The relative age effect on anthropometric characteristics and motor performances in Turkish children aged between 8 and 12 years

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Abstract. This study was carried out to investigate the effect of relative age on anthropometric properties and motor performance in Turkish children (girls n=423, boys n=601). Anthropometric measurement sites and techniques have been set out by the ISAK (International Society for the Advancement of Kinanthropometry). A group of tests involved in Eurofit Test Battery and other standard tests were used. For each age, the data of those who were born within the first three months and the last three months of the year were compared. The MedCalc Statistics Program was used for the differentiation and variation percentages between two periods were studied ($p \leq 0.001$, $p = 0.05$). Consequently effect of relative age was observed on anthropometric characteristics and motor performances of Turkish girls and boys between 8 and 12 years old. Researchers, trainers, families, sports managers and organizers are advised to consider Effect of Relative Age.

Keywords: relative age effect, anthropometric characteristics, motor performance, children

1 Introduction

In order for talented children to reach the most upper steps of mastery, selecting, observing and leading them in early age is very important. Although the required motor, psychological capacity and biometric/anthropometric features for output are valid for all sportive activities [12], their superiority varies according to each sports branch [23]. In order to be successful in output level in the future many children must participate in trainings. During this process personal development must be supported by considering the features such as early, normal or delayed developments and also new beginners and advanced children [16].

Motor development usually does not progress with the physical development at same rate. There is a wide variety among the children with same age in terms of structure [11].

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Separating athletes into age groups during childhood and adolescence periods has been planned to reduce their maturation differences and to provide and evaluate more balanced sports training [4]. In majority of sports systems athletes are grouped according to chronologic age [18]. The talent identification system for optimum level of competition provides advantages for those who were born rather earlier [21].

The variations between the birthdates of those who were born in the same year are defined as relative age differences and their results as the Relative Age Effect (RAE) [2]. The first study that examined RAE in sports was carried out by Grondin, Deschaies & Nault in [17]. RAE that identifies the general age differences between individuals in each age group may induce important performance differences [25]. In selection year, significant alterations may appear in academic and sportive performances due to growth and development differences between those who were born earlier and later [5]. Even though its effect on adults is small, it is important for children and may result in anthropometric variations [15]. Children who were born early in the year may be more advantageous cognitively, emotionally and physically than those who were born later [7] and RAE gives the impression that it may increase gradually from childhood to adolescence [21]. Those who were born later in the same year may constrain themselves and leave sports [19].

Anthropometric measurements give a good description of the body as a whole. The measurements are those which are routinely taken for a variety of purposes such as monitoring athletes, tracking growth, development, aging and motor performance, and linking physical activity and nutrition interventions to changes in body size, shape and composition [9]. There are studies in the literature that examine the effect of relative age on anthropometric properties [18]. Furthermore, children's abilities such as speed, agility, extremity swiftness, strength and power, endurance, balance and flexibility are measured with the help of standard tests used to determine motor performance and their development is observed. This study was carried out in order to investigate the effect of relative age on anthropometric properties and motor performance in Turkish children in between 8-12 ages.

2 Method

This study was carried out with 1024 children (girls n=423, boys n=601) aged between 8 and 12 years who participated in talent scanning tests in June and July 2013. Anthropometric measurements were performed in consistent with the protocol [9] identified by ISAK. The data related to motor performance were obtained through a group of tests involved in Eurofit Test Battery and other standard tests [20, 27].

Body weight (BW) was measured through an electronic scale with a sensitivity of 0.1 kg. Stature and sitting height were measured by Seca213 Stadiometer. Manouvrier Index was determined using the following formula: $(\text{Body Height} - \text{Sitting Height}) / \text{Sitting Height} \times 100$. Arm span, arm (relaxed, flexed and tensed) waist, hip and calf circumferences were measured with anthropometric tape (Cescorf-brand). The breadths of Humerus and Femur were measured with caliper (Cescorf-brand). In skin fold thickness, a Baseline-brand Skinfold Caliper (0.2 mm) was used. Measurements were performed at the right side of the body (triceps, subscapula, biceps, iliac crest, supraspinale, abdomen, femur and calf regions). Sum of 8 skinfolds was also determined. In addition, during measurements of body fat percentage (BF%) the formulas developed by Slaughter for girls and boys were used [3].

Hand grasping strengths were measured by Baseline-brand hand dynamometer in terms of kg. Flexibility test values were obtained by measuring angles in degrees while standing, standing upright with strained knees, grasping at the nadir with Baseline Bubble Inclinometer placed on back. The height of vertical jumping was measured electronically

on the Smart Jumping Platform. The best one of the three trials was recorded. The values of balance test were obtained through the number of trials performed (with shoes on) on the Flamingo balance board in order to be able to stand for one minute. Arm swiftness, Tapping test, was performed by two discs (20 cm in diameter) placed 80 cm apart on a table with 80 cm height. One hand was held stationary in the middle and other hand's 25 rotation time on the discs was measured with 1/10 sec sensitivity.

Agility, Pro-Agility Test values (participant is at the start position on the centerline of the racetrack, when ordered he/she runs rapidly to the right side and touches the line 5 yards ahead with the right hand and turns rapidly touches the line available 10 yards behind with the left hand and then returns and completes the test by reaching the starting line 5 yards behind) were measured by Smart Speed electronic chronometer. The better one of the two trials was recorded. Throwing ball backward test values (subject takes the position by turning his/her back toward the direction he/she will shoot. After he slightly bent his knees, he strains his body rapidly and throws the ball which he held with two hands in front of him backward) were measured by meter tape. The best one of the three trials was recorded.

20 m speed running test values were measured through Smart Speed electronic chronometer with 1/100 sec sensitivity. The better one of the two trials was recorded. Speed bounce test, was performed on the 20 cm high sponge hurdle on a synthetic platform. Each leap performed with double legs towards right and left sides on the hurdle for 20 sec was counted and recorded. The endurance Shuttle Run Test is a test where participants move from one line to the other one on a 20m racetrack, change directions by returning back and speed up according the signal consistent with test protocol. Here the purpose is to sustain the race rhythm as long as possible. Those who received three warnings due to not keeping up with the rhythm of the signal are excluded from test. The 20 m racetrack completed by each child during test period was taken into consideration.

For each age, the data of those who were born within the first three months of the year (Group I) were compared with of those who were born within the last three months of the year (Group II) by considering quarterly periods of the year [25]. In statistical analysis of data the MedCalc statistics program (t-test) was used and the differentiation and alteration percentages between two periods were studied.

3 Result

For each age, the data of those who were born within the first three months of the year (Group I) were compared of those who were born within the last three months of the year (Group II) by considering quarterly periods [25] and the significance levels of differentiation between two periods are given in Table 1 and Table 2 separately for girls and boys ($p \leq 0.001$, $p = 0.05$).

Table 1. In Turkish children (girls N=601) between 8 and 12 years of age, the RAE on anthropometric characteristics and motor performances.

Parameters	Age 12 n=62	Age 11 n=94	Age 10 n=114	Age 9 n=94	Age 8 n=59
Stature (cm)		p=0.0215*	p=0.0077**	p=0.0225*	
Sitting Height (cm)		p=0.0410*	p=0.0363*	p=0.0175*	
Arm Span (cm)		p=0.0494*	p=0.0423*	p=0.0014**	
Calf Girth (maximum) (cm)		p=0.0213*			
Right Hand's Grasping Strength (kg)					p=0.0498*
Vertical Jump (cm)		p=0.0360*			
Arm Swiftness (1/10 sec.)				p=0.0167*	
Agility (1/10 sec.)		p=0.0371*			p=0.0156*
Backward Ball Throwing (m)		p=0.0002***	p=0.0336*		
20-m Speed (1/100 sec.)					p=0.0006***
Speed Bounce (n/20sec)		p=0.0161*			

*p= 0.05 **p=0.01 ***p ≤ 0.001,

Table 2. In Turkish children (boys N=601) between 8 and 12 years of age, the RAE on anthropometric characteristics and motor performances.

Parameters	Age 12 n=101	Age 11 n=122	Age 10 n=132	Age 9 n=122	Age 8 n=124
Body weight (kg)	p=0.0097**		p=0.0343*	p=0.0235*	
Stature (cm)				p=0.0001***	
BMI (kg/m ²)	p=0.0162*		p=0.0334*		
Sitting Height (cm)	p=0.0251*		p=0.0255*	p=0.0004***	
MI				p=0.0417*	p=0.0214*
Arm Span (cm)				p<0.0001***	
Sum of 8 Skf. (mm)	p=0.0112*				
BF (%)	p=0.0089**				
Arm Girth (Relaxed) (cm)	p=0.0139*		p=0.0118*		
Arm Girth (Flexed and Tensed) (cm)	p=0.0094**		p=0.0133*		
Waist Girth (cm)	p=0.0056**		p=0.0147*		
Hip Girth (cm)	p=0.0140*		p=0.0071**	p=0.0428*	
Calf Girth (maximum) (cm)	p=0.0399*		p=0.0454*		
Humerus Breadth (Bicipondylar) (cm)	p=0.0367*				p=0.0397*
Femur Breadth (Bicipondylar) (cm)	p=0.0473*		p=0.0471*		
Right Hand's Grasping Strength (kg)				p=0.0003***	
Left Hand's Grasping Strength (kg)				p=0.0020**	
Flexibility (Degrees)	p=0.0475*				
Arm Swiftness (1/10 sec.)			p=0.0013**	p=0.0208*	
Agility (1/10 sec.)		p=0.0489*			
Backward Ball Throwing (m)		p=0.0474*	p=0.0016**	p=0.0007***	
20-m Speed (1/100 sec.)				p=0.0359*	p=0.0405*
Speed Bounce (n/20sec)				p=0.0002***	
Endurance (20m shuttle run) (n)		p=0.0052**			

*p= 0.05 **p=0.01 ***p ≤ 0.001,

4 Equations and mathematics

In sports the talent scanning and selection studies are generally carried out on children between 6 and 12 years age and primarily children's anthropometric characteristics, motor skills and technical skills specific to branches are assessed [7, 26] . The trainings and competitions specific to sports branch start early with an earlier specialization and sometimes two different age groups are evaluated in the same category.

There are many factors contributing to RAE (physical, cognitive, emotional and motivational reasons) [7]. In this study, when I. and II. Groups' values were compared in boys based on relative age, RAE-dependent marked differentiations were observed on

anthropometric properties at 9, 10 and 12 years of age and on motor performance values as well as anthropometric properties at 9, 10 and 11 years of age (Table 2).

In biological maturation process the interpersonal difference is a factor that affects growth, performance and physical fitness [10]. The composition of the human body is regulated by genes but is sensitive to environmental, behavioural, and nutritional factors. Interaction between the genetic and non-genetic influences contributes to the variability in body composition observed within and between populations [1]. Anthropometric measures such as circumference, skinfold, and skeletal diameter measurements have been used to assess total and regional body composition [14]. Body weight and height values and growth-development are the most fundamental data used for dietary attitudes and habits [28]. In this study, in-group I and II the RAE-dependent differences between boys' body weights (at 9, 10 and 12 years old) and statures (at 9 years old) were found statistically significant.

The relationship between BMI and BF% is affected by age, gender, ethnicity, and body build (Deurenberg et al. 1998; Snijder, Kuyf, and Deurenberg 1999) [14]. In this study, there were distinct differences in BMI of boys 10 and 12 years of age depending on RAE in between groups. Besides, in both groups stature values and BMI are found to be close to the mean values of Turkish boys [6]. However, BWs for 8-11 ages were higher than Turkish children mean values for each age group [6]. In this study it was observed that children (each age group) are increasingly gaining weight.

While sums of skinfolds may be used as estimates of overall fatness, specific skinfolds, and ratios between skinfolds, can be used to map subcutaneous fat distribution; even, it was reported that the sum of skin fold thickness is sufficient [29]. In this study, in BF% values of boys RAE varied only at the age of 12, and according to Lohman et al. (1997)'s the classification determined for 6 to 17 year age span [14], the BF% values of all boys were seen at medium level. Arm, waist circumferences and skinfold thicknesses are considered as additional measures in evaluation of physical dimensions [22] as an indicator of whole body composition [1]. In this study there were RAE-dependent differences in boys within 10 and 12-year of age. The period of fast growing stature coincides at 12-year of age in boys and 14-year of age in girls (Ross et al. 1977) [26]. It was reported that strength feature can be trained optimally right after the period of fast growing stature phase in girls and 1 – 1.5 years after this period in boys [26]. In this study a difference in strength ability was observed in boys at 9, 10 and 11 years of ages.

In both genders, ages between 6 and 10 years are the optimal periods of training for flexibility and emphasis must be put on this ability during period of fast growing stature [26]. In this study, RAE in flexibility parameter was observed at 12-year of age in boys. Neuromuscular maturation plays an important role in motor performance during childhood [10]. When evaluated in terms of biological functions, the one that develops best is biologic adaptation capacity among the nervous system, bone development, cardiovascular system, psychological development and muscle development [8]. In this study, RAE in agility parameter was observed at 11-year of age in boys.

Balance ability is observed between 7 and 10 years of age with very great increase each year. This increase continues at 10 and 13 years of age, reaching almost the most advanced level around 13 years of age. Gender-specific differences are not seen. Along with beginning of puberty, a pause or very little development is seen in balance ability [13]. In this study, in boys at all ages any difference could not be observed between groups. At the first stage of speed skill, girls (6-8 years old) and boys (7-9 years old) and at the second stage girls (11-13 years old) and boys (13-16 years old) can be trained better [26]. In this study any RAE-dependent difference was not observed in 8, 9 and 10-year of age in boys. Endurance can be trained best at the early period of fast growing body height. Aerobic capacity trainings are recommended to be given before reaching the period of fast growing

body height but aerobic power trainings must be given gradually after the growing rate has started slowing down [26]. In this study any RAE-dependent difference was not observed in 11-year of age boys. In girls, when the values of both groups are compared, at the ages of 9 and 10 (among anthropometric properties) the stature, sitting height and arm span values; at the age of 11, the stature, sitting height, arm span and calf circumference values were found statistically higher in Group I (Table 1).

When motor performance was examined, the right hand's grasping power, agility and speed at the age of 8; arm swiftness at 9, body strength at 10 and leaping power, agility, body strength and leaping power durability at 11 were found statistically significant in Group I. At ages of 8 and 11 any statistically significant difference was not observed between both groups in terms of other anthropometric properties and motor performance levels. At the age of 12 any statistically significant differences could not be seen between both groups in terms of both anthropometric properties and motor performance levels (Table 1). We think that this is a result of the fact that 12-year old girls have reached to a certain maturity after the puberty period. It was suggested that the optimal power development in girls can be trained right after the period of fast growing body height. In girls, the first stage of speed and agility can be trained better at the ages of 6-8 and the second stage at the ages of 11-13 [26]. Growth rate advances slowly in between 7-10 years of age in girls and 7-12 years in boys (juvenile) [24]. This situation has restricted the great differences that may occur in our data. However, the studies which could be carried out with different and larger groups may provide more certain information.

Finally, an effect of relative age was observed on anthropometric characteristics and motor performances of 8-12 years old Turkish children. Talent selection, identification and development programs must be multidimensional in a dynamic/prolonged process. Researchers, trainers, families, sports managers and organizers are advised to take into account RAE.

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