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ORIGINAL

PHYSICAL FITNESS IN EARLY ADOLESCENT ATHLETES OF COMBAT SPORTS

APTITUD FÍSICA EN DEPORTISTAS ADOLESCENTES TEMPRANOS DE DEPORTES DE COMBATE

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ABSTRACT

The aim of this research was to obtain reference data of early adolescent athletes of Judo, Taekwondo and Wrestling in a set of physical fitness tests, and to evaluate relationships between the tests. A battery of field tests was implemented: Handgrip strength (HAST), Abalakov, Countermovement and Squat jumps (ABJ, CMJ and SQJ), 0-10 m Sprint acceleration (0-10SA) and Sit and reach flexibility (SARF). Pearson's r was used to assess correlations between the physical capacities. Covariance analyses were carried out to evaluate comparatively the performances in HAST, ABJ, CMJ, SQJ, 0-10SA and SARF. SARF showed negligible correlations with the rest of the tests. The differences between boys and girls seemed to remain constant across sports. The judokas and taekwondists showed higher performances ABJ, and the taekwondists revealed higher performances than the wrestlers in CMJ, SQJ and SARF.

KEY WORDS: Strength; Power; Acceleration; Flexibility

RESUMEN

El propósito de esta investigación fue obtener datos de referencia de deportistas adolescentes tempranos de Judo, Taekwondo y Lucha en un conjunto de pruebas de aptitud física, y evaluar relaciones entre las pruebas. Una batería de tests de campo fue implementada: Fuerza en handgrip (HAST), Saltos Abalakov, con Contramovimiento y Squat (ABJ, CMJ y SQJ), Aceleración en sprint 0-10 m (0-10SA) y Flexibilidad "Sit and reach" (SARF). La r de Pearson fue usada para valorar correlaciones entre las capacidades físicas. Análisis de covarianza fueron realizados para evaluar comparativamente los rendimientos en HAST, ABJ, CMJ, SQJ, 0-10SA y SARF. SARF mostró correlaciones despreciables con el resto de las pruebas. Las diferencias entre varones y mujeres parecieron mantenerse constantes a lo largo de los deportes. Los judokas y los taekwondistas mostraron rendimientos más altos en ABJ, y los taekwondistas revelaron rendimientos más altos que los luchadores en CMJ, SQJ y SARF.

PALABRAS CLAVE: Fuerza; Potencia; Aceleración; Flexibilidad

1. INTRODUCTION

Combat sports have many practitioners in Argentina. The federated athletes of Judo, Taekwondo and Wrestling have national and international competitions at youth and adult levels. As well, within the educational sphere, national-level events including these sports are organized annually, embracing elementary and high school athletes from all provinces of the country.

Physical fitness is a set of attributes or characteristics that individuals have or attain, which is related to their abilities to perform physical activity (American College of Sports Medicine, 2014). The evaluation of physical capacities as an overall indicator of physical fitness is a common practice in sport training. Physical capacities such as strength, power, acceleration and flexibility are of special importance in combat sports, which are characterized by intermittent patterns of movement, combining explosive actions with ample ranges of motion.

There are many recognized field tests for the evaluation of physical fitness (Mackenzie, 2005; Wood, 2008b). Some of them are part of standardized field-based physical fitness test batteries for children and adolescents, such as the ones developed by the Singapore Sports Council (Keong, 1981); the Council of Europe (1988); the Young Men's Christian Association (Franks, 1989); the Australian Council for Health, Physical Education and Recreation (1996); the Ministry of Education, Science, Sports and Culture in Japan (Shingo & Takeo, 2002); Pilicz et al. (2005); The President's Council on Physical Fitness and Sports (2009); Tremblay and Lloyd (2010); Ruiz et al. (2011); and the Cooper Institute (Plowman & Meredith, 2013).

The handgrip strength test is a simple and popular method for the evaluation of upper-limb strength. Handgrip strength refers to the maximal isometric force that can be produced by the upper-limb muscles activated in the handgrip (Ruiz et al., 2006). This evaluation method is one of the most spread methods to measure muscle strength (Centers for Disease Control and Prevention, 2011), and has become a broadly accepted means for the evaluation of upper-limb isometric strength. In a comprehensive literature search, Roberts et al. (2011) found 11,604 research papers reporting the use of this technique in young and adult population. As well, this test has been frequently included in physical fitness test batteries (Council of Europe, 1988; Pilicz et al., 2005; Ruiz, et al., 2011; Shingo & Takeo, 2002; Tremblay & Lloyd, 2010). For its part, the Bosco jump protocol is a set of vertical jumps to assess height jumped and lower-limb power; the Abalakov, Countermovement and Squat jumps are, among others, part of the Bosco jump protocol (Wood, 2008a). In particular, these three jumps are simple, practical and well-known tests (Klavora, 2000; Walker, 2016b; Walker, 2017). The Squat jump is used to assess explosive strength of lower limbs; the Countermovement jump adds the elastic energy to the explosive strength; and the Abalakov jump measures these two components plus the coordinative ability by using trunk and upper limbs (Ruiz et al. (2006). Additionally, the height reached in a vertical jump is also a classical indicator of relative lower-limb power (Huffman & Berger, 1972). Furthermore, according to the kinematic laws, the height jumped can be indirectly assessed by measuring the flight time, and then an estimation of mechanical power may as well be obtained (Bosco et al., 1983; Fox & Mathews, 1974). On the other hand, the acceleration is usually evaluated in an indirect manner by recording the elapsed time to cover a distance of ten meters by running from a static initial position, testing procedure known as the 10 m Sprint test (Walker, 2016a). However, under the assumption of uniformly varied motion, an assessment in units of acceleration may be obtained by the application of the kinematic laws (Elert, 1998). Besides, in physical education, sports medicine and related health sciences, flexibility may be defined in simple terms as the range of motion available in a joint or group of joints (Alter, 2004). The Sit and reach test (Wells & Dillon, 1952) is a traditional method that provides a simple metric to evaluate low back and hamstring flexibility, which has been classically included in physical fitness test batteries (Australian Council for Health, Physical Education and Recreation, 1996; Council of Europe, 1988; Franks, 1989; Keong, 1981; The President's Council on Physical Fitness and Sports, 2009; Tremblay & Lloyd 2010). This test has become a widely spread method due to its simple and easy to administer procedure, which demands minimal skills training (Castro-Piñero et al., 2013).

Physical fitness testing at adolescent ages provides helpful data for a more specific analysis of the training process leading to better sport performance in combat sports. Moreover, the exploratory analysis of correlations among the components of a physical fitness test battery is a quantitative tool to measure the degree of dependence between the tests, and then to appraise how economical and efficient the test battery turns out to be. The aim of this research was to obtain reference data of early adolescent athletes of Judo, Taekwondo and Wrestling in a set of standardized field tests of upper-limb strength, lower-limb power, acceleration and flexibility, and to quantify the degree of relationship between the physical fitness tests implemented.

2. MATERIAL AND METHODS

2.1 PARTICIPANTS

Data of 518 male and female elementary and high school athletes who took part in inter-provincial competitions of Judo, Taekwondo and Wrestling were analyzed (age range: 11.9 to 14.9 years). Assent of the subjects and permission of those responsible for them were obtained for study participation. The research was carried out on the basis of the ethical principles of the Declaration of Helsinki of the World Medical Association. The chronological age of the participants was computed as decimal age, by means of subtracting the date of birth from the date of assessment (Morgan, 2006). The total sample included 182 judokas (100 boys and 82 girls), 171 taekwondists (93 boys and 78 girls) and 165 wrestlers (99 boys and 66 girls). Information of the physical characteristics of the subjects is reported in Table 1.

Table 1. Physical characteristics of the participants.

	Boys (n = 292)	Girls (n = 226)
Age (years)	13.7 ± 0.7	13.6 ± 0.8
Weight (Kg)	51.1 ± 8.2	49.6 ± 7.1
Height (m)	1.60 ± 0.08	1.55 ± 0.06
Body mass index ($kg \cdot m^{-2}$)	19.9 ± 2.3	20.6 ± 2.8

Data are expressed as mean ± standard deviation.

2.2 STUDY DESIGN

A cross-sectional study was conducted. The following battery of field tests was implemented: Handgrip strength (HAST), Abalakov, Countermovement and Squat vertical jumps (ABJ, CMJ and SQJ), 0-10 m Sprint acceleration (0-10SA) and Sit and reach flexibility (SARF). The evaluations were performed in an indoor sport hall and were completed in eight morning sessions. The protocol included previous warm-up exercises. The Handgrip strength test (Mackenzie, 2005) was performed using a digital hand dynamometer (Baseline 12-0286; Baseline Evaluation Instruments, China). The average score of the left and right hands was considered for the analysis (n = 511). The height reached in the Abalakov, Countermovement and Squat jump tests (Wood, 2008a) was assessed with a contact platform (WinLaborat WLACO2; WinLaborat Evaluación Deportiva, Buenos Aires, Argentina) (n = 506). The Sit and reach flexibility test was evaluated by means of a “sit and reach” box. The standard version of the test was implemented, with both knees held straight, and with the “zero” mark of the measurement scale at the level of the feet, so that the measures not reaching this level were negative, and the measures beyond this level were positive (Wells & Dillon, 1952). The score was rounded to the nearest integer (n = 517). And the elapsed time in the 0-10 m Sprint acceleration test (Walker, 2016a) was measured using photocells (TAGHeuer HL 2-35; TAG Heuer International SA, La Chaux-de-Fonds, Switzerland) (n = 438). A uniformly varied motion was assumed, and the acceleration was derived from the one dimensional equations of motion for constant acceleration (Elert, 1998):

$$x = \frac{1}{2} \cdot a \cdot t^2 , \quad (1)$$

hence

$$a = \frac{2 \cdot x}{t^2} , \quad (2)$$

where *a* is acceleration (in m·s^{-2}), x = 10 m is the distance travelled, and *t* is elapsed time in seconds.

2.3 STATISTICAL ANALYSIS

Descriptive statistics were computed to summarize the physical characteristics of the participants. Pearson’s r was used to assess correlations between the physical capacities; scatter plots were also produced. The traditional five “rules of thumb” proposed by Franzblau (1958) were followed to judge the level of association between variables: the coefficients whose absolute values lied in the intervals [0.0-0.2), [0.2-0.4), [0.4-0.6), [0.6-0.8) and [0.8-1.0] were interpreted, respectively, as indicating negligible, low, moderate, marked and high degrees of correlation. Covariance analyses were carried out to evaluate comparatively the performances in HAST, ABJ, CMJ, SQJ, 0-10SA and SARF, which included the factors Gender, Sport and their interaction, and Age as a covariate. Feasible weighted least squares were applied on HAST, ABJ and CMJ to account for the heteroscedasticity observed in these variables (Wooldridge, 2002). Post hoc Tukey-Kramer tests were conducted for multiple comparisons. The statistical significance level was fixed at $p < 0.05$. The R software environment version 3.3.3 was used for the analyses (R Core Team, 2017).

3. RESULTS

The correlations were high among the vertical jumps (0.82 to 0.91; $p < 0.001$), and from moderate to marked among HAST, 0-10SA and any of the jumps (0.50 to 0.65; $p < 0.001$). SARF showed negligible correlations with the rest of the tests (0.05 to 0.15; $0.0007 \le p \le 0.25$). The interaction term between Gender and Sport was not significant in the models analyzed. The results of the statistical tests for the interaction term in the models for HAST, ABJ, CMJ, SQJ, 0-10SA and SARF were, respectively: $F = 0.94$, $p = 0.39$; $F = 0.68$, $p = 0.51$; $F = 0.28$, $p = 0.75$; $F = 0.70$, $p = 0.50$; $F = 0.14$, $p = 0.87$; y $F = 0.21$, $p = 0.81$.

Gender was a significant factor in the six models ($p < 0.001$), and Sport was significant in the models for ABJ ($p < 0.001$), CMJ ($p = 0.003$), SQJ ($p = 0.03$) and SARF ($p = 0.008$). Boys exhibited higher performances than girls in HAST (27.9 ± 0.4 Kg vs. 23.7 ± 0.3 Kg), ABJ (31.5 ± 0.4 cm vs. 24.7 ± 0.3 cm), CMJ (26.7 ± 0.3 cm vs. 21.9 ± 0.3 cm), SQJ (24.6 ± 0.3 cm vs. 20.3 ± 0.3 cm) and 0-10SA (4.7 ± 0.04 $m \cdot s^{-2}$ vs. 4.0 ± 0.04 $m \cdot s^{-2}$), and lower in SARF (4.6 ± 0.4 cm vs. 9.5 ± 0.5 cm), (mean ± standard error). The post hoc comparisons between sports indicated that the judokas and taekwondists had significantly higher values than the wrestlers in ABJ (respectively, $p = 0.008$ and $p < 0.001$), and that the taekwondists had significantly higher values than the wrestlers in CMJ ($p = 0.002$), SQJ ($p = 0.02$) and SARF ($p = 0.005$). A summary of the correlations among the variables is presented in Figures 1, 2 and 3. In Figure 1 are evidenced the strong positive linear associations observed among the three vertical jump tests. For its part, in Figure 2 can be observed that the subjects with higher vertical jump values showed, on average, the higher records in running acceleration and in upper-limb strength, and also that the subjects with higher levels of upper-limb strength were those who tended to have the higher performances in running acceleration. Finally, in Figure 3 are illustrated the weak relationships found between the low back and hamstring flexibility with the rest of the capacities. The estimates of HAST, ABJ, CMJ, SQJ, 0-10SA and SARF for each sport within each gender derived from the analyses of covariance are displayed in Table 2.

Table 2. Mean response ± standard error (95% confidence interval) of Handgrip strength, Abalakov jump, Countermovement jump, Squat jump, 0-10 m Sprint acceleration and Sit and reach flexibility in boys and girls in the three sports.

	Boys		
	Judo	Taekwondo	Wrestling
Handgrip strength (Kg)	28.8 ± 0.7 (27.4 to 30.1)	28.0 ± 0.7 (26.7 to 29.3)	27.0 ± 0.6 (25.8 to 28.3)
Abalakov jump (cm)	31.7 [a] ± 0.7 (30.3 to 33.1)	32.8 [a] ± 0.6 (31.6 to 33.9)	29.9 [b] ± 0.6 (28.7 to 31.2)
Countermovement jump (cm)	26.8 [a,b] ± 0.5 (25.9 to 27.7)	27.8 [a] ± 0.5 (26.8 to 28.8)	25.6 [b] ± 0.6 (24.4 to 26.8)
Squat jump (cm)	24.6 [a,b] ± 0.4 (23.8 to 25.5)	25.5 [a] ± 0.5 (24.6 to 26.4)	23.6 [b] ± 0.5 (22.7 to 24.5)
0-10 m Sprint acceleration ($m \cdot s^{-2}$)	4.7 ± 0.1 (4.6 to 4.8)	4.7 ± 0.1 (4.6 to 4.8)	4.7 ± 0.1 (4.6 to 4.8)
Sit and reach flexibility (cm)	5.1 [a,b] ± 0.8 (3.6 to 6.6)	5.7 [a] ± 0.8 (4.1 to 7.2)	3.0 [b] ± 0.8 (1.4 to 4.5)
	Girls		
	Judo	Taekwondo	Wrestling
Handgrip strength (Kg)	23.9 ± 0.4 (23.1 to 24.7)	23.6 ± 0.5 (22.7 to 24.6)	23.6 ± 0.5 (22.6 to 24.6)
Abalakov jump (cm)	25.4 [a] ± 0.5 (24.5 to 26.3)	25.3 [a] ± 0.6 (24.1 to 26.4)	23.6 [b] ± 0.5 (22.6 to 24.6)
Countermovement jump (cm)	22.1 [a,b] ± 0.4 (21.3 to 22.9)	22.5 [a] ± 0.5 (21.5 to 23.5)	21.0 [b] ± 0.5 (20.0 to 21.9)
Squat jump (cm)	20.2 [a,b] ± 0.5 (19.3 to 21.2)	20.7 [a] ± 0.5 (19.7 to 21.6)	19.9 [b] ± 0.5 (18.8 to 21.0)
0-10 m Sprint acceleration ($m \cdot s^{-2}$)	4.1 ± 0.1 (3.9 to 4.2)	4.0 ± 0.1 (3.9 to 4.2)	4.0 ± 0.1 (3.8 to 4.1)
Sit and reach flexibility (cm)	9.4 [a,b] ± 0.8 (7.7 to 11.0)	10.8 [a] ± 0.9 (9.2 to 12.5)	8.2 [b] ± 0.9 (6.4 to 10.1)

Values with different letters indicate statistically significant difference between sports ($p < 0.05$) (averaged over both genders).
Boys significantly different from girls in the six variables ($p < 0.05$) (averaged over all sports).

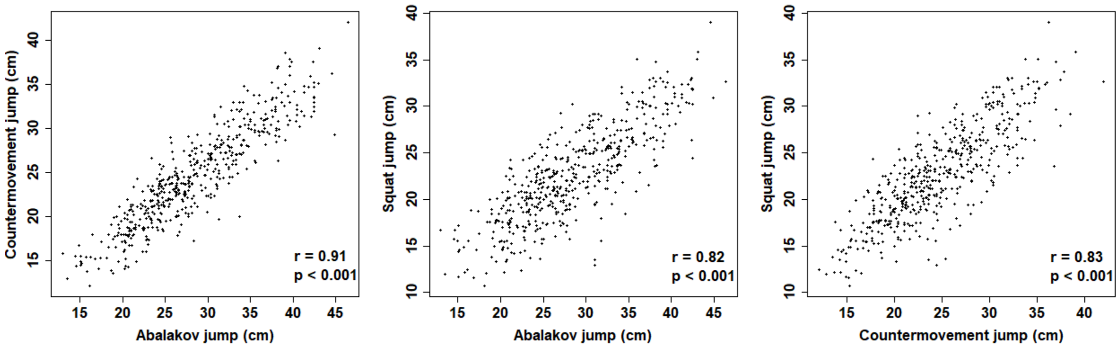

Figure 1. Correlations among the three vertical jumps.

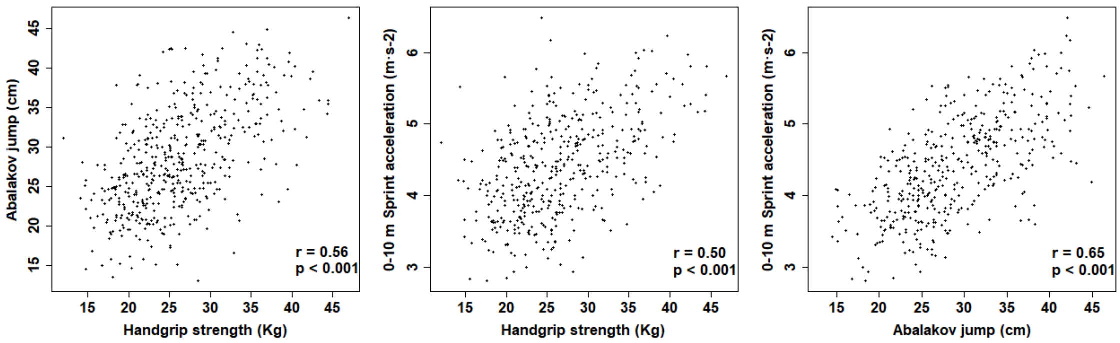

Figure 2. Correlations among Handgrip strength, Abalakov jump and 0-10 m Sprint acceleration.

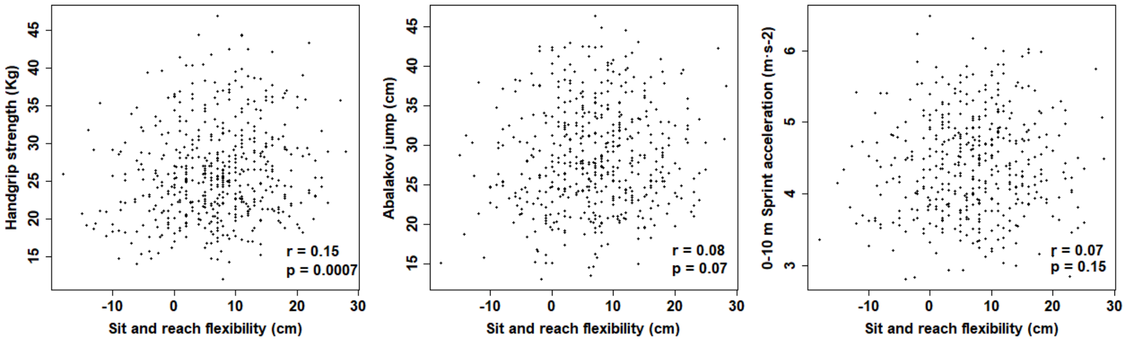

Figure 3. Correlations of Sit and reach flexibility with Handgrip strength, Abalakov jump and 0-10 m Sprint acceleration.

4. DISCUSSION

The process of monitoring the level of physical fitness by testing physical capacities has become an essential component in sport training. Strength, power, acceleration and flexibility are attributes of main importance in combat sports, and reference data of these capacities may provide helpful information to evaluate physical performance. On the other hand, a parsimonious selection of tests is desirable to build an economical physical fitness test battery. The analysis of statistical relationships among them provides a means to assess the extent of dependence between the evaluations implemented and, afterwards, to judge the efficiency of the test battery.

As expected, the Abalakov, Countermovement and Squat vertical jumps were highly correlated, showing Pearson’s r values over 0.8. On the other hand, the upper-limb strength, the height jumped and the sprint-running acceleration did not appear to be strongly associated, evidencing moderate to marked correlation coefficients. And the low back and hamstring flexibility had the lowest correlations with the rest of the capacities, exhibiting negligible coefficients. According to this last result, it can be suggested that the performances in upper-limb strength, vertical jump and sprint-running acceleration are at most weakly related to the level of low back and hamstring flexibility. As a consequence, with the sole exceptions of the correlations between the vertical jumps, no high levels of association were detected among the tests implemented. Hence, these findings allow for a more consistent interpretation in terms of economy and efficiency regarding the selection of tests.

Significant gender differences were verified in all the tests analyzed. The upper-limb strength, vertical jump and sprint-running acceleration results showed higher mean responses in boys, and, conversely, the low back and hamstring flexibility scores confirmed a superior performance in girls. On the other hand, significant differences among the three sports were only found in the three vertical jumps and in low back and hamstring flexibility. The post hoc comparisons revealed higher Abalakov jump values in judokas and taekwondists, and higher values of Countermovement jump, Squat jump and flexibility in the taekwondists with respect to the wrestlers. Furthermore, the interaction effect between Gender and Sport did not show statistically significant results in any of the six variables. Therefore, the contrasts between the levels of one factor can be equivalently interpreted across the levels of the other.

In the context of the HELENA study (De Henauw et al., 2007; Moreno et al., 2008), and with the aim of gathering specific information of physical fitness among European adolescents, Ortega et al. (2011) published normative values by gender and age categories on the basis of a set of tests implemented in 3,528 subjects aged between 12.5 and 17.49 years. They included the handgrip strength test, and also expressed its values as the average of the right and left hand scores. Given that the authors stipulated age categories by exact age, and that in the present work the boys and girls had a mean age around 13.5 years old, the mean values obtained in that work for the 13 and 14 year old categories may be averaged for comparison purposes. The handgrip strength mean values reported in that study for the 13 and 14 year old categories averaged 29.55 Kg in boys and 24.55 Kg in girls, being 1.6 Kg and 0.8 Kg higher than the ones found in this research (5.8% and 3.5 % higher, respectively). Although the observed differences were in favor of the adolescents evaluated in the HELENA study, the magnitudes of these differences do not appear to be substantial. On the other hand, the subjects evaluated in the present work were athletes of elementary and high school competitive level, so that their performance in upper-limb isometric strength is probably not so far from the one of the individuals of the population of reference.

Ortega et al. (2011) also included the Abalakov, Countermovement and Squat vertical jumps as part of the evaluation of physical fitness. Again, in order to obtain a standard of comparison, the average of the mean values reported in their study for the 13 and 14 year old categories may be used to be contrasted with the results obtained in the present work. The mean values of the Abalakov, Countermovement and Squat jumps published in that study for the 13 and 14 year old categories averaged, respectively, 29.40, 24.45 and 22.30 cm in boys, and 24.45, 20.60 and 18.60 cm in girls. In terms of difference, the values corresponding to boys are 2.1, 2.3 and 2.3 cm lower than the mean values estimated by the model proposed in this work (6.5 %, 8.5 % and 9.2 % lower), and the values corresponding to girls are 0.3, 1.3 and 1.7 cm lower (1.2 %, 5.8 % and 8.2 % lower).

The acceleration as a conditional ability can be defined as the ability to achieve speed of locomotion from a stationary position or from a slow moving position (Pokala, 2016). The acceleration may be indirectly assessed by the time spent in a 10 m sprint running (Walker, 2016a). However, as a physical quantity, acceleration is the rate of change of the velocity of an object with respect to time (Elert, 1998). According to the International System of Units, its unit of measurement is meter per second squared ($m \cdot s^{-2}$). Therefore, in order to obtain a more suitable interpretation of the results of an acceleration test, it is worthwhile to make the assessment in the proper unit of measurement, keeping in mind the physical meaning of the magnitude in question. However, no reference data were found in the literature for the 0-10 m sprint-running acceleration test expressed in $m \cdot s^{-2}$. On the other hand, it was previously mentioned that no significant effects were found for the factor Sport in this variable; in contrast, significant gender differences were observed. The acceleration mean values for boys and girls predicted by the statistical model applied were 4.7 $m \cdot s^{-2}$ and 4.0 $m \cdot s^{-2}$, respectively. Hence, taking these results and solving for time in either of the equations (1) or (2), the performance in terms of elapsed time is estimated to be 2.06 s for boys and 2.23 s for girls. Diverse research papers have been published containing reference time values related to sprint-running tests, which were usually conducted on football players. Some of them included subjects with similar ages to those of the participants of the present study. For instance, Mendez-Villanueva et al. (2011) evaluated acceleration using the time spent to cover the first 10 meters of a 40 m sprint test, which was administered to highly trained young male players aged between 12.0 and 17.8 years. They found mean performances of 1.93 s (n = 14) and 1.80 s (n = 22) at the under-14 and under-16 year old age groups, respectively. More recently, in a study that aimed to establish normative data conducted on male players with ages ranging from 9 to 35 years old, Nikolaidis et al. (2016) assessed elapsed time in the first and last 10 meters of a 20 m sprint-running test. The results were expressed in percentile values; the 50^{th} percentile corresponding to the 0-10 m split at the under-13 (n = 51), under-14 (n = 46) and under-15 (n = 37) age categories was equal to 2.25 s, 2.01 s and 1.99 s, respectively. On the other hand, in the context of an experimental design carried out on nineteen female youth football players, Mathisen & Pettersen (2015) also assessed time spent in the first 10 meters of a 20 m sprint test, and found baseline mean values of 1.99 s and 1.95 s in two groups aged 15.5 ± 0.7 years and 15.1 ± 0.5 years (mean ± standard deviation). And Mendes et al. (2015) applied the 10 m sprint test to 99 male and 72 female football players with age ranges of 11.0 to 14.0 years and 12.0 to 14.0 years, respectively. They found a mean time of 1.86 s in males, and 2.02 s in females. In general, the results obtained in this work were somewhat inferior than the ones reported in the cited works, which were conducted on competitive football players. Possibly this may be explained by the fact that running acceleration is an attribute specifically demanded and developed in sports such as football, and to a lesser extent in combat sports.

As it was previously pointed out, the Sit and reach test (Wells & Dillon, 1952) has been commonly included in physical fitness test batteries to measure low back and hamstring flexibility. According to normative values by gender for the standard version of the test, the performances estimated in this research for the judokas, taekwondists and wrestlers correspond to the “average” level (Australian College of Sport & Fitness, 2013; Wood, 2012). As well, Castro-Piñero et al. (2013) measured the degree of low back and hamstring flexibility by this test, in a large random sample of children and adolescents of both genders aged between 6 and 17.9 years (n = 2,712). However, they used a modified version of the test, the one implemented by The President’s Council on Physical Fitness and Sports (2009), where a score of 23 cm corresponds to 0 cm in the standard version. Corrected for this difference, all the mean values reported in their work, which were adjusted for gender and six two-year categories, were clearly lower than the ones obtained in the present study. More particularly, the corrected mean scores for the 12-13 (n = 603) and 14-15 (n = 313) year old categories were, respectively, 8.6 cm and 7.6 cm lower in boys, and 8.5 cm and 6.5 cm lower in girls.

The analysis of correlations among a menu of possible physical fitness tests offers a formal approach at the time of making a detailed evaluation of their inclusion for testing purposes. And performance estimates adjusted for a specific age range, and stratified by gender and sport, supply accurate assessments. In this research it was proposed a cross-sectional design to obtain reference data of early adolescent athletes of Judo, Taekwondo and Wrestling in a set of standardized field tests of specific physical capacities. The age group under study is of special interest for coaches involved in training processes during early adolescence. Correlation analyses among handgrip strength, relative leg power, sprint-running acceleration and low back and hamstring flexibility are presented, in order to put forward a portrait of the relationships between these capacities. And reference data by gender and sport are provided in suitable units of measurement, which represent useful information to control the development of training programs, and to enlighten the course of action in order to achieve higher levels of performance.

As a limitation of this study, it is pointed out that It would be advisable to consider a more comprehensive approach for the test battery, taking into account the assessment of other important components of physical fitness. The measurement of other capacities, such as the cardiorespiratory endurance and the muscular endurance, would also be enlightening. Moreover, the evaluation of physical capacities by means of sport specific testing may as well add valuable information.

5. CONCLUSIONS

Aside from the expectable strong relationships among the three vertical jumps, the results of the correlation analyses did not show high levels of association among the tests implemented. In particular, the low back and hamstring flexibility evidenced negligible correlations with the rest of the physical capacities. The performance differences between boys and girls seemed to remain constant across sports, being boys more capable in Handgrip strength, Abalakov jump, Countermovement jump, Squat jump and 0-10 m Sprint acceleration, and less capable in Sit and reach flexibility. Averaged over both genders, the judokas and taekwondistas showed higher performances in Abalakov jump, and the taekwondists revealed higher performances than the wrestlers in Countermovement jump, Squat jump and Sit and reach flexibility.

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