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Physical Education in Early Childhood Education and Care

Researches – Best Practices – Situation

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Introduction

You are holding a book that is one of the intellectual outcomes of the ERASMUS + project '590769-EPP-1-2017-1-TR-SPO-SSCP, Development of Preschool Physical Activity, Sports and Game Program for Strengthening of Grassroots Sports in EU. The project acronym is „LUDUS – Just Move and Have Fun“. This project, addressed in 2018 - 2019, is focused on supporting physical activity of preschool children. Six partner institutions are involved: Sport Volunteers Association and Hacettepe University in Turkey, University of Padua in Italy, Asterias Sports Club in Greece, Kindrgarden Mecho Pooh in Bulgaria and Comenius University in Bratislava, Slovakia.

The book is also part of the 4th Physical Education World Wide Survey, which is carried out by UNESCO in cooperation with FIEP and its partners. The publication is part of one of its lines, focusing on mapping the basic characteristics of physical education and physical activities of children and youth in the world at individual levels of schools, from pre-school education to universities. In 2017 the book "Physical Education in Primary School: Researches - Best Practices - Situation", edited by D. Collela, B. Antala and S. Epifani, was published by Pensa Multimedia in Italy and has 502 pages. 102 authors from 27 countries and 5 continents participated. In 2018, it was followed by a publication "Physical Education in Secondary School: Researches - Best Practices - Situation", published by the University of Montenegro in cooperation with the Montenegrin Sport Academy. The editors were S.Popovič, B.Antala, D.Bjelica and J.Gardaševič. It had 343 pages and was prepared by 84 authors from 24 countries and 5 continents.

The publication "Physical Education in Early Childhood Education and Care: Researches - Best Practices -Situation" is published in Slovakia by the Slovak Scientific Society for Physical Education and Sport. Its editors are B. Antala, G. Demirhan, A. Carraro, C. Oktar, H. Oz and A. Kaplánová. It has 464 pages. The contribution of the international organization AIESEP, whose members of its Special Interest Group for Early Years, is also a significant part of the publication. A series of these 4th Physical Education World Wide Survey publications will be completed in 2020 with the publication of "Physical Education in Universities: Researches - Best Practices - Situation"

The book is divided into four parts. In the first part of "LUDUS - Just Move and Have Fun" we bring the results of the scientific part of the project focused on literary reviews in the individual participating countries of the project and the results of comparative research of the opinions of parents, teachers, directors of institutions and trainers in individual countries on selected issues of pre-school children participating in regular exercise activities at nurseries and kinder gardens. In the second part of the publication called "Researches", we bring the latest research findings aimed at exploring the physical activity of children in pre-school facilities. The third part, the “Best Practices” brings examples of good practice from different countries of the world and the last fourth part “Situation” is focused on presenting knowledge related to the characteristics of the state of the issue in various countries of the world.

120 authors from 32 countries and five continents participated in the book, of which 20 were European countries (Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Finland, Germany, Greece, Italy, Ireland, Lithuania, Norway, Poland, Portugal, Serbia, Slovakia, Spain, Turkey, Ukraine, United Kingdom) 2 countries from America (Mexico, USA), 4 countries from Asia (China, Hong Kong, Malaysia, Singapore), 3 countries from Africa (Algeria, RSA, Senegal) and 3 countries from Oceania (Australia, New Zealand, Samoa). Therefore, the publication brings a broad international perspective on the issue of pre-school physical education and physical activities in pre-school facilities.

A thank you goes also to the reviewers who, through their comments and advice, helped the authors improve the quality of their contributions.

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Anthropometric Measurements in Children: A Great Help to Determine their Body Composition and Health Status

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Abstract

The WHO indicated that Non-Communicable Diseases (NCD) has become the leading cause of death globally- representing approximately 63% of all deaths worldwide in 2013. The increase in childhood overweight and obesity as risk factors associated with NCD's, has stimulated much interest in identifying accurate ways to assess the body composition of children in school and clinical settings. The negative health consequences of obesity are well documented in the literature and popular media. Over the last two decades, the prevalence of childhood overweight and obesity has increased at an alarming rate in many countries in the world. A major concern is that children who are obese, tend to become obese adults who have a relative high risk of developing diseases and disorders associated with excess body weight and body fatness. The accurate assessment of body composition in children and adolescents, is complicated and challenging. Children are chemically immature and changes in the proportions and densities of the fat-free mass components due to growth and maturation, directly affect the overall density of the fat-free mass. Anthropometric measurements and specifically skinfolds are the most appropriate for use in field settings to determine the body composition of children and adolescents and can be used as markers of adiposity or of fat distribution. Information on the body composition of children, can also be used for the purpose of monitoring changes during growth and development and classifying the levels of body fatness and health.

Key words: Children; Anthropometry; Body composition; Health

Introduction

Over the last three decades, the prevalence of childhood overweight and obesity has increased at an alarming rate (1). A major concern is that children who are obese, tend to become obese adults who have a relative high risk of developing diseases and disorders associated with excess body weight and body fatness (2). Because of these public health implications, the epidemic increase in childhood overweight and obesity has stimulated much interest in identifying accurate and reliable ways to assess the body composition and health status of children in school and clinical settings.

The aim of this chapter is to provide an overview of the anthropometric measurements in children which can be of great help to determine their body composition and health status.

Body composition changes

Growth and development during the childhood years, is generally characterized as slow and gradual. However, marked changes in physical size, shape and body composition occur during puberty (2). During the adolescent years, both genders show significant body weight increases. In girls, the peak weight velocity occurs approximately 6-9 months later than the peak height velocity. In boys, both peak height and weight velocity occur at approximately the same time (2). During adolescent years the body composition is characterised by deposition of body fat in girls and in boys by skeletal muscle mass (2). The combined effects of body fat increase and/or change in deposition and also the skeletal muscle mass changes result in the characteristic android (apple) and gynoid (pear) shape in males and females, respectively (2).

The assessment of body composition

The accurate assessment of body composition in children and adolescents, is complicated and challenging. Children are chemically immature and changes in the proportions and densities of the fat-free mass components due to growth and maturation, directly affect the overall density of the fat-free mass (2, 3). Body composition assessment methods at best provide estimations or predictions. Therefore, all methods, except cadaver analysis, are indirect methods. The range of available body composition assessment methods is extensive and range from relatively simple and inexpensive field methods to more complex and expensive laboratory techniques requiring advanced equipment. The latter are generally not available to most researchers and therefore are out of reach of most school teachers, health practitioner workers, coaches and exercise and sport scientists. During the assessment of children's body composition, the following is important (2, 3):

- Prior to body composition testing, inform the parents so they will understand the purpose and procedures of this assessment.
- Maintain records of these measures over time to assess the interaction effects of growth, maturation, diet, and physical activity on body composition changes.
- Measure only standardized sites and follow established procedures.

- If it is necessary, the teacher, nurse or the child's parent may be present during body composition testing.
- Ensure confidentiality by sharing individual measurements and body composition results only with the child and parents/guardians concerned.
- Do no use body composition measurements results for grading purposes and ensure that the body composition assessment is a positive experience for each child. Do not label or criticize children during any phase of the assessment period.

Anthropometric measurements

The major advantages of anthropometric techniques are that they are non-invasive, the equipment is commonly portable and therefore suited to use in a wide range of settings (2). Perhaps most importantly, anthropometry is often the preferred approach, because it is relatively inexpensive and can be used as a field method. Field methods are according to (3), commonly used in school and clinical settings to estimate body composition of children for the purpose of monitoring changes during growth and development and classifying the levels of body fatness and health.

As in any other science, anthropometry is reliant on certain "rules and regulation" that must be adhered to during the measuring process. These "rules and regulations" are usually determined by an international body and for the purpose of this chapter, the authority of ISAK is accepted unilaterally, as it is the largest and most influential society in the field of anthropometry in the world (4).

All the subjects are to be measured on the right side (4). The body mass and stature should be taken at least twice. A third set of measurements should be taken when the first and second readings differ by more than 1%. The mean is taken when there are two measurements and the median when there are three measurements (4).

Body Mass Index (BMI)

Two anthropometric measurements are needed to determine the BMI.

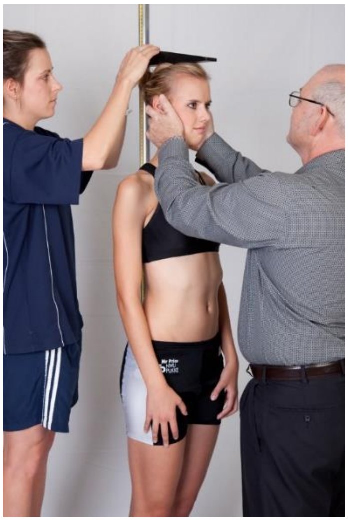
a. Body Mass (figure 1)

A calibrated scale is used to measure body mass. Ideally, body mass should be obtained on an accurately calibrated beam-type balance or a portable electronic scale and recorded to the nearest 0.1 kilogram. The subject should be weighed nude or in clothing of a known weight so that a correction to nude weight can be made (4).

The most stable values for monitoring weight change are those obtained routinely in the morning (12 hours after having ingested food) and after voiding. Since it is not always possible to standardise the measurement time, it may be important to record the time of day when the measurement is made. Check that the scale is reading zero, then the subject

stands on the centre of the scales without support and with the mass distributed evenly on both feet. The head is up and the eyes look directly ahead (4).

b. Stature (figure 2)

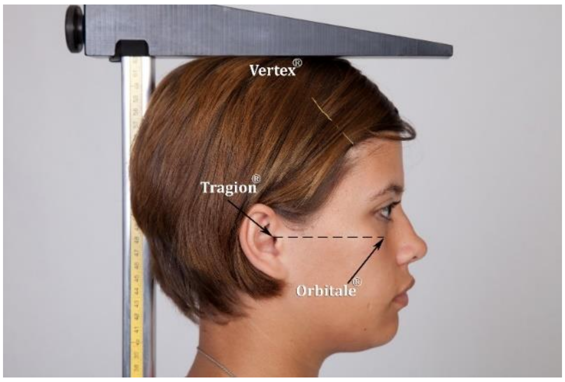


A stadiometer is used to measure stature. There are three general techniques for measuring stature: free-standing stature, recumbent length and stretch stature (4). The standard method used in this chapter is *stretch stature*. An explicit description of the selected technique (and then strict adherence to the technique) is important. The measurement is normally made with the instrument known as a stadiometer, although a constructed device is not essential.

The instrument can be fairly elaborate and feature ball-bearing counterweighted headboards and digital readouts, or it can be little more than two wooden planes at right angles. The practice of using a wooden rectangular chalk box and pencil marks on a doorjamb can yield satisfactory results. A carpenter's retractable tape measure with a foot piece can be used to measure the length from the floor to the mark (4).

c. Frankfort Plane (figure 3)

The stretch technique requires precise positioning of the subject to obtain useful measurements. The measurement is taken as the maximum distance from the floor to the vertex of the head. Technically, the vertex is defined as the highest point on the skull when the head is held in the Frankfort plane (4). Figure 3 illustrates that this position is achieved when the line joining the orbital to the tragion is horizontal or at right angles to the long axis of the body. The orbital is located on the lower or most inferior position on the margin of the eye socket. The tragion is the notch above or superior to the flap of the ear at the superior aspect of the zygomatic bone. This position corresponds almost exactly to the visual axis when the subject is looking directly ahead (4).



During the stature measurement, the measurer has the barefoot subject stand erect with the heels together and the arms hanging naturally by the sides. The heels, buttocks, upper part of the back, and (usually but not necessarily) back of the head are in contact with the vertical wall. The subject is instructed to look straight ahead and to take a deep breath. One of the measurers ensures that the subject's heels are not elevated while the other measurer applies stretch force by cupping the subject's head and applying gentle traction alongside the mastoid processes. The first measurer then brings the headpiece firmly down and into contact with the vertex and makes a reading. Care

must be taken to have the subject's head is properly oriented. Occasionally, the cue "stretch up, lower your shoulders, up" helps achieve the correct positioning (4). The Body Mass Index (BMI) is calculated by the following equation (2):

$$\text{BMI} = \frac{\textit{body mass}\,(kg)}{\textit{stature}^2\,(m)}$$

Despite BMI being the most common anthropometric index to predict relative overweight (5), the appropriateness of the index in children and adolescents has been of questionable value during periods of growth when height is continually changing. BMI can also be distorted by the proportionality of sitting stature and leg length. Relatively long legs will decrease BMI scores (6, 7). BMI does not measure body fatness per se and therefore may not be sensitive to differences in actual body composition. The problem is that the BMI does not differentiate between the non-fat and fat masses, and BMI is therefore best viewed as a measure of heaviness, rather than fatness (6, 7). In children younger than 15 years of age, BMI is not totally independent of height, and individuals with the same BMI may be quite different in terms of the proportion/ratio/content of body fat and skeletal muscle tissue (2). It is important to remember that BMI is only a crude index of body composition and/or obesity and should be used with care (6). Also presented in this chapter is the compilation table by Cole *et al.* (2000) that provides cut-off values for overweight and obesity for up to 18 years of age (see Table 1).

Waist girth and WHR

As a single measure, **Waist Girth (figure 4)** is valued for its relationship with central adiposity in adults. The measure has gained increasing acceptance in children and adolescents, however the cut-off points are not available to relate waist girth to health status in this population (8). Waist girth is measured at the level of the noticeable waist narrowing and is located approximately halfway between the costal border and the iliac crest. The measurer stands in front of the subject to correctly locate the narrowing of the waist. If there is no obvious narrowing, the measurement is taken on the mid-point between the upper border of the 10th rib and the lower border of the iliac crest. The measurement is taken at the end of a normal expiration with the arms relaxed at the sides (4). With regard to the waist-to-hip ratio (WHR). The WHR is not valid for evaluating fat distribution in pre-pubertal children and it is therefore not recommended.

Table 1 Cut-off values for overweight and obesity up to 18 years of age (Cole *et al.*, 2000)

	Body mass index 25kg/m²		*Body mass index 30kg/m²*	
Age (years)	Males	Females	Males	Females
2	18.41	18.02	20.09	19.81
2.5	18.13	17.76	19.80	19.55
3	17.89	17.56	19.57	19.36
3.5	17.69	17.40	19.39	19.23
4	17.55	17.28	19.29	19.15
4.5	17.47	17.19	19.26	19.12
5	17.42	17.15	19.30	19.17
5.5	17.45	17.20	19.47	19.34
6	17.55	17.34	19.78	19.65
6.5	17.71	17.53	20.23	20.08
7	17.92	17.75	20.63	20.51
7.5	18.16	18.03	21.09	21.01
8	18.44	18.35	21.60	21.57
8.5	18.76	18.69	22.17	22.18
9	19.10	19.07	22.77	22.81
9.5	19.46	19.45	23.39	23.46
10	19.84	19.86	24.00	24.11
10.5	20.20	20.29	24.57	24.77
11	20.55	20.74	25.10	25.42
11.5	20.89	21.20	25.58	26.05
12	21.22	21.68	26.02	26.67
12.5	21.56	22.14	26.43	27.24
13	21.91	22.58	26.84	27.76
13.5	22.27	22.98	27.25	28.20
14	22.62	23.34	27.63	28.57
14.5	22.96	23.66	27.98	28.87
15	23.29	23.94	28.30	29.11
15.5	23.60	24.17	28.60	29.29
16	23.90	24.37	28.88	29.43
16.5	24.19	24.54	29.14	29.56
17	24.46	24.70	29.41	29.69
17.5	24.73	24.85	29.70	29.84
18	25	25	30	30

Skinfolds and percentage body fat

Skinfolds have been used traditionally to assess the subcutaneous adipose tissue at multiple sites and use one of a variety of regression equations to estimate the percentage body fat. Approximately one-half of the body fat is located subcutaneously, and regression equations that estimate percentage body fat have been developed based upon this relationship (9). The double fold of skin, plus the underlying subcutaneous adipose tissue is measured using skinfold callipers. The advantages of the skinfold technique is that it requires relative inexpensive equipment, it is a field method and therefore useful to those without access to a laboratory and that the procedure is relatively simple to use The skinfold technique has the advantage that the equipment is relatively inexpensive, it is field method and useful to those without access to a laboratory and it incorporates a low technology method and are relatively simple and easy to use (2).

Inaccurate location of skinfold sites was found to be the greatest source of error among investigators. Therefore, the skinfold site should be carefully located using the correct anatomical landmarks. Skinfold measurements should not be taken after training or competition, sauna, swimming, or showering, since exercise, warm water and heat produce increased blood flow in the skin with a concomitant increase in skinfold thickness (4).

Skinfold technique

Three skinfolds are recommended for measuring children. The skinfold calliper is used to obtain a skinfold thickness. All the skinfold measurements are made on the right side of the body irrespective of the preferred side of the subject. The reading is made approximately 2 seconds after application and release of the skinfold calliper's trigger. The reading should be taken even if the needle is still moving. The skinfold site should be carefully located using the correct anatomical landmark (4).

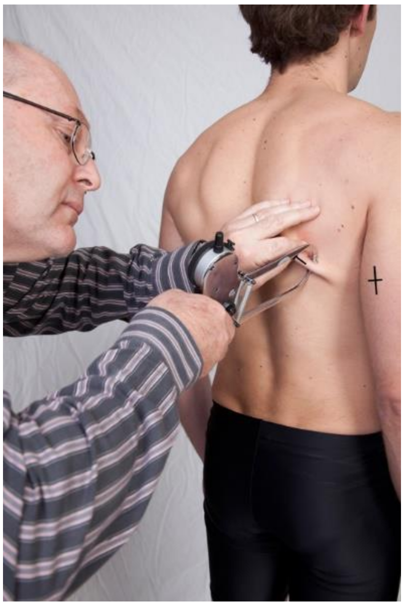
The skinfolds should be taken at least twice. A third set of skinfolds should be taken when the first and second readings differ by more than 5%. The mean is taken when there are two measurements and the median when there are three measurements. The fold is grasped firmly and held throughout the measurement. The skinfold is raised at the designated site and the calliper applied so that the near edge of the pressure plate is 1 cm from the lateral side of the controlling thumb and index finger (4).

a.Triceps Skinfold (figure 5 & 6)

This skinfold is raised with the left thumb and index finger on the marked posterior mid-acromiale-radiale landmark. The landmark is the mid-point of the straight line joining the Acromiale and the Radiale landmarks. The Acromiale landmark is the point on the superior aspect of the most lateral part of the acromion border (4). The Radiale landmark is the point at the proximal and lateral border of the head of the radius (4).

The fold is vertical and parallel to the line of the upper arm. The skinfold is taken on the most posterior surface of the arm over the triceps muscle when viewed from the side. For the measurement, the arm should be relaxed with the shoulder joint slightly externally rotated and the elbow extended by the side of the body (4).

b. Subscapular Skinfold (figure 7 & 8)



The skinfold is raised with the left thumb and index finger, raising a fold that is oblique to the inferior angle of the scapula in a direction running obliquely downward and laterally at an angle of about 45 ° from the horizontal. The subject should be standing erect with the arms by the side (4).

The skinfold is raised on the subscapular skinfold site which is a site 2cm along a line running laterally and obliquely downward from the Subscapulare landmark at a 45 degree angle (4). The Subscapulare landmark is the undermost tip of the inferior angle of the scapula. The line of the skinfold is determined by the natural fold lines of the skin (4).

c. Medial Calf Skinfold (figure 9 & 10)

This skinfold is raised with the left thumb and index finger, on the relaxed medial right calf at the Medial Calf skinfold site. The Medial Calf skinfold site is the point on the most medial aspect of the calf at the level of the maximal girth (4).

It is a vertical skinfold and this is the easiest to obtain when the subject's leg is flexed to an angle of 90 ° at the knee by placing the foot on a box. The calf must be relaxed (4).

Skinfold equations for children

Table 2 Skinfold equations for children and adolescents (Slaughter *et al.,* 1988) (8-17 years)

Skinfolds	Gender	Equation
∑SKF=*triceps* + *calf*	Boys (all ages) Girls (all ages)	1. %BF = 0.735 (∑SKF) + 1.0 2. %BF = 0.610 (∑SKF) + 5.1
∑SKF=*triceps* +*subscapular* (∑SKF>*35mm*)	Boys (all ages) Girls (all ages)	3. %BF = 0.783 (∑SKF) + 1.6 4. %BF = 0.546 (∑SKF) + 9.7
∑SKF=*triceps* +*subscapular* (∑SKF<*35mm*)	Boys (all ages) Girls (all ages)	5. %BF = 1.21 (∑SKF) – 0.008 $(∑SKF)^2$ +I* 6. %BF = 1.33 (∑SKF) – 0.013 $(∑SKF)^2$ – 2.5
I*		
Age	**Caucasian**	**Black**
Prepubescent Pubescent Postpubescent	-1.7 -3.4 -5.5	-3.2 -5.2 -6.8

Important: The triceps + calf skinfold equations may be more suitable than the triceps + subscapular equation for children who are not comfortable having the subscapular site measured.

To determine the percentage body fat of children by means of skinfold equations the Slaughter *et al.* (1988) equations are recommended. The reason for that is that the Slaughter *et al.* equations are based on the 4-C model reference measures of percentage body fat (%BF). These equations

are also age- and gender-specific and use the sum of 2 skinfolds to predict the % BF. These equations may be used to assess the body composition of African Americans and Caucasian boys and girls from 8 to 17 years of age. For the triceps and + subscapular skinfolds, fatness specific equations were also developed. There are different equations for children whose sum of the two skinfolds is less than or greater than 35mm. The intercept of the triceps and + subscapular equation (Σ 2SKF < 35mm) for boys varies depending on maturation stage (see Table 2).

Body fat standards for children

In Table 3 the recommended % BF levels for children are presented. Take note that the minimal averages and obesity fat values, vary with age, gender and activity status. However, the information in Table 3 can still be used to classify levels of body fatness for children and adolescents.

Table 3 Recommended %BF levels for children and adolescents (Heyward & Wagner, 2004:6)

NR*= Not Recommended

	NR*	**Low**	**Mid**	**High**	**Obesity**
Males 6-17 yr	<5	5-10	11-25	26-31	>31
Females 6-17 yr	<12	12-15	16-30	31-36	>36

Conclusion

Anthropometric measurements and specifically skinfolds, are the most appropriate method to use in the field to determine the body composition of children and adolescents. The major advantages of these anthropometric techniques as discussed, are that they are non-invasive, the equipment is commonly portable and therefore suited to use in a wide range of settings. Perhaps most importantly, anthropometry is often the preferred approach, because it is relatively inexpensive and can be used as a field method. Field methods are commonly used in school and clinical settings to estimate body composition of children for the purpose of monitoring changes during growth and development and classifying the levels of body fatness.

It is important to remember that BMI is only a crude index of body composition and/or obesity and should be used with care (6). Presented in this chapter is the compilation table by Cole *et al.* (2000) that provides cut-off values for overweight and obesity up to 18 years of age (see Table 1). To determine the percentage body fat of children by means of skinfold equations the Slaughter *et*

al. (1988) equations are recommended. The reason for that is that the Slaughter *et al.* equations are based on the 4-C model reference measures of percentage body fat (%BF).

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