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Influence of a strength unit on the medicine ball throw performance in high school students

Influencia de una unidad didáctica de fuerza en el rendimiento de lanzamiento de balón medicinal en alumnos de bachillerato

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Abstract

The aim of this study was to analyze the effect of a strength unit on the medicine ball throw capacity (LBM) in high school students. 132 adolescents (16,8 ± 0,7 years; 61,7 ± 11,1 kg; 1,68 ± 0,09 m; 21,9 ± 3,1 kg·m^{-2}), corresponding to 1st high school level of Benjamin Institute, participated in this study. 57 were boys and 75 were girls. In a previous session before starting the study (T1), an assessment of medicine ball throw capacity (LBM) was performed for all participants. Then, 2 sessions per week during 8 weeks of a strength unit was developed. After this intervention (T2), the same assessment was again performed. A t test for paired samples was used to compare the differences between the results in T1 and T2 for all participants, for boys group and for girls group. The results showed a significant improvement ($p < 0,01$) in the LBM in all participants (% = 6,28; d = -0,34), in boys (% = 7,41; d = -0,51) and in girls (% = 5,22; d = -0,28) after a 8-week intervention program. Strength unit that, consisted in 16 sessions with 60 minutes per session and 8 consecutive weeks, induced an improvement on the medicine ball throw capacity in boys and girls of the 1st high school level.

Keywords

Education; intervention; strength; power; upper limbs.

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Resumen

El objetivo de este estudio fue analizar el efecto de una unidad didáctica de fuerza en la capacidad de lanzamiento de balón medicinal (LBM) de alumnos de bachillerato. En este estudio participaron 132 alumnos (16,8 ± 0,7 años; 61,7 ± 11,1 kg; 1,68 ± 0,09 m; 21,9 ± 3,1 $kg \cdot m^{-2}$) pertenecientes al Primer curso de Bachillerato del Instituto Benjamín de Tudela, de los cuales 57 eran chicos y 75 eran chicas. En una sesión previa al comienzo del estudio (T1), se realizó una prueba de valoración de la capacidad de lanzamiento de balón medicinal (LBM) de todos los participantes. Seguidamente se desarrollaron las 2 sesiones semanales de la unidad didáctica de fuerza durante 8 semanas. Tras finalizar la intervención (T2), se volvió a realizar el mismo test de valoración. Para determinar las diferencias entre los resultados obtenidos en el T1 y el T2 para el total de los participantes, y de forma independiente para el grupo de chicos y el de las chicas, se utilizó una prueba t de muestras relacionadas. Los resultados mostraron una mejora significativa ($p < 0,01$) en el LBM de todos los participantes (% = 6,28; d = -0,34), del grupo de los chicos (% = 7,41; d = -0,51) y del grupo de las chicas (% = 5,22; d = -0,28) después de las 8 semanas de intervención. La unidad didáctica de fuerza, que consistía en 16 sesiones con una duración de 60 minutos por sesión y que se realizaron en 8 semanas consecutivas, generó una mejora en la capacidad de LBM en los chicos y las chicas de primero de bachillerato.

Palabras clave

Educación; intervención; fuerza; potencia; extremidades superiores.

Introduction

One of the keys to an active and healthy life is doing sport from early stages (Eisenmann & Malina, 2005). Therefore, one of the main objectives of physical education is to educate the students about the importance of doing physical activity from childhood and adolescence (Eisenmann & Malina, 2005). Thus, the development of basic physical qualities (endurance, strength and speed) plays a fundamental role not only in adulthood but also in adolescence (Jones, 2013). It has been shown regular participation in strength and fitness programs has benefits from a healthy view (Faigenbaum & Westcott, 2009). So in the field of education they have included tests to assess teenager's capacity and muscle strength as a starting point for afterwards measure possible improvements (Faigenbaum et al., 2003; Harman, 2008). Actually the number of physical tests that have been designed and implemented in adolescents has increased enormously. This has two purposes, on one hand to find the best predictor of performance (Eisenman & Malina, 2003; Miliken et al., 2008), and

on the other hand to improve performance in the different basic physical qualities (Jones, 2013).

The Royal Decree 3473/2000 states that one of the main goals of physical education is to plan and carry out activities according to the needs of students, prior assessment of the state of fitness, and to increase their chances of motor performance through fitness. Although physical fitness, in terms of muscle strength, has usually been measured and evaluated with tests involving the muscles of lower extremities (Cohen et al., 2014; Tounsi et al., 2015), it would be also relevant to know the muscular strength of upper extremities.

One of the parameters used to determine the performance or even the influence of specific intervention programs in the upper body, especially in team and individual sports (basketball, handball, judo...), has been throwing medicine ball (LBM) (Drid et al., 2015; Gil et al., 2015; Sisic et al., 2015). However, few studies have used this test in the educational context (Sacchetti et al., 2012; Dumith el al., 2010). It would therefore be interesting to know the effect of a teaching unit of physical education area in the performance of upper body strength.

Thus, the objective of this study was to analyze the effect of a didactic unit of strength in the ability to throw medicine ball (LBM) in boys and girls eleventh grade class of a public school.

Material and Method

Participants

This study involved 132 students (16.8 ± 0.7 years, 61.7 ± 11.1 kg, 1.68 ± 0.09 m, 21.9 ± 3.1 $kg \cdot m^{-2}$) that belonged to the of eleventh grade of Benjamin Institute of Tudela (Navarra) distributed in 6 classes. Participants were differentiated respect to gender: boys (n = 57; 16,5 ± 0,8 years; 64,1 ± 12,6 kg; 1,73 ± 0,11 m; 21,8 ± 3,1 $kg \cdot m^{-2}$) and girls (n = 75; 16,9 ± 0,7 years; 59,7 ± 9,3 kg; 1,70 ± 0,15 m; 22,0 ± 3,1 $kg \cdot m^{-2}$). All parents or legal guardians of the participants were informed of research procedure and signed informed consent. The study follows the guidelines set out in the Helsinki Declaration (2013) and was conducted under

established ethical standards for research in sports science and exercise (Harris & Atkinson, 2013).

Procedure

The research was carried out for 8 weeks belonging to the first fourth month period of the academic year 2015-2016. In a previous session before the study started (T1), a test for assessing the ability of medicine ball throw (LBM) of all participants was conducted. Then the 16 sessions of the strength didactic unit were developed, directed by the physical education teacher. After the intervention (T2), the same assessment test was done again. Before carrying out the test a 15 minutes long warm up was performed. It consisted in 3 min of low intensity running, 7 min passing a handball in couples and 5 throws of an underweight medicine ball (2kg). All sessions were conducted at the sports center of the school and they were supervised by the principal researcher.

Strength didactic unit

For 8 weeks 2 weekly sessions were performed geared to all manifestations of strength (general, maximum, speed, endurance, etc.). Each session (Table nº1) lasted 60 minutes and they had different teaching styles.

Table nº1. Timing of the strength sessions of the didactic unit and test sessions.

Session	Content	Description
T1	Test	Medicine ball throw.
1	Jump fences	Games involving jumps as obstacles relays, bags relays and hurdle race. Situation to solve with recyclable material.
2	Skipping	Progression of exercises from simpler to more complex ones, both individually and in groups.

3	Tonification	Overall strength circuit composed of corners in which different material is used (weights, medicine balls, benches and rubber bands, suspenders...) and different muscle groups work (abdominal, gluteus, quadriceps, hamstrings, calf, biceps, triceps...).
4	Tonification	Overall strength circuit composed of corners in which different material is used (weights, medicine balls, benches and rubber bands, suspenders...) and different muscle groups work (abdominal, gluteus, quadriceps, hamstrings, calf, biceps, triceps...).
5	Body weigth load	Exercises in which the resistance to be overcome is only the weight of the individual. They are performed in circuit format or by following the guidelines of the teacher with music according to the intensity of the exercises.
6	Body weigth load	Exercises in which the resistance to be overcome is only the weight of the individual. They are performed in circuit format or by following the guidelines of the teacher with music according to the intensity of the exercises.
7	Body Pump	Session conducted by a guest specialist teacher who adapts the exercises to the level of students.
8	Body Pump	Session conducted by a guest specialist teacher who adapts the exercises to the level of students.
9	Transport games	Games played in pairs, small groups and large groups that require the cooperation of boys and girls. They consist in moving, transporting, helping, dragging, etc. classmates to certain places.
10	Transport games	Games played in pairs, small groups and large groups that require the cooperation of boys and girls. They consist in moving, transporting, helping, dragging, etc. classmates to certain places.

11	Speed games	Games where the reaction speed, gestural speed and scrolling speed is manifested.
12	Speed games	Games where the reaction speed, gestural speed and scrolling speed is manifested.
13	Endurance games	Games where aerobic and anaerobic endurance is manifested.
14	Endurance games	Games where aerobic and anaerobic endurance is manifested.
15	Standalone session	Students put into practice a session that they have previously prepared and which is related to one of the objectives worked during the didactic unit.
16	Standalone session	Students put into practice a session that they have previously prepared and which is related to one of the objectives worked during the didactic unit
T2	Test	Medicine ball throw.

Medicine ball throw test (LBM)

All participants performed two medicine ball throws (LBM), following the protocol previously established by Gonaus and Muller (2012). Participants throwed the medicine ball as far as possible by sticking after the line that marks the starting point. They standed with both feet at the same height and slightly separated. They held the ball with both hands behind his head, slightly bend their legs and arch their back. Boys launch a 3 Kg weight ball and girls 2kg one (Blázquez, 1989). The launch was invalid if: a) feet or body exceeded the line after launch, b) they went forward in the same direction as the ball, c) it was launched with one hand and d) the launch is not made leaving the ball from behind the head.

The reléase distance (m) is measured from the starting line to the point where the ball first boat (Neto et al., 2014). The recovery time between each launch was 60 s. For the statistical analysis was considered the best record of the two launches.

Statistical analysis

Results are presented as mean ± standard deviation (SD) of the mean. The normality of the data was analyzed using the Kolmogorov-Smirnov, in order to verify the need for parametric or nonparametric tests. To determine the differences between the results obtained in the T1 and T2 for the total of participants, and independently for the group of boys and girls, t test of paired samples was used. The percent change (%) between T1 and T2 was calculated by the formula: % = [(T2 – T1) / T1] x 100. The effect size (TE) was calculated taking into account the method proposed by Hopkins et al. (2009). The TE was interpreted as trivial (<0.2), low (0.2-0.6), moderate (0.6-1.2), high (1.2-2.0), high (2.0 to 4.0) and extremely high (>4.0) (Hopkins et al., 2009). Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS Inc, version 20.0 Chicago, IL, USA). The statistical significance was set at $p \leq 0.05$.

Results

LBM results in both in the T1 as in the T2 for the total sample, for the group of boys and for the girl group are shown in Table number 2. As can be observed, a significant improvement in LBM of all students ($p < 0,01$; % = 6,28; d = -0,34), in the group of boys ($p < 0,01$; % = 7,41; d = -0,51) and in girls group ($p < 0,01$; % = 5,22; d = -0,28) was obtained after conducting the 8 weeks strength didactic unit.

Table nº 2. Results obtained by all pupils, the group of boys and the gropu of girls at the medicine ball throw test (LBM) before (T1) and after (T2) the intervention program.

Test	Gender	T1 (mean ± DT)	T2 (mean ± DT)	T1-T2 TE	%
LBM (m)	All (n =132)	4,70 ± 0,88	5,00 ± 0,90**	-0,34 low	6,28
	Boys (n =57)	5,16 ± 0,75	5,54 ± 0,75**	-0,51 low	7,41
	Girls (n = 75)	4,34 ± 0,80	4,57 ± 0,77**	-0,28 low	5,22

TE = affect size, % = change percentage between T1 and T2. ** Significant differences between T1 and T2 ($p < 0,01$)

Discussion

The training of basic physical abilities in adolescents, especially muscle strength, plays an important role in a general and multilateral physical training. In recent decades there has been an increase of obese or overweight youth. This leads to increased adiposity in the body and consequently a decrease in physical performance of young people. For this reason it is absolutely necessary a strength and endurance training and suitable to their age (Sacchetti et al., 2012). Thus, the objective of this study was to analyze the effect of a didactic unit of strength in the ability to throw medicine ball (LBM) in boys and girls eleventh grade class of a public school.

This is the first study that showed scientific evidence of the effectiveness of the above didactic unit in a performance indicator of upper body power. The main results reported a significant improvement, both boys and girls in, in the capacity of LBM after the completion of 16 sessions oriented to the strength work in its various forms over a period of 8 weeks.

LB test has been used in sports and educational field to measure the power of the upper extremities (Davis el al., 2008). This test has proved to be valid and reliable (Mayhew et al., 1993), however, is difficult to compare the results of different studies because of the different types of throws (Davis et al., 2008; Mayhew el al., 1993; Faigenbaum et al., 2010). In a study done with 20 adolescent athletes (14-18 years), 3.48 m average values were recorded in the test LBM with a weight of 4 kg medicine ball from a standing position, and no significant differences respect to gender were found (Faigenbaum et al., 2010). Instead, Castro-Pinero et al. (2009) tested a 513 Spanish children (10-11 years) and showed that boys reached greater distances than girls (7.11 vs. 6.18 m) using a basketballFurthermore, Salonia et al. (2004) showed values of 3.47 m distance achieved with children of 10-11 years using a 2.7 kg ball.

Although it is difficult to compare our results with those obtained in previous researches, especially because of the different methods used, it seems that in adolescence (14-18 years) there are differences in the LBM between boys and girls. It would therefore be interesting to carry out another type of test that involves the muscles of the upper body, which would describe the evolution of the strength of the upper extremities at this critical stage in the maturation of young people.

An improvement in muscle strength of the upper extremities is related to a better fitness level (Neto et al., 2014). Therefore, it takes special relevance the implementation of physical activity or sport programs to achieve an improvement of strength in all its manifestations.

Neto et al. (2014) observed improved performance in the LBM (Pretest = 3.1 ± 0.7 m vs. 3.3 ± 0.5 Postest = m), but in this case with 5 kg balls, in high school male students who performed three weekly sessions of 60 minutes duration based on different sports. In our study a significant improvement in LBM was also reported after a 8 weeks intervention program in both the boys (T1 = 5,16 m ± 0.70 vs. 5.54 ± 0.75 T2 = m) and in girls (4.34 ± 0.80 T1 = T2 = 4.57 m vs. 0.77 ± m). These results show that the strength unit carried out during physical education sessions led to an improvement of the capacity of LBM in students of eleventh grade. Future research should aim to describe and compare the evolution of strength in the upper extremities, by medicine ball throw test throughout adolescence. To do this, it is recommended to standardize ball weight, body position and type of launch.

Moreover, it would be interesting to determine whether the test performance of of the upper extremities strength correlates with the inferiors.

This study has some limitations. First, considering that the motivation of students toward physical education subject is not the same for all, it could have been interesting to determine the motivation of the participants before the investigation. Second, although all students who participated in this study conducted two test sessions (T1 and T2), it is possible that some participants lost a session during the intervention program, and this fact is not contemplated in the design of research. In addition, some of the students did sports or other physical activities outside school hours, so the training load is not the same for all students.

Conclusions

The strength unit, consisting in 16 sessions og 60 minutes that were conducted in 8 consecutive weeks, generated an improvement in the ability of LBM in boys and girls of eleventh grade.

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