

Somatic development and body composition of
6- to 18-year-old boys – The first Cypriot growth
study

Ph.D. thesis

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Introduction

The biological growth and maturation of children have been systematically studied for more than 150 years in many countries of Europe. The basic concepts are built on a strong historical foundation in the medical, anthropological, and human biological sciences. As children progress growth, maturation, and development are central processes. The relevance of these processes to physical activity and performance and to the understanding of human biological variability is then considered. In addition to a basic interest in human biological variation, the record of growth, maturation, performance and activity provides basic information relative to several more specific issues. As for instance: status, prediction, tracking, and comparison. Above all I have to stress there were no longitudinal or cross-sectional representative human biological data collections in Cyprus during the past decades.

Nevertheless, the general hypoactive lifestyle, as described by Tomkinson and associates (2003) is highly characteristic in our school-age and young adult generations. The present cross-sectional growth study is definitely a health-related approach and it has the following aims:

The basic aim of the study was to determine the growth pattern of Cypriot boys along the age group differences in height, body weight, body mass index, body fat content relative to body mass, and growth type indices.

Our second aim was to estimate the prevalence of overweight and obese children and adolescents within the population.

The third aim was to create the standards for the estimations of morphological age and prediction of young adult stature.

Material and methods

The anthropometric data collection was carried out with the kind permission of the Ministry of Education and Culture in various sizes and geographic location settlements within the Greek part of the country. Beyond the permission of the Ministry the active co-operation of the school principals and physical education teachers were also the important conditions of this investigation. Among the institutions there were both, elementary and secondary schools as well as governmental and private lower and higher secondary schools.

A total of 4271 elementary and high-school children took part in the cross-sectional data collection between 2006 and 2007. According to the prescription of the Declaration of Helsinki the subjects were volunteer boys exclusively. All of them were definitely Greek origin. Beyond the kind co-operation of the pupils and the school-staff members, the written consents of one of their parents were also collected. The following settlements were involved to the investigation:

Nicosia and its suburbs: Deftera, Tseri, Lakatemia, Latsia, Pallouristissa, Strovolos,

other settlements: Pafos, Mesogi, Polis, Larnaca, Aradippou, Geri, Limassol, Germasogeia, Paralimni, Deryneia, Sotira.

The children were healthy at the time of investigation. All of them took part in the curricular physical education classes (2×45 minutes in a week). Although the level of habitual physical activity can markedly influence

on the body composition taking into account the low rate of extra curricular physical activity of these boys was not taken into account.

By the information of the Ministry of Education and Culture the total number of schoolboys was between 70.153 and 70.355 in the school years of 2006 and 2007. The nation-wide sample represents 6.09% or 6.07% of the respective population.

Internationally accepted anthropometric procedures were used. By using the 12 anthropometric variables the growth type indices (Conrad, 1963), relative body fat content, BMI and lean body mass were calculated. In taking body dimensions and the determination of age groups the suggestions of the International Biological Program (Weiner and Lourie, 1969) were observed. Nutritional status were determined according to the suggestions of Lohman (1992) (F%), and Cole and associates (2000) (BMI).

Results

In spite of the three various aims this material focuses on the effects of over-nutrition. The mean height of the overweight and obese boys was significantly taller from 6 to 12 years of age and no statistical differences were found between 13 and 18 years. The standard deviations in the two subgroups were identical, for the taller stature of overweight and obese did not refer greater within group variability.

Body mass means of the overweight and obese children were significantly heavier in all 13 age groups. The mean weight differences increased markedly with age. It is additional information that standard deviations were significantly larger in the overweight boys from 8 years

of age. A marked increase could be observed in the subsequent standard deviations.

The over-nutrition had significant effect on body linearity. The overweight and obese boys had significantly greater metric indices in all the 13 age groups. The differences exceeded the 1 SD distance in every age group. The SDs in the over-feed subjects were significantly greater from 11 years of age. However, the age dependent patterns of mean metric indices were similar in this comparison, but the age group differences were more consistent in the sample of normal body composition children and adolescents. The difference between the two curves was the largest between 11 and 16 years of age. The over-feed had significant effect on plastic index. The overweight and obese boys had significantly greater plastic index means. The standard deviations did not differ significantly in this comparison. The plastic index has significant correlation with stature (Szmodis et al. 2007), it may have interest to evaluate the age dependency in the height-related plastic indices too.

The relative plastic index means describe a significant second power pattern. The means were very similar in early childhood and the post-adolescent years. From 6 and 7 years the relative plastic index means decreased significantly up to 11 and then those were greater year by year. The largest within-group variability was observed in 11 year of age (4.99 % of the mean). The effect of unhealthy body fat content was consistently significant. The overweight and obese subjects had greater plastic index means on one hand, but on the other hand the over-feed did not modify the age related and significant second power pattern.

The lean body mass can be evaluated as one of the descriptors of bone-muscle development. Behnke in 1969 proposed that the LBM and minimum weights are the same in males. For certain physiologic measures, values expressed in the function of lean body mass are particularly appropriate. LBM, which encompasses all body tissues except depot fat, includes the fitness-related organs as well as the mass of skeletal muscle. LBM, then, should be more closely related than body mass to measures such as VO_2 max, cardiac output, and muscle strength (Rowland et al., 2000).

The prevalence of overweight and obese children was high irrespective of separation of two risky conditions or the results of joint evaluation. Both categories increased with age. The joint prevalence in the group of 6-year-old children was only 10.13% near and during puberty 34-38% of subjects were qualified as overweight and obese. In 13-year-old boys the relative frequency of obese boys was greater than that of the overweight. The prevalence decreased moderately after puberty, those were between 23.93% and 27.7%.

One of the indirect estimations of fatness is the body mass index. By the qualification of Cole and associates (2000) this weight-height ratio indicates accurately the level of over-nutrition. The mean BMI increased with age ($F = 229.6$), but in general, the one year difference was not significant. The within-group variability was consistently great. The largest standard deviations were characteristic between 12 and 14 years of age.

The estimated relative fat means in the normal body composition children describes a slight, but significant linear increase with age. This pattern in the over-feed

subjects is an exponential curve, with peak fatness of 13-year-old boys. This mean is greater than 30%. Interestingly there were no significant differences in general, between the standard deviations. If the result of statistical analysis was significant the standard deviation refers to the normal body composition group.

The calculated common variances: By the opinion of Daniels and associates (1995), only those relationships may have practical importance in the auxology, which explains more than 50% of the common variances. Nevertheless, by the statement of Szmodis and associates (2007) the scientific importance of any significant correlation cannot be neglected. It seems to be obvious, the common biological content of relative fat, body weight or BMI was remarkably greater than the common variances of estimated fat and growth type characteristics, but none of the mentioned measures and indices are not independent from body fat content.

The observed prevalence of overweight and obese subjects was unfavourably high in our sample. These proportions were obviously greater than the estimated ones in Hungary (Prókai et al., 2005), or the western countries (Kemper, 2004; Thompson et al., 2003). These were very similar to the findings of Ogden and associates (2002) in the US. The highest prevalence in our sample was observed in the years of puberty.

Several analyses (Rowlands et al., 2000; Wardle et al., 2006; Taeymans et al., 2007) suggest that childhood body fatness is correlated with adult adiposity with known and well established health risks. Prediction of adiposity and relative distribution from the adiposity patterns in childhood may be important.

There is a growing body of evidence that adipose tissue is an active metabolic tissue which secretes different bioactive peptides acting as autocrine or paracrine and endocrine hormones. Both excess and deficiency of adipose tissue can have severe metabolic consequences and represent important medical and socio-economic burdens. Prediction of subcutaneous adipose tissue distribution from childhood measures seems to be more difficult in males than in females (Trudeau et al., 2001). Since the prevalence of overweight and obesity in the Cypriot schoolage population was high, the unfavourable prevalence predicts towards the future cardio-vascular and metabolic health risks. We have to take into account, the overweight and obese children were not only overweight or obese additionally they were moderately or markedly advanced in their biological development. The observed prevalence can not be evaluated as an individual problem it is really a social problem.

Physical activity has an important role in the treatment of overweight and obese subjects. A stronger emphasis on lower-intensity physical activities is needed, given that overweight and obese children may experience greater perceived exertion, pain and relative oxygen cost. Programs should emphasise short- and moderate-term benefits, such as enhanced quality of life and functional capacity. Long-term benefits include reduced risk for morbidity.

We have to evaluate the scientific accuracy, reproducibility and also the efficiency of the two methods (F%, BMI) used for the assessment of body composition. The key point of this comparison sources from the statement of Cole and associates (2000): "The ideal de-

definition, based on percentage body fat, is impracticable for epidemiological use. Although less sensitive than skinfold thicknesses the BMI is widely used as a definition of overweight and obesity.” Nevertheless, several critical remarks were published against the use of BMI in children and adolescents. Currently, there is no universally accepted system for classification of childhood overweight and obesity, although several BMI-based approaches have been proposed (Must et al., 1991; Cole et al., 2000; Kuczmarski et al., 2000). However, such a cut-offs are hard to identify with any precision. Children have less obesity-related disease than adults and the dose-response curve linking obesity and outcome is essentially linear over a broad spectrum of adiposity in childhood (Burniat et al., 2002).

Conclusions

1. The growth patterns in height and body mass of Cypriot boys were in accordance with the normal patterns of healthy children and adolescents. The growth in height is genetically determined but the environmental effects may also have significant importance. Nevertheless, the increase in body weight is mostly under the pressure of lifestyle. Significantly taller stature and the non-proportionate body mass of the overweight and obese boys between 6 and 12 years of age should be attributed to their advanced biological development that is influenced by the over-feeding. Consequently the normal growth patterns of our subjects were and are markedly modified by the environmental effects.

2. The exponential pattern of change with age in growth type indices of Cypriot boys did not differ from those of Hungarian and German ones, but there were sig-

nificant between age group differences. The Cypriot subjects can be characterised as slightly more picnomorphic physique. This various inter-group variability was associated to the ethnic differences.

3. The observed prevalence of overweight and obese children was unfavourably high. The prevalence increased between childhood and adolescence and did not change during the post-pubertal years. The high prevalence of over-feed subjects should be related to the sedentary lifestyle and dietary habits. Taking into account the health consequences of long-lasting overweight and obesity our predictions cannot be positive. Since the over nutrition was characteristic in 25-28% of the sample, it can be interpreted as a real social problem.

4. The calculated references can be used for the estimation of morphological age in Cypriot boys. It cannot be excluded the depot fat corrected references result in more accurate age estimations in physically active children and adolescents.

5. Because of the high prevalence of over-feed boys, and also the biologically high averages in non-overweight or -obese subjects, the means of BMI and relative fat content cannot be evaluated as reference. The validity of the calculated references of height, weight, metric, plastic indices can not be determined accurately. According to the relatively high and stable life standard in Cyprus we can assess their applicability about 20 years.

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