban area at the average age of 13 years and 3 months, and the age limits are 11 and 14, while in the rural area the age limits are 12 and 15. The pubertal age of boys in the urban area is 15 years and 4 months, while for the rural area it is 16 years and 3 months.

Participants

The study was conducted on secondary school pupils from Eco-School no. 16 "Take Ionescu" from Timișoara; the study group consisted of 87 pupils (45 girls and 42 boys) with an average age of 13.23 ± 2.12 years. The group is representative when compared to the total number of pupils from this school.

Methods

The methods used were the somatoscopic and somatometric evaluation of the pupils from the study group.

Besides the somatoscopic appreciation of the somatic development, the following parameters were determined: waist, body mass, perimeters of the thorax, abdomen and buttocks, the biacromial and bitrohanterian diameters, torso, scale, length of the limbs; the percentage of adipose tissue was calculated (by measuring 7 skinfolds: tricipital, pectoral, subscapular, axillary, abdominal, suprailiac, thigh), the body mass index, the Erissman harmony index, the Adrian Ionescu proportionality index, the Burgusch-Goldstein index, the Guifrida Ruggeri index, the ratio between the biacromial and bitrohanterian diameters, the scale/waist ratio.

The following calculation formulas were used:

- Percentage of adipose tissue = $[(4.95/\text{Bone density}) - 4,5] \times 100$;
- Bone density = $1,112 - (0,00043499 \times \text{SUM7}) + (0,00000055 \times \text{SUM7}^2) - (0,00028826 \times \text{Age})$, where SUM7 is the sum of the 7 skin folds measured;
- Erissman harmony index = the thoracic perimeter - waist/2;
- Adrian-Ionescu proportionality index = Torso - Waist/2;
- Burgusch-Goldstein Index: Thoracic Perimeter x 100/Waist;

- Guifrida Ruggeri Index: Torso X100/Waist.

Furthermore, a questionnaire was applied on the pupils regarding their nutritional habits, habitual physical activity, sleep, as well as their own perception regarding wellbeing, physical development, as well as the main means and/or methods they might apply in order to improve.

Results and discussions

The results of the somatoscopic and somatometric evaluation, as well as the calculated anthropometric indexes are provided in Table I.

Table I. Somatometric parameters and indexes for the study group

	Girls	Boys	Group (girls and boys)
Body weight (kg)	54.45 ± 16.51	52.76 ± 18.37	53.63 ± 17.63
Waist (m)	1.60 ± 0.19	1.62 ± 0.26	1.61 ± 0.23
Torso (cm)	85.21 ± 7.53	82.39 ± 8.65	83.85 ± 8.07
Length of upper limbs	65.48 ± 10.54	67.29 ± 9.42	66.35 ± 9.89
Length of lower limbs	88.39 ± 8.72	88.68 ± 9.37	88.56 ± 9.02
Thoracic perimeter (cm)	81.45 ± 9.16	75.59 ± 8.37	78.62 ± 8.78
Abdominal perimeter (cm)	72.63 ± 9.27	72.65 ± 8.72	72.64 ± 9.01
Perimeter of the buttocks (cm)	78.59 ± 10.31	76.18 ± 8.94	77.43 ± 9.65
Biacromial diameter (cm)	37.19 ± 0.48	38.26 ± 0.31	37.71 ± 0.39
Bitronhanterian diameter (cm)	33.42 ± 0.96	30.59 ± 0.85	32.05 ± 0.91
Height (cm)	1.61 ± 0.13	1.63 ± 0.21	1.62 ± 0.16
Body Mass Index (kg/m ²)	21.34 ± 2.86	20.10 ± 4.15	20,74 ± 3.64
Percentage of adipose tissue (%)	20.48 ± 5.23	14.62 ± 3.96	17.65 ± 4.62
Guifrida Ruggeri Index (%)	53.25 ± 0,12	50.86 ± 0.17	52.09 ± 0.15
Erissman harmony index	1.45 ± 0.14	-5.41 ± 0.06	3.39 ± 0.93
Adrian-Ionescu proportionality index	5.21 ± 0.08	1.39 ± 0.07	3.37 ± 0.08
Biacromial diameter/Bitrohanterian diameter	1.11 ± 0.06	1.25 ± 0.07	1.18 ± 0.06
Burgusch-Goldstein Index	50.91 ± 0.15	46.67 ± 0,19	48.83 ± 0.67
Height/Waist	1.01 ± 0.16	1.01 ± 0.23	1.01 ± 0.19

According to the results obtained, we may appreciate that:

- The body mass index of the pupils from secondary school registers, as an average, within the accepted normal limits for this age category. Still, by analysing the individual values of the BMI, we

have noticed that only 59% have normal values for their age and gender, 20% being overweight and 21% are underweight.

- The percentage of adipose tissue is a parameter which complements BMI by providing essential data regarding the composition of the pupils'

bodies; as in the case of body mass, the average values are within normal limits related to the evaluated pupils' age and gender, while the individual values present significant variations and

show a higher percentage of the pupils with an excess of adipose tissue as compared to those with a high BMI.

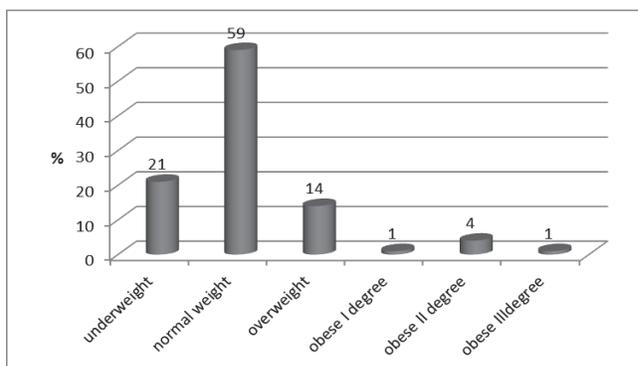


Figure 1. Results regarding BMI for the study group

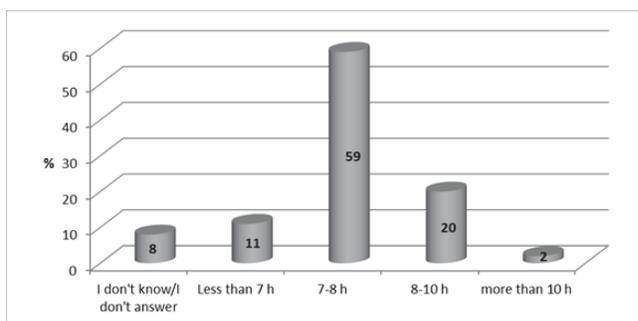


Figure 2. Results regarding the quantitative level of sleep for the study group

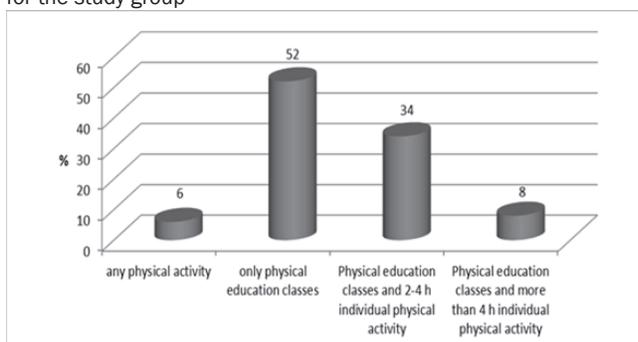


Figure 3. Results regarding individual physical activity in the case of the study group

Following the application of the aforementioned questionnaire, we have extracted from the pupils' answers some elements regarding the factors which have a remarkable influence on their development.

▪ **Sleep**

As regards passive rest, only 79% of pupils sleep between 7 and 10 hours/day, while an important percentage (11%) do not sleep more 7 hours/day; 8% did not answer this question, while 2% sleep more than 10 hours/day.

▪ **Physical activity**

The static physical activities (outside of the 5-7 hours of daily didactic activity) occupy daily over 6 hours in the case of 21% of pupils, between 3-6 hours in the case of 25% of pupils, 1-3 hours in the case of 27% of pupils and less than an hour in the case of 27% of pupils. The physical activities are represented only by physical education classes in the case of 52% of pupils (2 hours/week), being complemented by another 2-4 hours/week in the case of 34% of pupils and with over 4 hours in the case of 8% of pupils.

▪ **Nutritional habits**

In regard to diet, 55% of pupils answered that they are supervised by their parents, 24% by their grandparents, while the rest (21%) make their daily diet by themselves. As regards breakfast, according

to the pupils' answers, 40% do not have breakfast, 44% drink only tea or milk, while only 16% have a proper breakfast. Snacks are absent from the daily diet of 20% of pupils, while in the case of 65% of pupils these snacks consist of fruit, dairy products,

sandwiches or croissants. In 15% of situations these snacks are represented by inappropriate foods (chips, chocolate etc.). Lunch is represented in the case of 9% of pupils by fast foods, while for 67% of pupils it corresponds affirmatively to the needs from a quantitative and qualitative point of view. Dinner represents a much more important meal than breakfast or lunch in case of 48% of pupils; 29% eat only salads or dairy products for dinner, while 23% eat accordingly.

▪ **Wellbeing**

Overall wellbeing is claimed by only 69% of pupils, while 31% declare themselves to be unsatisfied with the way they feel.

▪ **Own perception regarding nutritional habits, physical activity and physical development**

Linked to these aspects, 58% of pupils answered that they do not consider that they have sufficient notions regarding the correct nutritional habits, 28% declare that they know the principles of a healthy diet, while 14% did not know how to answer this question.

Physical development is a reason of self-appreciation for 61% of pupils, of self-dissatisfaction for 31% of pupils (the rest of 9% did not answer this question or were undecided about it). The number of pupils with problems of stature and weight is greater than those who are not satisfied with their condition, reason for which the acknowledgement of these problems becomes necessary regarding the prognosis of some deviations from normal of the appreciated parameters. 47% of pupils consider that they do not have an adequate physical activity from a quantitative and/or qualitative point of view to their age or state of health; 38% consider that the level of their individual physical activities is adequate, and 15% could not answer the question.

Asked what they should change their way of life, 30% declare that they should change their nutritional habits, 24% their level of physical activities, while 46% do not consider that they should change any aspects regarding their life. 21% of pupils expect that these changes be initiated by their parents, while the rest consider that specialists from the field of sports (25%) or medicine (26%) should initiate these changes as far as they are concerned. The fact that many of these pupils acknowledge that they should dedicate more time to physical activities and pay more attention to their nutritional habits is a positive aspect which should be capitalized by those able to guide these pupils.

Discussion

A clear understanding of the notion of “physical activity” and of the effects that this has during puberty and adolescence can completely change the number of people that suffer from nutritional disorders. Comparing the data obtained from completing the questionnaire with what the measurements show us make us understand why secondary and high school pupils develop the way they do and why obesity has a high rate of incidence. The lack of a diet scheme specific for the child’s age determines the appearance of various nutritional deviations; proof stand the 99 pupils measured: out of them 24 are underweight, 12 are overweight and 1 has type 2 obesity.

Conclusions

According to this study, we might state that there are quite a few problems among secondary school pupils in regard to the development of their stature and weight, correlated with certain errors in their lifestyle (nutritional habits, physical activity, sleep). Still, taking into account the fact that a significant number of these pupils are aware that there are

perfectible aspects in regard to these elements and they want to change their lifestyle, to receive information and advice, we consider that being well informed, counselled and guided will grant these pupils the capacity to solve certain of these problems.

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