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Faculdade de Ciências do Desporto e Educação Física
UNIVERSIDADE DE COIMBRA

REPEATED DRIBBLING ABILITY IN YOUTH SOCCER

Test properties, interrelationship with repeated sprint tests and variation by age group

Mestrado em Treino Desportivo para Crianças e Jovens

JOÃO PEDRO MARQUES DUARTE

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Test properties, interrelationship with repeated sprint tests and variation by age group

Thesis submitted to the Faculty of Sport Sciences and Physical Education of the University of Coimbra, for the degree of Master in Youth Sports Training.

Supervisors: PhD Manuel João Coelho e Silva and MSc Vítor José Santos Severino.

JOÃO PEDRO MARQUES DUARTE

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ABSTRACT

The purpose of this study was to develop a repeated dribbling ability (RDA) test for young soccer players. Variability by age groups, association between repeated dribbling and repeated sprints (RSA), and reproducibility of RDA protocol were considered. The sample consisted of 58 young male soccer players (15.98±1.74 years) who were measured in RSA and RDA protocols within the following age groups and according to the structure of Portuguese youth soccer: under-15 (n=16), under-17 (n=19) and under-19 (n=23). Analysis of variance (ANOVA) was used to test the effect of age group in body size, maturity and functional capacities. Multiple linear regression analyses were used to estimate the relative contributions of years of formal training, CA, maturity, body size and thigh volume to variation in RDA and RSA, and also the relationship between RSA and RDA. Older players performed significantly better, but post-hoc comparisons showed that differences were not significant between 15-16 and 17-18 years. Repeated dribbling ability was more related to lower limb strength than with any other anthropometric or functional variable and a large relationship between RSA and RDA was found, but only for total time. Analysis of RDA reproducibility (2 time moments) confirmed the future usefulness of the test (reliability coefficients: total time = 0.83 and ideal time = 0.85). RDA might be a useful test to assess young soccer players from beginners to older players. In the meantime, future research using sport-specific distance with variation in the number of repetitions, among different age groups, competitive level and playing position is needed for a better insight considering validity assets.

Keywords: Youth soccer; technical skills; short-term effort; field-testing.

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INTRODUCTION

Soccer is undoubtedly the most popular sport in the world (Bangsbo, 1994), practiced by children and adults, male and female. According to FIFA (2012) there are 265 million soccer players around the world.

In Portugal, soccer is a sport activity that currently holds a position of great prominence (Ramos, 2002). According to this author, the importance of soccer has been increasing, which is evident not only because of the large amount of resources engaged in it, but also because of its relevance as an educational and sports activity. This allows soccer to enjoy a priority status in various programmes and institutions. With regards to youth sports, it is well reported that there is a significant number of children and adolescents who participate in organized sports programs (Siegel, Peña Reyes, Barahona & Malina RM, 2004).

According to Malina (2005), participation in sports increases with age during childhood, but suffers a subsequent decline during the transition to adolescence, around 12-13 years old, and during the very period of adolescence. Thus, the numbers are higher during childhood but decline during adolescence, as the sports activity becomes more demanding and specialized. Many children participate in competitive sport-specific frames in very early ages. In some cases, according to Stratton (2004), the child may be only 3-4 years of age but, in most cases, it starts competitive sports at 6-8 years of age. In a review study prepared by Silva, Fernandes and Celani (2001) on the age of sports initiation, particularly in the case of soccer, the recommendations were found to be between 8-14 years of age, with an average of 11.7 years of age.

Participation in youth team sports is based primarily on chronological age groups, which often span 2 years. In Portugal, competitive soccer models start at age 9. Variation in size, function and skill associated with age *per* se and with maturity status within 2-year age groups can be considerable. Studies of young athletes are often limited to growth and maturity status independent of functional capacities and sport-specific skills; the same is true for studies of function and skill (Malina, 1994; Malina, Bouchard & Bar-Or, 2004a). As stated by the Portuguese Soccer Federation (2011/2012), all soccer players can be registered "[…] according to respective age in the respective stage: under-7; under-9; under-11; under-13 (classified as infantiles); under-15 (classified as initiates); under-17 (classified as juveniles) and under-19 (classified as juniors)".

Huijgen, Elferink-Gemser, Post and Visscher, (2010) reported that sprinting and dribbling on the same course are partly related, although the skill of dribbling is more complex than that of sprinting. Therefore, the fastest sprinters are not always expected to be the fastest on the dribble.

To our knowledge, studies examining the ability to repeat sprints efforts with brief recovery periods do not systematically incorporate the technical dimension. Dribbling was noted as a discriminator between players who attained professional and amateur level. During adolescence, dribbling performance may be helpful in hypothesizing the successful players for the future (Huijgen et al., 2010). Thus, the purpose of this study is to develop a repeated dribbling ability test for young soccer players. The first step towards accomplishing this goal was to establish the possible link between sprinting and dribbling as well as the possible connection between the two tests. The second aim of this study was to investigate the development of sprinting and dribbling among talented youth soccer players aged 12–19 years. According to Huijgen et al. (2010) sprinting and dribbling improve over the years and hypothesize that the greatest improvements will occur at younger ages.

REVIEW

Sports Training is a globalizing process, which concerns not only the development of soccer specific abilities (physical, tactical, technical and psychological techniques), but also the creation of sports habits, health improvement, and the acquisition of a set of values such as responsibility, solidarity and cooperation, thus contributing to the integral formation of the youngster (Pacheco, 2001). According to the same author, when it comes to teaching soccer, whether in training or game situations, coaches should use the necessary methods and demand that players use the means that will allow the development of a high-quality game, even if at times it implies jeopardizing winning.

Due to the great morphological variability that exists among young people, it is possible that, when detecting and selecting talents, readiness shown at the time may be considered more important than talent itself. According to Garganta (1998) when it comes to detecting talents, it is essential to be aware of a set of assumptions, such as: a) Technical skill in speed; b) Tactical availability (creativity); c) Organizational and muscular efficiency: agility, speed, quick reaction and stopping, quick changes of orientation and direction; d) High moral value: self-control, courage, confidence, fighting spirit and character. According to Balyi (2001), an athlete has to train from 8 to 12 years or 10,000 hours in order to reach the elite level. This conclusion contributes even further to the fundamental idea that, in sports activities that do not require early specialization (like soccer), the training process should be long, continuous and evolving, developed in stages, with different objectives and characteristics, according to the stages of development. Stratton (2004) considers Long-Term Athlete Development to be a model from which the soccer coaches may withdraw guidelines (adapted) when developing training programs for soccer.

PHYSICAL DEMANDS OF THE GAME

Soccer is an extremely complex game, with specific actions that demonstrate a typology of intensive effort and, metabolically, clearly appeal to different energy sources (Santos & Soares, 2001). The ability to perform short-term maximal intensity exercise is fundamental in almost all team games. Soccer is a team sport that requires simultaneously the use of technical skills throughout high intensity intermittent exercise (Reilly, 1997).

Match analysis of elite soccer players has indicated that high-intensity actions are important in soccer (Di Salvo et al., 2010). Short high-intensity sprints in the range of 10–30 meters are common in soccer and often precede decisive moments in a match (Impellizzeri et al., 2008; Coelho e Silva et al., 2010a; Rampini et al., 2007; Reilly et al., 2000). Although aerobic capacity is the predominant metabolic pathway in a soccer game, many of the important game actions are likely anaerobic (Reilly et al., 2000). Consequently, the anaerobic capacity pathway seems to be quite important in the crucial moments of the game: winning the ball, scoring goals or preventing the opponents from doing it. According to Reilly et al. (2000), anaerobic power associated with muscular strength is important when shooting, passing and in individual duels that involve physical contact.

YOUTH SOCCER PHYSICAL DEMANDS

As previously mentioned, the physiological requirements of a soccer game depend on an extended number of factors. Among these factors, one may consider the environmental conditions, the level of performance, tactical and positional parameters, game strategies and the type of game played by each team/coach. According to Stratton (2004), soccer games practiced by young people involve multiple episodes of short sprints, jogging, running, jumping, shooting and changes of direction. In order to maintain a high level of practice, it is necessary that the youngster has a good post-exercise recovery capacity, taking into account the maintenance / recovery of ball possession.

In a study with 6 soccer players (11 years old), Capranica, Tessitori, Guidetti and Figura (2001) verified during two matches of 11-a-side soccer (regular field-100 x 65 m) and 7-a-side soccer (reduced field-60 x 40 m) that in both cases young soccer players spent 38% of play time walking, 55% running, 3% jumping and 3% inactive.

In general terms young players tend to demonstrate lower values of VO_{2max} (<60 $ml.kg^{-1}.min^{-1}$), when compared with senior players (Stølen, Chamari, Castagna & Wisløff, 2005); however, there are some exceptions. Helgerud, Hengen and Wisløff (2001) reported values of 64.3 $ml.kg^{-1}.min^{-1}$ in junior soccer players, while Strøyer, Hansen and Hansen (2004), in a study with young soccer players aged 14 years old, reported superior VO_{2max} values in midfielders and strikers when compared with defenders (65 $ml.kg^{-1}.min^{-1}$ e 58 $ml.kg^{-1}.min^{-1}$, respectively). This VO_{2max} variations evidence, depending on the specific tactical position, was also reported by Felci, De Vito, Macaluso, Marchettoni and Sproviero (1995).

All available data on children and young soccer players regarding the demands of youth soccer suggest some similarity with those reported for adult players. However, in terms of formal competition, young soccer players spend 63% and 37% of playing time under aerobic and anaerobic conditions, respectively, while in adult games the values are different and the athletes spend 66% and 34% of play time under aerobic and anaerobic conditions, respectively (Stratton, 2004).

GROWTH AND MATURATION

According to Malina (2004), children and teenagers are involved in three interacting processes: growth (increase in body size, as a whole and in parts), maturation (process of developing the different body functions aiming at biological maturity – "timing" (time) and "tempo" (rhythm) of maturation are considerably variable among different individuals and development (skills acquisition and qualitative behavior, i.e., learning appropriate behaviors that are expected by society).

STATURE, BODY MASS AND ADIPOSITY

The body volume and its proportions, body composition and physical structure are important in physical performance and physical condition. Anthropometry allows quantification of the external dimensions of the human body through a set of systematic measurement techniques, normalized measuring positions and the use of adequate tools (Claessens, Beunen & Malina, 2000). Anthropometry involves the use of carefully defined points for body measurements, a specific position of the subject at the time of the measurements and the use of adequate instruments. Measurements are normally carried out by parts: body mass, distances between points or lines, which may be lengths, diameters and circumferences, surfaces, volumes and mass measurements; there are also skinfolds of subcutaneous fat (Lohman, Roche & Martorell 1988).

According to Crawford (1996), some of the biggest advantages of using anthropometric measurements are its non-invasive nature, easy transportation and the use of equipment that are usually portable. The reference measures proposed by the International Working Group on Kinanthropometry, described by Ross and Marfell-Jones (1991), are recommended for the evaluation of anthropometric variables.

Stature and body mass are two of the most frequently used dimensions to monitor the growth of children and adolescents (Malina, 2004). Nine to ten-year-old girls and eleven to twelve-year-old boys experience an increase in the rate of stature growth, which marks the beginning of the pubertal growth spurt (period of rapid growth that is highly variable among different individuals). The growth rate increases until reaching its peak, called peak velocity (PV). The increments of the stature depend on the increase in the trunk and lower limbs size, considering different growth rates. Malina et al. (2004a) reported that rapid growth of the lower extremities is a characteristic of the beginning of the puberty spurt, and the ages of the take-off to leg length and sitting height differ about 0.1 years. This evidence suggests that the growth stage of the trunk is longer. During the pubertal growth spurt, boys go through an increase in trunk/body fat and at the same time there is a decrease in limbs adiposity. This finding are reinforced by Malina et al. (2004), indicating that boys over eleven show a decrease in the values of the limbs subcutaneous fat and a slight increase in the values of the trunk.

Considering body composition, and from a bicompartmental perspective, there is stabilization or a slight increase in fat mass in males during the pubertal spurt. However, there is a sharp increase of fat-free body mass during this period, as a result of the substantial increase in muscle and bone mass (Malina et al., 2004).

The equations of Slaughter et al. (1988) are the most widely used in studies of body composition in pediatric populations and in the FITNESSGRAM battery, specifically. In recent years, Slaughter has been the most referenced author of studies carried out with adolescents.

Slaughter et al. (1988) used three methods to predict the percentage of BF with specific groups of children and youngsters (65 prepubertal, 59 pubertal and 117 postpubertal) and 68 adults, aged 8 to 29, male and female, Caucasian and Black, using different assessment techniques based on a three compartment model and with crossed validity and anthropometric measurements based on the sum of two skinfolds, triceps with subscapular and triceps with geminal.

To estimate the body density (Bd), one used the method of hydrostatic weight corrected by residual pulmonary volume. The total body water (TBW) was determined by diluting deuterium oxide (2H2O) and bone mineral (BM) was estimated by using DEXA. The study by Slaughter et al. (1988) suggests two alternatives to calculate the percentage of body fat (% BF): Based on the triceps (T) and geminal medial (GLM) and based on the triceps (T) and subscapular (Sub) taking into account different constant per each pubertal status.

These equations were validated in a study by Janz et al. (1993). The study proceeded to cross validation by comparing the measured criterion of the equations of Slaughter et al. (1988) performed with a two-compartment model using hydrostatic weighing. With a sample of 122 subjects aged between 8 and 17 years, it showed values validation with high correlations of r = 0.79 - 0.99 and standard error of estimate (SEE) between 3.6 and 4.6%. In boys, the equation of Slaughter et al. (1988) using the triceps and medial geminal tends to overestimate body density with a total error of 0.0112 g/cc, or 5.4% of MG.

SOMATIC MATURATION

Somatic maturation refers to the progress of somatic or morphological characteristics. According to Faulkner (1996), somatic maturation is useful insofar as it sorts children, retrospectively, into maturation groups in order to analyze the growth data. Percentage of mature (adult) stature method is based on the estimation of adult stature through the current stature and skeletal and chronological age; some techniques also use parental stature and, in the case of girls, menarche age. (Tanner et al., 1983; Khamis & Guo 1993, Khamis & Roche, 1994; Beunen et al., 1997).

Khamis and Roche (1994) discard the information on skeletal age. In order to determine the mature stature, they use the current stature, body mass and parental average stature multiplying the variables presented in weighting coefficients associated with the chronological age of the individuals observed. This method was developed with a sample of the *Fels Longitudinal Study*, and the authors found an average error in boys of 2.2 cm between the predicted stature and the actual stature at the age of 18. This estimated error shows only a slight increase over the one recorded in the Roche-Wainer-Thissen method, using the bone age. The coefficients for the calculation of this method were published again in errata by Khamis and Roche (1995). The determination of the predicted mature stature was used by Malina et al. (2005) to classify a sample of American football players regarding maturation. These authors justify the choice of a non-invasive method with the opposition that parents, sports organizations and ethics committees showed against the relatively small exposure to radiation when obtaining bone age, and the invasion of privacy associated with the assessment of secondary sexual characteristics. The authors used the Khamis-Roche method (Khamis & Roche, 1994, 1995) and subsequently determined the z score for each athlete regarding the percentage of mature stature attained and grouped the sample subjects into late matures (if z score <-1.0), average (if z score ≥ -1.0 and ≤ 1.0) and early matures (if z score ≥ 1.0). The same procedure was adopted by Cumming, Battista, Standage, Ewing and Malina (2006) in a study with young soccer players.

REPEATED SPRINT ABILITY (RSA)

The ability to repeat sprinting efforts with brief recovery periods has been labeled "Repeated Sprint Ability" (RSA) and has received particular attention in literature (Buchheit, Mendez-villanueva, Simpson & Bourdon, 2010). Field tests have been developed and construct validity of the tests as indicators of match-related physical performance in soccer have been evaluated among professional players using a video-computerized image system (Rampini et al., 2007). Mean RSA times were significantly correlated with high and very high intensity running, sprinting distance and total distance covered during a match. Although there is an increasing interest in RSA tests, literature has not considered developmental changes in sprinting performances.

Research on elite young Brazilian soccer players found that fullbacks made fewer sprints whereas attackers made most sprints; also, forwards and offensive midfielders sprinted more with the ball than players from other positions (Pereira, Kirkendall, & Barros, 2007). Another research on young non-elite soccer players found that forwards were the fastest players in the 30-m straight and agility sprint, followed by midfielders (Gil, Gil, Ruiz, Irazusta, & Irazusta, 2007a). These results indicate that forwards are the best sprinters, although limited information is available regarding which position shows the best dribbling performance. Longitudinal modelling can indicate which factors contribute to the development of dribbling performance in soccer. Previous cross-sectional research on talented youth soccer players has reported improvements on dribbling and sprinting tests with age (Gil, Ruiz, Irazusta, Gil, & Irazusta, 2007b; Kukolj, Ugarkovic & Jaric 2003; Rosch et al., 2000; Vanderford, Meyers, Skelly, Stewart, & Hamilton, 2004). It has also been shown that practice is a major feature for the development of soccer skills (Ericsson, Krampe, & Teschromer, 1993; Helsen, Hodges, Van Winckel, & Starkes, 2000; Helsen, Starkes, & Hodges, N. J., 1998). Previous research also showed height to be a significant factor for running speed in a group of talented soccer players (Malina, Eisenmann, Cumming, Ribeiro, & Aroso, 2004b). Another contributor to performance in sports is lean body mass, which is related to body muscle percentage and body fat percentage. Various test batteries have revealed that athletes who perform better on change-of-direction sprint tests, also over short distances, tend to have a lower percentage of body fat (Gabbett, 2002; Meir, Newton, Curtis, Fardell, & Butler, 2001; Negrete & Brophy, 2000; Reilly et al., 2000). As the hypothesis is that sprinting and dribbling (speed) are correlated to some extent, the variables that influence sprinting might also influence dribbling in talented youth soccer players.

REPEATED DRIBBLING ABILITY (RDA)

Many actions in soccer involve repeated short sprinting and dribbling with changes of direction and he main technical skills are shooting, passing, heading, ball control and dribbling (Bloomfield, 2007). Dribbling can be categorized into dribble actions while accelerating and dribble actions with quick changes of direction (Huijgen et al., 2010).

The intermittent nature of soccer requires the ability to repeatedly produce high-intensity actions every 72 seconds (Bradley et al., 2009), although only 1.2 – 2.4% of the total distance covered is with the ball possession (Di Salvo et al., 2010). Regardless of position, in soccer, the performance of dribbling speed is a characteristic of its players (Reilly et al., 2000). Thus, the technical ability of dribbling at high speed is essential (Huijgen et al., 2010). Previous research has indicated that the best players distinguish themselves by their running speed while dribbling the ball (Malina et al., 2005; Reilly et al., 2000; Vaeyens et al., 2006).

METHODS

SAMPLE

The sample comprised 58 young male soccer players within the following age groups and according to the structure of Portuguese youth soccer: under-15 (classified as initiates, 13/14 years, n=16), under-17 (classified as juveniles, 15/16 years, n=19) and under-19 (classified as juniors, 17/18 years n=23). The players belong to "Futebol Clube da Pampilhosa", a club in the midlands of Portugal, affiliated in the "Aveiro Soccer Association" and "Portuguese Soccer Federation". The study followed the established ethical standards for sports medicine (Harris & Atkinson, 2009). The participation of the players was voluntary, and parents were asked for a written statement of consent. The sport entity was also informed about the whole experimental procedure.

TIME AND RESOURCES

This study comprises 3 different moments. An experimental (pilot) study with eight soccer players was firstly considered. All tests were recorded and the athletes were questioned regarding the perception of the procedures. Therefore, two protocols were defined: 1) starting the test with ball (dribbling) and in the last 9 meters sprinting without it (tendency to give one last touch before the last turn); 2) performing the whole test (as defined by Bangsbo, 1994) with the ball. The second protocol seemed to be "natural": the fact that the players had to continue with the ball forced them to get around the last cone with the ball under control. The players' perception was "*after the first one it becomes easier*" (learning effect), so it was suggested that a trial should be included in the warm-up for all subjects.

The study contained two parallel data collection. Firstly, a group of 58 young soccer players were assessed in both protocols (RSA and RDA) as well as in the other anthropometric and functional variables. Afterwards, a subsample was asked to repeat the RDA protocol (n=25). Note that for the total sample, the procedures were organized in two moments with one weak apart. In the first moment data collection included anthropometry, functional capacities and RSA. One weak later the second moment was performed to obtain the assessment of RDA and also to conclude missing data.

VARIABLES

Anthropometry

Anthropometry involved the use of references carefully defined and described for the standardization of measurement procedures. A single anthropometrist measured stature, body mass, and two skinfolds (i.e., triceps and subscapular) following standard procedures described by Lohman, Roche and Martorell (1988), also referred by Malina et al., (2004a). Stature was measured to the nearest 0.1 m using a Harpenden stadiometer (model 98.603, Holtain Ltd, Crosswell, UK) and body mass to the nearest 0.1 kg using a SECA balance (model 770, Hanover, MD, USA). Skinfolds were measured to the nearest mm using a Lange caliper (Beta Technology, Ann Arbor, MI, USA). Technical errors of measurement for stature (0.27 cm), sitting stature (0.31 cm), body mass (0.47 kg), and skinfolds (0.47-0.72 mm) were well within the range of several health surveys in the United States and a variety of field surveys (Malina et al., 2004a). Percentage of fat mass was estimated from triceps (T) and geminal medial skinfold thicknesses using the protocol of Slaughter et al., 1988:

$$0.735\ (Glm + T) + 1.0$$

Somatic Maturation

The percentage of predicted mature stature, proposed by Khamis and Roche (1994, 1995) was used. This procedure included the use of stature at the time of the study, body mass and mid-parental stature. Information on the stature of the biological parents of the players was obtained through photocopy of the identity card of each parent.

Field tests

RSA performance was assessed with the 7-sprints protocol (Bangsbo, 1994). The test included seven consecutive sprints (about 35 m with a slalom) with a recovery period of 25 seconds between sprints during which the player ran/walked from the end line back to the starting line. The time for each sprint was recorded by a digital chronometer connected to photoelectric cells (Globus Ergo Timer Timing System, Codogné, Italy). The protocol provided the following indicators: the best sprint, the worst sprint, total time, ideal time (total theoretical time of accomplishment of the sprints with the best mark) and decrement score (Bishop, Spencer, Duffield & Lawrence 2001).

The soccer specific test was the one described above, plus adding a ball. In the beginning of the test there were 7 balls with the same air pressure and the same brand. The 25-second recovery period was performed without ball. The same indicators were extracted from this test: the best sprint, the worst sprint, total time, ideal time and decrement score (Bishop et al., 2001).

Standing Long Jump

The standing long jump was used to test the power (Council of Europe, 1988). The subject stood just behind the take-off line with the feet together and was instructed to jump as far as possible. The test was performed twice and the better score was counted.

Sit-ups

The sit-up test was used to evaluate the dynamic endurance of abdominal muscles (Council of Europe, 1988). The subject was lying down on his back on the mat with the arms folded and the hands on the shoulders. The knees were bent (90 degrees) and the heels were in contact with the floor. The ankles were held by another subject who counted aloud each time a complete sit-up was performed. With each sit-up the elbows had to touch the knees. The test leader corrected the subject`s technique if necessary, especially if he did not touch the knees with his elbows or did not touch the mat with his shoulders. The test is performed once and the total number of correctly performed and fully completed sit-ups within the 30 seconds limit was taken as the score.

All tests were done with the control of temperature and humidity. Tests were also performed on the same day of the week (Mondays) and at the same hour interval (18:00 – 20:00).

Training and competition indicators

At the same time, information on the sports participation of young soccer players was collected. Thus, information was gathered on the number of years (sports seasons) of federated practice in the sports activity and on the specialized position in the activity.

QUALITY CONTROL

Intra-observer technical errors of measurement for anthropometric dimensions and coefficients of reliability for the functional capacity and soccer skill tests were calculated. The technical error of measurement is the square root of the squared differences of replicates divided by twice the number of pairs:

$\sigma_e = \sqrt{\Sigma d^2 / 2N}$ (Malina, Hamill & Lemeshow 1973).

It is also known as the measurement error standard deviation. The coefficient of reliability is based on the ratio of within subject (r) and inter-subject (s) variances:

R = 1 – (r^2/s^2) (Mueller & Martorell, 1988).

Higher values indicate greater reliability. Technical errors for anthropometric dimensions compare favorably with corresponding intra- and inter-observer errors in several health surveys in the USA and a variety of field surveys, including studies of young athletes (Malina 1995), while reliability coefficients indicate moderate to high reliabilities which are adequate for group comparisons.

Means and standard deviations at time moments 1 and 2 are respectively 67.28 $\pm$ 6.23 s and 69.31 $\pm$ 7.13 s for the total time. Respective values for the ideal time were 63.04 $\pm$ 5.68 and 64.53 $\pm$ 7.02 s. Technical error of measurement (TEM) was calculated using the formula proposed by Mueller and Martorell (1988) and were 2.78 s and 2.48 s respectively for total and ideal time. Correspondent reliability coefficients were 0.83 and 0.85, which means that inter-individual variability comprises 17% of intra-individual variability for the total time, and 15% for the ideal time. Percentage of variance [(TEM/overall mean) x 100] was 4.07% for total time and 3.89 for ideal time. Overall mean corresponds to total mean from cases assed in time moment 1 and in time moment 2.

STATISTICAL ANALYSIS

Descriptive statistics were calculated for the total sample (minimum, maximum, mean and standard deviation) and Kolmogorov-Smirnov test was used to check normality. When assumptions were violated, log-transformations were performed to reduce non-uniformity of error. Analysis of variance (ANOVA) was used to test the effect of age group in body size, maturity and functional capacities. The effect size correlations (ES-*r*) were estimated using the square root of the ratio of the F-value squared and the difference between the F-value squared and degrees of freedom (Rosnow and Rosenthal, 1996). Coefficients were interpreted as follows: trivial ($r < 0.1$), small ($0.1 < r < 0.3$) moderate ($0.3 < r > 0.5$), large ($0.5 < r < 0.7$), very large ($0.7 < r < 0.9$), nearly perfect ($r > 0.9$) and perfect ($r = 1$). If a comparison was significant, pairwise comparisons with a Bonferroni adjustment were used to identify differences between specific pairs. Multiple linear regression analyses were used to estimate the relative contributions of years of formal training, CA, maturity, body size and thigh volume to variation in RDA and RSA. Afterwards, total sample and age group-specific multiple linear regression analyses were used to examine the relationship between parameters of

RDA and RSA protocols. Significance was set at $p < 0.05$. The Statistical Program for Social Sciences – SPSS, version 20.0 for Mac OS X was used.

RESULTS

Descriptive statistics for the total sample are summarized in tables 1 and 2.

Table 1. Descriptive statistic for total sample (n=58).

Variables	Units	Min	Max	Mean	Std. Deviation	Kolmogorov-Smirnov (k-s)	
						value	*p*
Training	years	1.0	12.0	6.0	2.8	0.119	0.040
Chronological age	years	12.90	18.65	15.98	1.74	0.098	0.200
Estimated mature stature	%	84.6	99.8	97.1	4.2	0.218	0.000
Stature	cm	152.2	187.0	170.4	8.3	0.095	0.200
Body mass	kg	36.3	101.0	62.0	13.1	0.065	0.200
Thigh volume	L	3.1	11.8	5.7	1.8	0.134	0.012
Fat Mass	**%**	9.1	37.0	17.4	0.7	0.164	0.001
Standing long jump	cm	126.0	239.5	201.2	24.1	0.116	0.051
Sit-ups	#	17.0	39.0	28.6	4.7	0.080	0.200
RSA – total time	s	48.81	71.80	53.89	3.95	0.145	0.004
RSA – ideal time	s	42.56	64.47	51.23	3.54	0.117	0.047
RDA – total time	s	59.26	95.26	67.91	6.84	0.137	0.008
RDA – ideal time	s	55.86	83.09	63.42	5.85	0.207	0.000

As presented in table 1, several variables did not fit the normal distribution. Therefore, it was decided to produce log-transformed values on variables that failed normal distribution: attained percentage of estimated mature stature (k-s value = 0.224, $p \geq 0.01$), thigh volume (k-s value = 0.084, $p = 0.20$), training years (k-s value = 0.198, $p \leq 0.01$), percentage of fat mass (k-s value = 0.078, $p = 0.110$), RSA total time (k-s value = 0.129, $p \leq 0.05$), RSA ideal time (k-s value = 0.104, $p = 0.10$), RDA total time (k-s value 0.124, $p \leq 0.05$), RDA ideal (k-s value = 0.197, $p \leq 0.01$). It seems that after obtaining the log-transformed values some of the above-mentioned variables attained the assumption of normal distribution while others did not.

Table 2. Descriptive statistic for total sample (n=58) by age group.

	Units	13-14 (n=16)	15-16 (n=19)	17-18 (n=23)	*	F	p	ES - r
		Mean ± Std. Deviation	Mean ± Std. Deviation	Mean ± Std. Deviation				
Training	years	3.4 ± 2.1	6.2 ± 1.9	7.7 ± 2.6	*	18.069	0.000	0.630
Chronological age	years	13.68 ± 0.53	15.88 ± 0.55	17.67 ± 0.74		189.828	0.000	0.935
Estimated mature stature	%	91.4 ± 3.4	98.1 ± 1.8	100.1 ± 0.6	*	81.861	0.000	0.865
Stature	cm	162.3 ± 8.2	172.8 ± 6.9	174.0 ± 5.5		15.901	0.000	0.605
Body mass	kg	50.5 ± 11.4	64.8 ± 11.7	67.7 ± 10.3		12.304	0.000	0.556
Thigh volume	L	4.8 ± 1.6	5.8 ± 2.0	6.2 ± 1.6	*	5.085	0.009	0.395
Fat mass	%	19.1 ± 1.7	16.6 ± 1.2	17.0 ± 0.7	*	1.189	0.334	0,197
Standing long jump	cm	172.5 ± 17.8	203.2 ± 15.1	219.5 ± 12.3		47.239	0.000	0.795
Sit-ups	#	25.4 ± 4.3	27.6 ± 3.8	31.8 ± 3.6		13.948	0.000	0.581
RSA – total time	s	58.25 ± 4.29	53.08 ± 2.46	51.52 ± 1.63	*	30.103	0.000	0.723
RSA – ideal time	s	55.16 ± 3.28	50.42 ± 2.50	49.17 ± 1.93	*	27.618	0.000	0.708
RSA – decrement score	s	5.56 ± 2.70	5.33 ± 2.63	4.87 ± 3.92	*	0.610	0.547	0.147
RDA – total time	s	75.11 ± 7.64	66.85 ± 4.25	63.77 ± 3.19	*	25.681	0.000	0.695
RDA – ideal time	s	70.36 ± 5.89	62.06 ± 2.74	59.71 ± 2.78	*	38.871	0.000	0.765
RDA – decrement score	s	6.66 ± 3.45	7.75 ± 5.73	6.82 ± 2.77	*	0.070	0.932	0.051

*Variables that did not fit the normal distribution were tested using log-transformed values.

As expected, the three age groups differed in years of training (F = 18.069, $p \leq 0.001$), chronological age (F = 189.828, $p \leq 0.001$) and estimated mature stature (F = 181.861, $p \leq 0.001$). As presented in table 3, post hoc comparison noted significant differences between initiates (under-15) and juveniles (under-17) and initiates (under-15) and juniors (under-19) for the three dependent variables. However, no differences were noted between juveniles (under-17) and juniors (under-19) regarding years of training, in contrast to chronological age and estimated mature stature that significantly differed between the two groups.

Tables 2 and 3 also compared the three age groups for anthropometry. Stature (F = 15.901, $p \leq 0.001$), body mass (F = 12.304, $p \leq 0.001$) and thigh volume (F = 5.085, $p \leq 0.001$) were significantly affected by the independent variable. No differences were found for percentage of fat mass. Juveniles and juniors did not differ in any somatic characteristics. Differences between initiates and juniors (U15 < U19) were found for the three body size descriptors (stature, body mass and thigh volume). Finally initiates and juveniles differed in stature and body mass (U15 < U17), but did not differ in appendicular volume.

Regarding functional capacities, the three groups derived from the independent variable significantly differed for standing long jump (F = 47.239, $p \leq 0.001$), sit-ups (F = 13.948, $p \leq 0.001$), RSA total time, (F = 30.103, $p \leq 0.001$), RSA ideal time (F= 27.618, $p \leq 0.001$), but did not differ for the RSA decrement score. Standing long jump evidenced significant different performance between initiates, juveniles and juniors (U15 < U17 < U19); sit-ups did not differ between the two youngest groups (initiates and juveniles) in contrast to significant differences between initiates and juniors (U15 < U19) and juveniles and juniors (U17 < U19). For the RSA total time and RSA ideal time, results in table 3 noted only significant differences between initiates and juveniles (U15 < U17) and initiates and juniors (U15 < U19). The two oldest groups did not differ in the outputs derived from the RSA protocol.

Table 3. Mean differences and significant value obtained for the post hoc comparison between initiates (under-15) and juveniles (under-17), initiates (under-15) and juniors (under-19) and juveniles (under-17) and juniors (under-19).

	Units	under-15 x under-17		under15 x under-19		under-17 x under-19		Post hoc pairwise comparisons *
		Mean difference	p	Mean difference	p	Mean difference	p	
Training	years	- 2.7	0.002	- 4.2	0.000	-1.5	0.098	U15 < U17; U15 < U19
Chronological age	years	- 2.19	0.000	- 3.99	0.000	- 1.79	0.000	U15 < U17 < U19
Estimated mature stature	%	- 6.8	0.000	- 8.8	0.000	- 2.0	0.008	U15 < U17 < U19
Stature	cm	- 10.5	0.000	- 11.7	0.000	- 1.3	0.999	U15 < U17; U15 < U19
Body mass	kg	- 14.3	0.000	- 17.3	0.000	- 2.9	0.999	U15 < U17; U15 < U19
Thigh volume	L	- 1.1	0.222	- 1.4	0.041	- 0.4	0.999	U15 < U19
Fat mass	%	0.1	0.434	0.1	0.999	0.090	0.942	
Standing long jump	cm	- 30.7	0.000	- 47.0	0.000	- 16.3	0.003	U15 < U17 < U19
Sit-ups	#	- 2.2	0.298	- 6.4	0.000	- 4.2	0.003	U15 < U19; U17 < U19
RSA – total time	sec	5.2	0.000	6.7	0.000	1.5	0.242	U15 < U17; U15 < U19
RSA – ideal time	sec	4.7	0.000	6.0	0.000	1.2	0.359	U15 < U17; U15 < U19
RSA – decrement score	sec					0.5	0.999	
RDA – total time	sec	8.3	0.000	11.3	0.000	3.1	0.169	U15 < U17; U15 < U19
RDA – ideal time	sec	8.3	0.000	10.7	0.000	2.3	0.167	U15 < U17; U15 < U19
RDA – decrement score	sec	-1.1	0.999	0.7	0.999	0.9	0.999	

* For timed events, lower scores indicate better performances.

Considering RDA, the results were similar to trends observed for RSA outputs. First, the independent variable produced significant variance on the dependent variable: RDA total (F = 25.681, $p \leq 0.001$), RDA ideal (F = 38.871, $p \leq 0.001$). Second, the RDA decrement score was not affected by age. Third, post hoc comparison did not any significant difference between juveniles and juniors. Finally, significant differences in RDA total and RDA ideal were noted between initiates and juveniles (U15 $<$ U17) and initiates and juniors (U15 $<$ U19).

Table 4. Results of linear regression models to examine the relationship between parameters of RDA and RSA protocols by age group and for the total sample (n=58).

Age group	Y_i	X_i	Constant		β		ε (95%CI)	r^2	SEE
			Unstandardized	St. error	Unstandardized	St. error			
13-14 (n=16)	RDA total time	RSA total time	12.546	22.172	1.074	0.380	0.603 (0.408 to 0.745)	0.364	6.305
	LN RDA total time	LN RSA total time	0.740	1.188	0.880	0.292	0.627 (0.440 to 0.762)	0.393	0.0786
	RDA ideal time	RSA ideal time	-2.512	17.903	1.321	0.324	0.737 (0.591 to 0.836)	0.543	4.119
	LN RDA ideal time	LN RSA ideal time	0.051	1.064	1.047	0.265	0.726 (0.576 to 0.829)	0.527	0.059
	RDA decrement score	RSA decrement score	8.805	1.998	-0.386	0.325	-0.302 (-0.520 to -0.047)	0.091	0.026
15-16 (n=19)	RDA total time	RSA total time	3.709	16.201	1.189	0.305	0.687 (0.521 to 0.803)	0.472	3.177
	LN RDA total time	LN RSA total time	0.480	0.962	0.937	0.242	0.684 (0.517 to 0.801)	0.468	0.046
	RDA ideal time	RSA ideal time	34.373	11.583	0.549	0.229	0.502 (0.280 to 0.673)	0.252	2.436
	LN RDA ideal time	LN RSA ideal time	2.348	0.730	0.454	0.186	0.509 (0.289 to 0.678)	0.259	0.039
	RDA decrement score	RSA decrement score	7.631	3.129	0.023	0.529	0.010 (-0.249 to 0.268)	0.000	5.897
17-18 (n=23)	RDA total time	RSA total time	1.880	17.388	1.201	0.337	0.614 (0.423 to 0.753)	0.377	2.581
	LN RDA total time	LN RSA total time	0.388	1.060	0.956	0.269	0.613 (0.421 to 0.752)	0.375	0.040
	RDA ideal time	RSA ideal time	41.063	14.925	0.379	0.303	0.263 (0.005 to 0.488)	0.069	2.749
	LN RDA ideal time	LN RSA ideal time	3.016	0.917	0.275	0.235	0.247 (-0.012 to 0.475)	0.061	0.045
	RDA decrement score	RSA decrement score	5.059	0.823	0.360	0.133	0.510 (0.290 to 0.679)	0.260	2.441
Total sample (n=58)	RDA total time	RSA total time	-7.275	7.421	1.395	0.137	0.805 (0.690 to 0.880)	0.648	4.095
	LN RDA total time	LN RSA total time	-0.246	0.417	1.119	0.105	0.819 (0.711 to 0.889)	0.671	0.055
	RDA ideal time	RSA ideal time	-4.038	6.845	1.317	0.133	0.797 (0.678 to 0.875)	0.635	3.561
	LN RDA ideal time	LN RSA ideal time	0.127	0.427	1.021	0.109	0.783 (0.658 to 0.886)	0.613	0.055
	RDA decrement	RSA decrement score	6.322	1.039	0.145	0.170	0.113 (-0.150 to 0.361)	0.013	4.097

The results of multiple linear regressions between outputs derived by the RSA and RDA protocols are presented in Table 4.

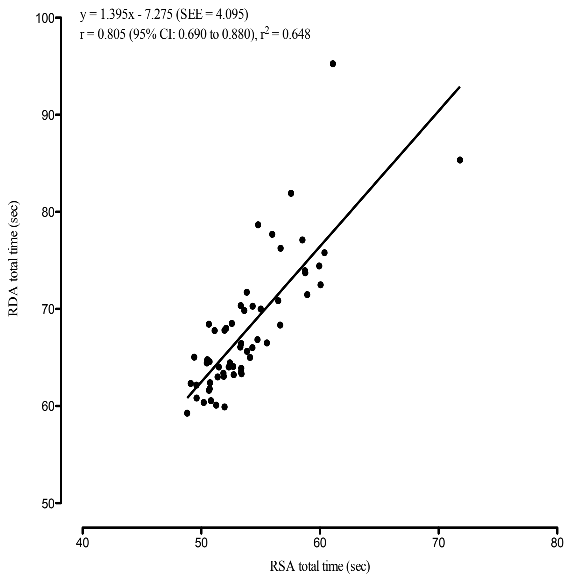

Figure 1. Linear relationship between RDA total time (seconds) and RSA total time (seconds) for the total sample (n=58).

Coefficients of correlation were respectively 0.805 and 0.797 for the total times and ideal times. The linear relationship is graphically presented in figure 1 and figure 2.

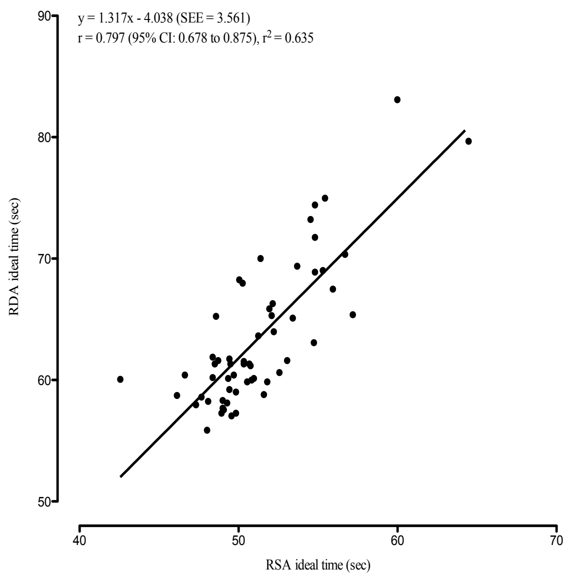

Figure 2. Linear relationship between RDA ideal time (seconds) and RSA ideal time (seconds) for the total sample (n=58).

For ideal time the coefficient slightly decreases for 0.797 to 0.783 (respectively original values and log-transformed data). For the total time, the log-transformed data presented a slightly higher coefficient (0.819) compared to 0.805 noted with the original data. The linear relationships between RSA decrement score and RDA decrement score was not significant (*r* = 0.113, 95% CI: -0.150to 0.361) and no graphic was produced.

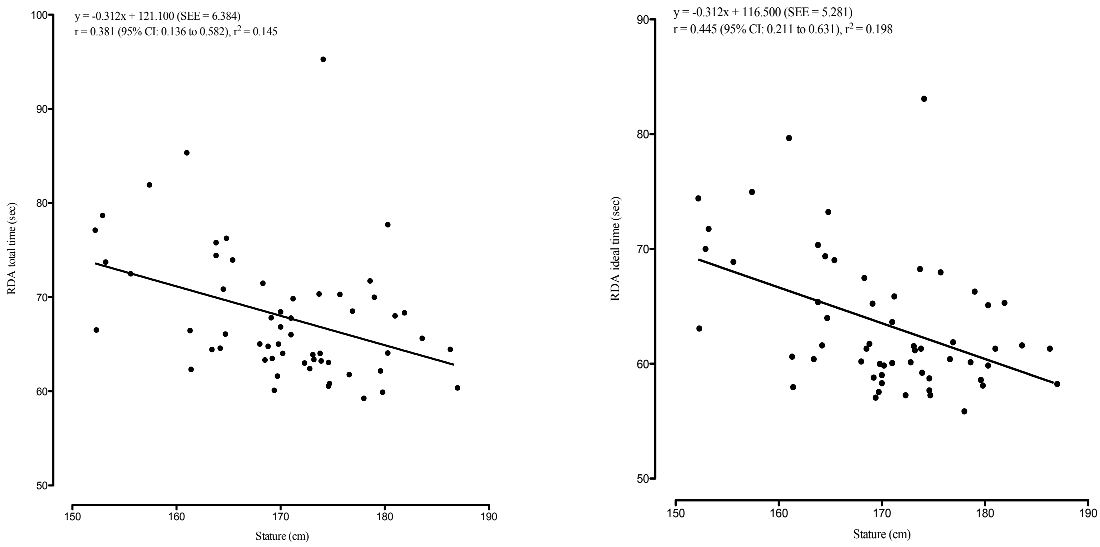

Figure 3. Linear relationship between RDA total time [seconds, (left panel)] and RDA ideal time [seconds, (right panel)] with stature (cm), for the total sample (n=58).

When considering age groups, it seemed that between RSA total time and RDA total time the magnitude of the coefficients range from 0.603 (initiates) to 0.687 (juveniles). Where the correlations were performed using log-transformed data, the magnitude did not substantially change.

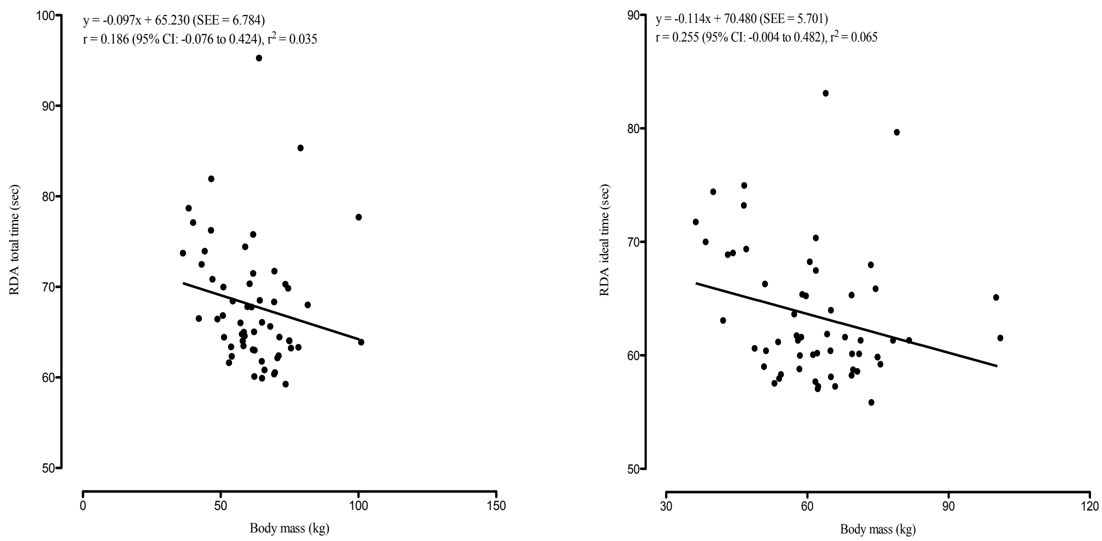

Figure 4. Linear relationship between RDA total time [seconds, (left panel)] and RDA ideal time [seconds, (right panel)] with body mass (kg), for the total sample (n=58).

The relationships between RSA ideal time and RDA ideal time were also large (r = 0.502 for juveniles) and very large for initiates (r = 0.737). The coefficient was surprisingly lower for juniors (r = 0.263). As for the total sample, the coefficients using the log-transformed data did not substantially vary from the coefficient obtained using the original data and this was noted for initiates, juveniles and juniors.

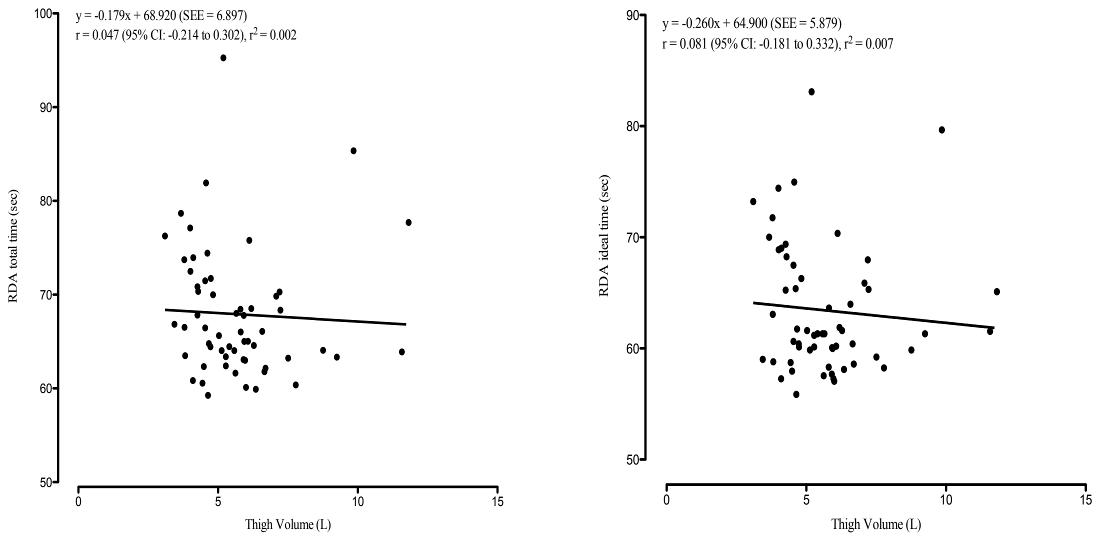

Figure 5. Linear relationship between RDA total time [seconds, (left panel)] and RDA ideal time [seconds, (right panel)] with thigh volume (L), for the total sample (n=58).

Figures 3 – 8 summarize the linear relationship between RDA total time (3a, 4a, 5a, 6a, 7a, 8a) and stature, body mass, thigh volume, sit-ups, standing long jump, and percentage of fat mass. Similarly figures 3b, 4b, 5b, 6b, 7b, 8b present the linear relationship between some somatic and functional variables (mentioned above) and RDA ideal time.

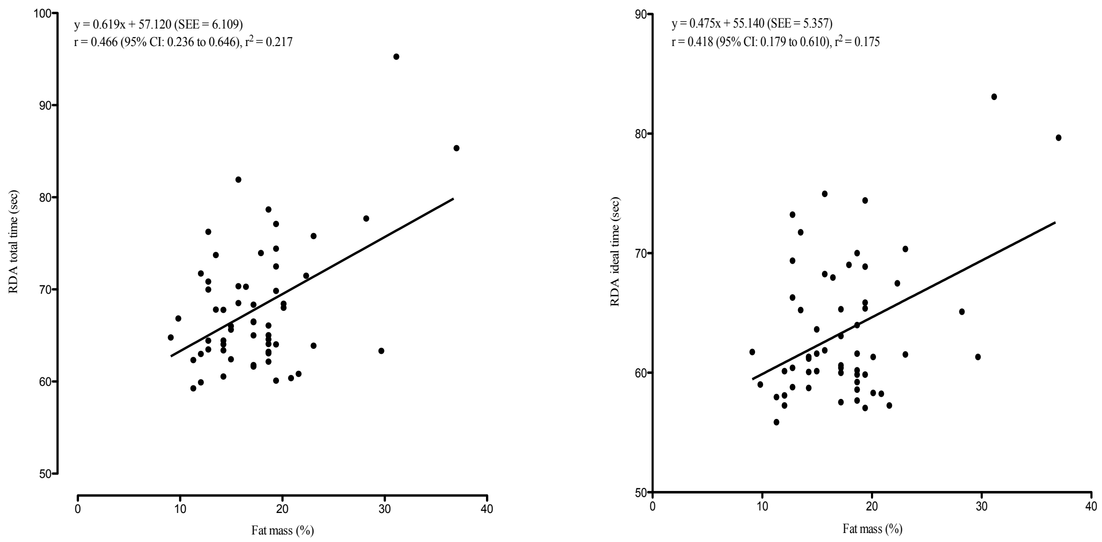

Figure 6. Linear relationship between RDA total time [seconds, (left panel)] and RDA ideal time [seconds, (right panel)] with fat mass (%), for the total sample (n=58).

The relationships with RDA outputs were more related with stature (RDA total time: r = 0.381; RDA ideal time: r = 0.445) then with body mass (RDA total time: r = 0.186; RDA ideal time: r =0.255). The relationships with thigh volume were negligible and moderate with sit-ups (RDA total time: r =0.463; RDA ideal time: r =0.449) and percentage of fat mass (RDA total time: r = 0.466; RDA ideal time: r = 0.418).

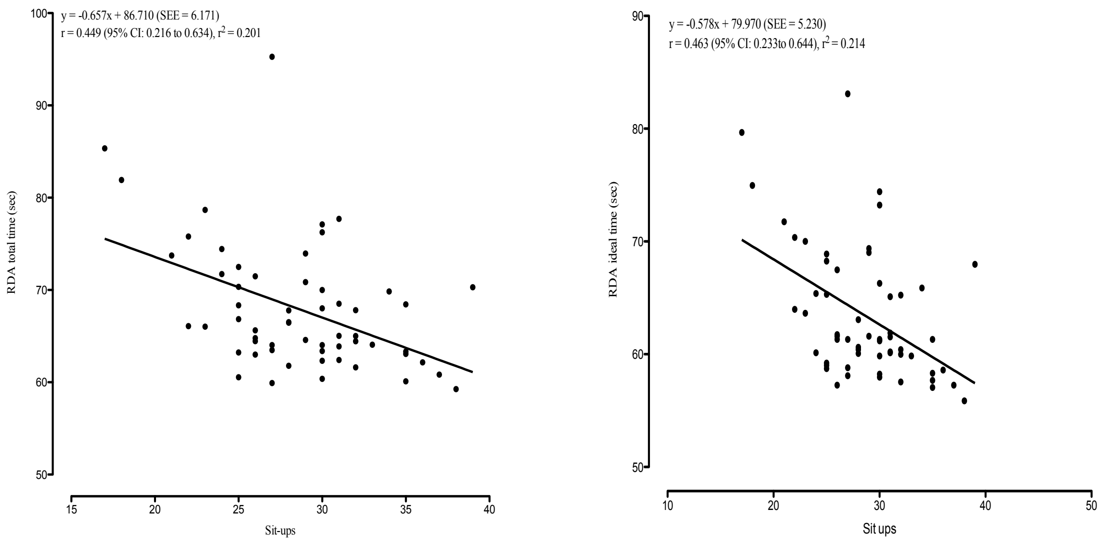

Figure 7. Linear relationship between RDA total time [seconds, (left panel)] and RDA ideal time [seconds, (right panel)] with sit-ups (#), for the total sample (n=58).

Standing long jump presented coefficients that were substantially higher than noted for sit-ups: RDA total time (*r* = 0.720), RDA ideal time (*r* = 0.758). Some of these coefficients may be suspiciously affected by age and future researches with larger subsamples (initiates, juveniles and juniors) need to re-examine the relationship between RDA outputs and measurements of body size and functional capacities.

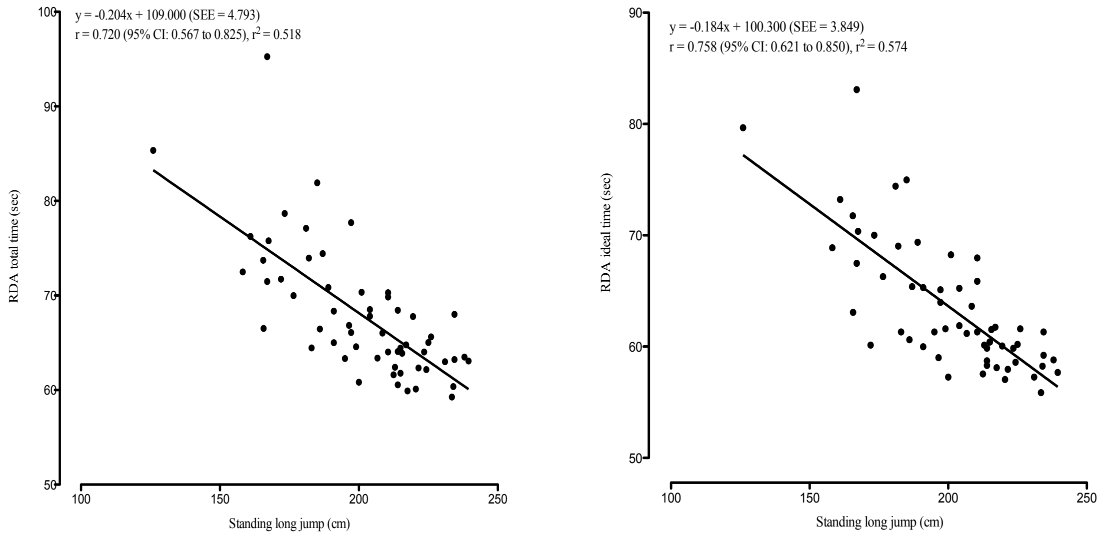

Figure 8. Linear relationship between RDA total time [seconds, (left panel)] and RDA ideal time [seconds, (right panel)] with standing long jump (cm), for the total sample (n=58).

DISCUSSION

Many team sports require participants to repeatedly produce maximal or near maximal sprints of short duration (1-7s) with brief recovery periods, over an extended period of time (60-90 min). Therefore, an important fitness component for these sports is what is often termed repeated sprint ability (RSA). A variety of tests have been devised to assess RSA. However, while the reliability of some of these tests has been noted, the validity of RSA tests is not extensively reported. In a study organized to compare the growth and maturity status, functional capacities, sport-specific skills and goal orientation of youth soccer players in two age groups (11-12 years and 13-14 years), anaerobic fitness was assessed with the seven-sprint protocol and the derived outputs were the best sprint and the mean sprint (Figueiredo, Gonçalves, Coelho e Silva & Malina 2009a). The reliability coefficients were 0.81 and 0.88, respectively, for the best trial and the mean time.

The reliability and validity of a soccer-specific field test of repeated sprint ability was also assessed in seven male soccer players aged 23 (Wragg, Maxwell & Doust, 2000). A within-subject mean coefficient of variation of 1.8% was found for performance in the repeated sprint test. The mean coefficient of variation across trials 2-4 was found to be 1.9%, compared to trials 4-6, where it was 1.4%. The ANOVA showed that a significant difference was present between the trials and a Tukey post-hoc test showed that significant differences were present between trial 1 and trials 3-6, and trial 2 and trial 5. The learning effect was complete by trial 3.

The present study examined age-related variation in repeated sprint and repeated dribbling ability. Repeated dribbling was evaluated using the same protocol as described by Bangsbo (1994) but while dribbling a ball. Reproducibility of repeated dribbling was tested and results confirmed the reliability of the test. Figueiredo et al. (2009a) reported with young soccer players aged 11-14, using the same protocol, a reliability coefficient of 0.88 for the mean of 7 sprints. Similar reliability coefficient (0.83) was obtained with the repeated dribbling ability protocol in our study.

During repeated-sprint exercise, performance is related with the ability to replenish muscle phosphocreatine (PCr) storage and to restore muscle pH regarding resting levels (Weston et al., 1997). It has also been previously reported that RSA is influenced by the duration of the recovery between repeated sprints (Balsom, Seger, Sjodin & Ekblom, 1992). Considering this, the three moments evaluated in our study had 1-week recovery breaks. To eliminate learning effect, two repetitions of sprinting were considered in the warm-up test.

Performance in the repeated sprint test was weakly correlated to maximal anaerobic running test laboratory protocol (Wragg, Maxwell & Doust, 2000). Mean sprint time in the repeated sprint test and total running time in the laboratory protocol had a correlation coefficient of r = -0.298 (p = 0.516, n = 7) suggesting that the energetics of the two tests are not closely related.

In the meantime, muscle strength is thought to be a major factor in athletic success. However, the relationship between muscle strength and sprint performance has received little attention. A previous study examined the relationship in elite rugby players of isokinetic muscle strength and sprinting performance over 15m and 35m (Dowson, Nevill, Lakomi, Nevill & Hazeldin, 1998). Isokinetic torque was measured at the knee, hip and ankle joints at low, intermediate and high speeds during concentric and eccentric muscle actions. Using linear regression and expressing sprint performance as time, the strongest relationship, for the joint actions and speeds tested, was between concentric knee extension at 4.19 $rad.s^{-1}$ (high speed) and sprint performance (15-m: r = - 0.518, $p < 0.01$; 30m times: r = - 0.688, $p < 0.01$). These relationships were improved for only the short sprint distance (15 m) by expressing torque relative to body mass (r = - 0.581). In the conclusion it was suggested that the relationship between isokinetic muscle strength and sprint performance over the acceleration phase is improved by taking limb length and body mass into account.

In the current study repeated dribbling ability was more related to lower limb strength than with any other anthropometric or functional variables, although a previous study with basketball players suggested the relevance of performance obtained in the 60-s sit-ups protocol and time elapsed skills (Coelho-e-Silva et al. 2010b).

The ability to perform repeated sprints with minimal recovery between sprints bouts, termed RSA, may be an important aspect of team-sport competition. The physiological and metabolic responses of repeated-sprint activities are influenced by variations in exercise protocols (e.g. exercise mode, sprint duration, number of sprint repetitions, type of recovery and training status). Therefore, if the physiological and metabolic responses of repeated-sprint protocols are to be specific and relevant to field-based team sports, then the sprint and recovery durations should replicate the movement patterns of these sports.

Studies assessing short-duration sprinting (< 10 seconds) are more relevant to field-based team-sport performance than the others of long-duration (> 10 seconds) (Spencer, Bishop, Dawson & Goodman 2005). It is evident that the ATP production during short-duration sprinting is provided by considerable contributions from both PCr degradation and anaerobic glycolysis, confirming the significance of glycolytic activity during this type of exercise. It is also evident that the relative contribution of anaerobic glycogenolysis is reduced during the performance of subsequent sprints, which is partially explained by an increase in aerobic metabolism. Furthermore, the sprint duration may significantly influence the relative energy system contribution during repeated sprints exercise.

As RSA has been subject of many research studies, changes in protocol like exercise mode, sprint duration, number of repetitions, duration and type of recovery, and training status, can significantly affect results.

The concurrent validity of a popular RSA test was examined in ten moderately trained males (23.6+3.0 years) on three occasions, each separated by at least 48 hours (Bishop et al. 2001). Testing consisted of a 5 x 6-s cycle test (maximal sprints every 30 s), a graded exercise test (GXT) and a simulated game. The simulated game consisted of a 1-min circuit that was repeated 15 times in each period. The circuit replicated typical movement patterns observed during motion analysis of field hockey games. Each circuit commenced with a 15-m maximum sprint through timing gates. Time to run 5, 10 and 15 m was recorded. Oxygen consumption was measured during both the GXT and the simulated game with a portable gas analysis system (Cosmed K4 b 2, Italy). This study found significant correlation between power decrement during the 5 x 6 s cycle test and decrement in 15-m time across the three periods ($r = 0.76$, $P<0.05$), but not decrement in 10-m time ($r = 0.54$) or 5-m time ($r = 0.42$). These results suggest that the 5 x 6 s cycle test is valid for assessing the decrement in 15-m time, but not the decrement in 5 or 10- m time. Thus, one measure of RSA (sprint decrement) appears to be specific to the test protocol, rather than a general quality. The most likely explanation is that the energy requirements of the 5 x 6 s cycle test more closely match those required to repeatedly run 15 m (mean time = 2.74 s) than to repeatedly run 10 m (mean time = 1.97 s) or 5 m (mean time = 1.13 s). It is therefore suggested that, while the 5 x 6 s cycle test is often used to assess RSA ability in a wide range of sports, it may need to be modified to reflect the common sport distances found in specific sports.

The current study considered the distance but also pattern of movement including the ball control. Future research is needed to examine the ability of the repeated sprint ability and repeated dribbling ability as concurrent predictor of competitive level (elite versus local players). However, in contrast to the study of Bishop et al (2001) that emphasized the decrement scores, the present study was very critical to its reliability and inter-relationship between protocols with and without the ball. The number of sprint repetitions may be an additional source of variation in the determination of decrement scores.

A systematic review noted a large range of protocols from 4 to 40 repetitions, obviously adopting different sprint distances (15-m to 40-m), recovery duration (24-s to 60-s) and different recovery modes (passive stretching, slow cycle, walk). It may be possible that within a single sport the relationship between repeated sprint tests (running or dribbling) depends on the number of repetitions that may be less to initiates compared to juniors and seniors who would probably evidence fatigue and performance decrement after a larger number of repetitions. Future research is needed using sport-specific distance with variation in the number of repetitions.

A previous study examined variation in sport specific skills in two age groups, 11-12 and 13-14 years (Figueiredo et al., 2009a). The test battery was selected on the basis of a principal components analysis of eight tests of soccer skills, six from the Portuguese Soccer Federation (1986), namely ball control with the body, ball control with the head, dribbling speed, dribbling with a pass, passing accuracy, and shooting accuracy. In all the mentioned tests older players performed significantly better, but no differences were found considering contrasting maturity status within each age group. In our study, with a larger span of age, this trend was also noted for repeated dribbling outputs. However, post-hoc comparisons showed that differences were not significant between 15-16 and 17-18 years. The lack of differences in these age groups may reflect selective practices and influence of regular training (experience associated with selection). Furthermore, morphological and functional variability associated with maturation likely reflects the worst results found in 11-12 years age group (early adolescence).

Similar trends were found in another study, considering the selective process itself. Baseline soccer-specific skills were compared in youth soccer players (11-12 and 13-14 years) who subsequently discontinued participation in the sport, continued to participate at the same level or moved to a higher playing standard (Figueiredo, Gonçalves, Coelho e Silva & Malina 2009b). Elite players were significantly better in dribbling speed in both age groups, which may reflect the importance of this specific skill for success in soccer. Developmental changes (longitudinal study over 7 years) in dribbling were also examined in a sample of Dutch talented youth soccer players aged 12-19 (Huijgen et al., 2010). Soccer practice was found to account for a great proportion of the development of the improved slalom dribble and dribbling showed most rapid improvements from ages 12 to 14.

A recent study described obtained longitudinal model and estimated the development for optimal dribbling performance (peak dribbling) and for dribbling performance under fatigue (repeated dribbling), for players ultimately reaching professional status and for players reaching amateur status (Huijgen, Elferink-Gemser, Post & Visscher, 2009). The results gained insight in the required level of the technical skill dribbling during adolescence as they can show a player`s capability of becoming a professional soccer player. Talented players aged 14-18 were annually measured while they were part of a developmental soccer program and were identified as professional or amateur later on in their career (age>20). The longitudinal results showed that during adolescence the talented players who ultimately became professionals were on average 0.3 s faster on 30-m peak dribbling performance and on average 1 second faster on 3 x 30-m repeated dribbling performance than the players who ultimately turned amateur. Similar studies with concurrent protocols, adopting several numbers of repetitions and different types of recovery are needed in literature. Also of interest would be the prospective informative value of different protocols across age (infantiles, initiates and juveniles) since it is well recognized that talent detection, selection and development are sequential operations that claim for unique batteries.

CONCLUSIONS

The present study examined variation in RSA and RDA. Reproducibility of the RDA protocol was also considered and results confirmed the future usefulness of the test (reliability coefficients: total time = 0.83 and ideal time = 0.85). Similar results, for similar age groups, considering RSA are presented elsewhere (Figueiredo et al., 2009a). However, when considering decrement score, the present study was very critical to its reliability and interrelationship. The number of sprint repetitions may be a source of variation in the determination of decrement scores, but the technical dimension (by age group) should also claim for attention in future research. The relevance of the repeated sprint ability and repeated dribbling ability as concurrent predictor of competitive level (elite versus local players) and playing position should be considered as well.

In the current study repeated dribbling ability was more related to lower limb strength than with any other anthropometric or functional variable, which likely reflects the better results of the older players, considering functional variation associated with maturation and morphology. On the other hand, differences were not significant between 15-16 and 17-18 years. The lack of differences in these age groups may reflect selective practices and influence of regular training (experience associated with selection). Follow-up studies and longitudinal-based approaches are needed for a better insight considering this dimension.

Finally, there was a large relationship between RSA and RDA for total time. The magnitude of the coefficients ranged from 0.603 (initiates) to 0.687 (juveniles). This supports the notion that repeated dribbling ability might be a valid test to assess young soccer players from beginners to older players. RDA test can be a discriminant measurement between soccer players. Future research, using sport-specific distance with variation in the number of repetitions, among different age groups, competitive level and playing position is needed.

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