EFFECTS OF A MAINTENANCE RESISTANCE TRAINING PROGRAM ON MUSCULAR STRENGTH IN SCHOOLCHILDREN

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Abstract:

Physical education (PE) teachers carry out resistance training programs at the beginning of a school year so that children can do other tasks safely during the whole course. However, after a few weeks of detraining, children revert back to their initial strength level. The purpose of this study was to evaluate the effects of a maintenance resistance training program on muscular strength in children in a PE setting. Seventy-five children, 10-12 years of age, from four different 6th grade PE classes were cluster-randomized into either an experimental group (EG=38) or a control group (CG=37). After an eight-week development program and a four-week detraining period, the EG completed a four-week maintenance program once a week. The program included two circuits of eight stations of 15/45 to 35/25 seconds of work/rest. Abdominal and arm muscular endurance and explosive strength of the legs were measured before and after the development program and after the maintenance program. After the development and maintenance programs abdominal and arm muscular endurance were higher in EG ($p<.05$), while they did not change in CG ($p>.05$). No significant differences were found between groups in the legs' explosive strength ($p>.05$). The present results showed that a resistance program carried out once a week can maintain muscular endurance of schoolchildren. These results could help PE teachers design programs that permit students to maintain fit strength levels.

Key words: *strength training, intermittent reinforcement, muscular endurance, primary school, children, physical education setting*

Introduction

Physical fitness is considered an important health-related marker in childhood (Ortega, Ruiz, Castillo, & Sjöström, 2008). Thus, in recent decades governments of economically developed countries have been variously promoting physical fitness programs for youth (Department of Health and Human Services, 1990). Among the strategies implemented, there is an expansion of public sports programs and a decrease in costs to make them widely accessible. Nevertheless, frequently, the success of these strategies depends mainly on the choices and the will of the parents. Another approach of these governments has been to focus on modifying school legislation in order to give health a more important role in the educational system (Ministerio de Educación y Ciencia, 2006). Such modification should be more effective in these countries because education is obligatory for children, *de facto* they have the opportunity to be involved in these educational courses.

In many developed countries, schools are attempting to increase the health level of the pupils by using measures such as the improvement of their physical fitness through physical education (PE) (Ministerio de Educación y Ciencia, 2006). This can be done through a variety of procedural interventions, such as nutritional knowledge, hygiene education, or endurance and strength programs. Amongst these interventions, some researchers have focused on school strength training programs (Annesi, Westcott, Faigenbaum, & Unruh, 2005; Faigenbaum, et al., 2011; Sadres, Eliakim, Constantini, Lidor, & Falk, 2001). Several studies have demonstrated that following the appropriate recommendations and strictly supervising all interventions (American Academy of Pediatrics, 2008; Behm, Faigenbaum, Falk, & Klentrou, 2008; Faigenbaum, et al., 2009), it is possible to design PE-based programs that positively affect strength in a safe way (Annesi, et al., 2005; Faigenbaum, et al., 2011; Sadres, Eliakim, Constantini, Lidor, & Falk, 2001).

One recommendation is to carry out a strength training program at the beginning of a school year so that children might catch up the condition necessary to accomplish other tasks safely (Faigenbaum & Micheli, 2000). These programs cannot last nor they can be allocated a large part of it since many curricular contents have to be performed in a school year. Another obstacle in this planning is that after four weeks of detraining most children lose a significant part of strength gains obtained (Faigenbaum, et al., 1996). Moreover, even if in some studies the results have been contradictory (Da Fontoura, Schneider, & Meyer, 2004; Faigenbaum, et al., 1996; Ingle, Sleap, & Tolfrey, 2006; Isaacs, Pohlman, & Craig, 1994; Tsolakis, Vagenas, & Dessypris, 2004), the majority of authors agree that after 8 to 12 weeks of detraining children revert back to their initial strength level (Faigenbaum, et al., 1996; Ingle, et al., 2006; Isaacs, et al., 1994; Tsolakis, et al., 2004), meaning that the effects of the strength program are completely cancelled out.

As in other countries, Spanish PE teachers face these problems, for they too 'deliver' a large volume of curricular contents during each academic course (Hardman, 2008). Among these activities, the Spanish Ministry of Education (2006) includes strength as an obligatory activity for its importance in health improvement. In addition, PE in Spain is limited because of the frequency and distribution of class hours (Ministerio de Educación y Ciencia, 2006): there are only two classes a week dedicated to PE and their distribution depends on schedules criteria not related to physical activity. Consequently, it is not possible to develop a single content activity in a year (Viciana, Salinas, & Cocca, 2008).

A possible solution for this problem could be the execution of short maintenance programs during the whole academic course. These programs, known as *intermittent reinforcements* (Le Ny, 1980), permit us to sustain the strength level achieved without interfering in the normal course of PE planning, but the data about intermittent reinforcements in school-age children are contradictory. In their study, DeRenne, Hetzler, Buxton, and Ho (1996) comparing one and two days of training for strength maintenance, obtained satisfactory results regardless of the frequency of training sessions among adolescents. On the other hand, Blimkie, Martin, Ramsay, Sale, and MacDougall (1989) did not obtain positive results after a program of strength maintenance (once a week) with pre-adolescent children. Currently, as there is a lack of scientific information about the application of maintenance programs in the school environment, research is required in this area. Consequently, the purpose of this study was to evaluate the effects of a maintenance resistance training program on muscular strength in children in PE classes setting.

Methods

Participants and study design

Seventy-five apparently healthy children (boys, n=42; girls, n=33) from four different 6th grade PE classes in a public elementary school participated in this study. The following exclusion criteria were used: (a) children with a chronic pediatric disease, (b) children with an orthopedic limitation, (c) children classified in Tanner's third stage or higher of development (Tanner, 1962), and (d) children having previous experience in resistance training or carrying out any kind of strength training at the moment the intervention started. All volunteers were accepted for participation in the study.

For practical reasons and the nature of the present study (intervention focused on reality and school context), a cluster-randomized controlled trial was used (Faigenbaum, et al., 2011; Sadres, et al., 2001). Natural classes were assigned randomly to form one of the study groups (two classes for each group): experimental group (EG, n=38, age 11.05±0.39 yrs, height 144.61±7.01 cm, body mass 41.31±9.32 kg, body mass index 19.64±3.47 kg/m^2), or control group (CG, n=37, age 11.14±0.36 yrs, height 148.92±5.73 cm, body mass 45.23±11.22 kg, body mass index 20.28±4.42 kg/m^2). EG and CG consisted of a two-gender-balanced group (21 boys for each group). Previous studies assure similar ratios of strength for boys and girls during pre-adolescence (Blimkie, 1992).

The participants of the CG were urged to maintain their normal levels of physical activity, but they were not allowed to carry out any strength training during the intervention period. All participants were allowed to participate in physical sports activities. Twenty-seven children in the EG (75%) and 27 children in the CG (73%) regularly participated (at least twice per week) in organized sports programs. The children and their legal guardians were fully informed about all the features of the study and the relative risks for health (the risk of injuries was low with this study design), and were required to sign an informed consent document. The study protocol was also approved by the Ethical Committee of the University of Granada.

Testing procedures

The participants were evaluated using strength tests proposed in the EUROFIT battery (Council of Europe Committee for the Development of Sport, 1988), validated and standardized by the Council of Europe. The test sessions were carried out during PE classes at the beginning and at the end of the development resistance training program (pre-test and post-test). Subsequently, after a period of detraining and the application of the maintenance program the participants were evaluated again (re-test). The tests were administered under the same environmental conditions, on the same day and at the same time for each student (Souissi, et al., 2012). Also, the students were given guidelines to follow in the days before the testing sessions: to sleep at least eight hours during the previous night; to have breakfast at least two hours before the tests (Viciana, Cocca, & Salinas, 2009), follow their normal nutrition habits; and to abstain from strenuous exercises 48 hours prior to the tests.

Two researchers monitored the whole evaluation process, keeping to the regulations established in the protocols of the tests. The same researchers took all the measurements using the same equipment. These tests were conducted in an indoor sports-center court with a non-slip floor. The participants carried out the battery of tests after a standardized warm-up consisting of five-minute running from low to moderate intensity. Presented below are the order and a brief description of the test protocols.

Standing long jump test (SLJ). This test was used to measure the explosive strength of the legs. From a standing position, with both feet shoulder-width apart, the children executed a counter-movement with the legs before executing a horizontal jump as far as possible. To help carry out the counter-movement, the children used their arms to complete the jump. A measuring tape was extended along the floor and was used to measure the horizontal distance reached. The best score of two attempts was retained.

Sit-up abdominal 30-second test (SUA). This test was used to measure the abdominal muscular endurance. The participants laid on the mat with their knees bent at 90 degrees, with their feet held flat on the floor by the evaluator. The fingers were interlocked behind the head. On the command 'Go', the participant raised his/her chest so that the upper body was vertical, then the trunk was lowered back to the floor so that the shoulder-blades or upper back touched the floor. For each sit-up the back had to return to touch the floor to qualify as a completed sit-up. Participants had to perform as many sit-ups as they could in 30 seconds. The total number of completed repetitions in 30 seconds was retained. One attempt was permitted for each participant.

Flexed arm hang test (FAH). This test was used to measure the arm muscular endurance. In this test the participant had to maintain a flexed arm hang position using an overhand grip (palms facing away from the body). Hips and knees were extended, while the eye level had to be above the bar. Once the participant assumed the correct position, the researcher started the manual stopwatch. The participant then attempted to maintain this position for as long as possible. The stopwatch was stopped when his/her eyes dropped below the top of the bar. Also, it was not permitted to use the chin to keep him/herself above the bar. One attempt was allowed for each participant.

Development resistance training program

A strength training program was applied to the EG during the PE classes. The EG participants trained twice a week on non-consecutive days for eight weeks, under the supervision of one of the researchers. They completed a total of 14 training sessions, since two classes coincided with festival days and could not be used. Each session lasted 50 minutes and consisted of a warm-up of five minutes by playing a tag game, 40 minutes of strength training, and a cool-down by two series of 15–30 seconds of static stretching, primarily for the hamstrings and lumbar region (Table 1).

According to previous studies concerning strength development in children (Sadres, et al., 2001; Weltman, et al., 1986), the intervention

Table 1. Resistance training session

Phase (time)/ Exercises	Intensive progression (level 1/ 2/ 3)[a]	Material
Warm-up (5 minutes)		
Tag games		
Main part (40 minutes)		
Strength stations		
a. Throwing from the chest	1 kg/ 1.5 kg/ 2 kg	MB
b. Rowing	Low/ medium/ high resistance	Elastic band
c. Going up-down	Body weight/ +1 kg/ +2 kg	Swedish bench, MB
d. Triceps extension	Low/ medium/ high resistance	Elastic band
e. Biceps curl	Low/ medium/ high resistance	Elastic band
f. Skipping rope	Micropause/ with/ without rebound	Rope
g. Crunches	Arms stretched forward/ chest/ backward	Mat
h. Bridging	Body weight/ +1 kg/ +2 kg	Mat, MB
Additional station		
i. Racing games		
Cool-down (5 minutes)		
Static stretching		

Note. MB = medicine ball; [a]All participants began at the first level of difficulty. When a student could perform more than one repetition per second, he/she was allowed to advance to the next level (Weltman, et al., 1986).

was organized in a circuit, which also permitted a greater motor engagement time (Lozano, 2005). Two circuits of eight stations were constructed. Each station consisted of an exercise lasting 15−35 seconds, with a rest time of 25−45 seconds between stations (Table 2). The time of work/rest changed along the intervention following the stimulation increment principles. According to Weltman et al. (1986), during work time, the students should complete as many repetitions as possible in a controlled manner. As other studies show, the last repetition of each set represents the momentary muscular fatigue (Faigenbaum, et al., 2002; Faigenbaum, Milliken, Moulton, & Westcott, 2005; Faigenbaum, Westcott, LaRosa-Loud, & Long, 1999; Faigenbaum, et al., 1996). In order to achieve this, the children were offered three levels of difficulty in each station (see Table 1), so that the intensity of exercise was best suited to each student. All participants began at the first level of difficulty, and when a student could perform more than one repetition per second, he/she was allowed to advance to the next level (Weltman, et al., 1986). At the end of every circuit the participants played a tag game together for five minutes. The researcher gave positive feedback to motivate participants in achieving it (Viciana, Cervelló, & Ramírez-Lechuga, 2007).

All exercises were fully explained and demonstrated by the researcher, and the children were asked to try them out a few minutes before starting the first session of the intervention. Before the start of the training program, the participants were given details that included useful information in order to carry out the program in a safe and healthy way. However, according to the educational normative, PE teachers are expected to instruct the pupils about the general recommendations on health (such as healthy nutrition, proper hydration or adequate sleep time) throughout the Primary Education phase academic course (Ministerio de Educación y Ciencia, 2006).

In the course of the study period, the EG participants also participated in their organized sports activities, as well as in their normal activities of daily living. Nevertheless, they did not participate in the normal PE classes. In fact, they executed the intervention program at the same time the CG students participated in the PE classes outlined in the course planning. The participants included in the CG continued participating in their organized sports and daily living activity during the research period, as well as in the normal PE classes. During these classes, the students of the CG carried out sessions of traditional games, and were introduced to basketball and volleyball. No participant was allowed to carry out any strength training activities outside the supervised setting.

Detraining period and maintenance resistance training program

After a period of detraining (four weeks) coinciding with the Christmas vacation, the EG participants completed the maintenance training program. It was composed of one session per week during four weeks. During the period of maintenance, a session of reinforcement was alternated with a normal class of PE according to the course planning

Table 2. Development training program during the first eight weeks

Week	Session	Circuits	Stations	Work (s)	Rest (s)
1	1st	2	8	15	45
	2nd	2	8	15	45
2	3rd	2	8	20	40
	4th	2	8	20	40
3	Holiday				
	5th	2	8	25	35
4	6th	2	8	25	35
	7th	2	8	25	35
5	8th	2	8	30	30
	9th	2	8	30	30
6	10th	2	8	30	30
	11th	2	8	30	30
7	12th	2	8	35	25
	13th	2	8	35	25
8	Holiday				
	14th	2	8	35	25

Note. Circuits = number of circuits in each session; Stations = number of stations (exercises) in each circuit, Work = time of work in each station (seconds); Rest = time of rest between each station (seconds).

designed by the teacher (Table 3). Regarding the sessions of reinforcement, the students followed the same protocol described previously for the strength training program (see Table 1). Concerning the normal PE classes, the planned activities were an introduction to basketball and volleyball. On the other hand, the CG participants were involved in normal PE classes throughout this period.

Statistical analysis

Descriptive statistics (means and standard deviations) for age, height, body mass, body mass index, and strength tests were calculated. A two-way analyses of variance (ANOVA) with each group (EG, CG) as the between-subjects factor and time (pre-test, post-test, re-test) as the repeated measures factor were calculated for the dependent variables (SUA, FAH, SLJ). For the *post-hoc* analyses, α values were corrected using the Bonferroni adjustment. As the FAH variable did not follow a normal distribution, the data were transformed using a logarithm (Bland & Altman, 1996). The effect size was used to determine the magnitude of treatment effects (Hedges, 1981). Statistical power (p) for the *n* size was determined as well. The test-retest reliability for strength tests was estimated using the intraclass correlation coefficient from two-way ANOVA ($ICC_{3,k}$) (Shrout & Fleiss, 1979). Furthermore, as suggested by Baumgartner and Chung (2001), a 95% interval of confidence was calculated. All statistical analyses were performed using the Statistical Package for Social Sciences, version 15.0 for Windows (SPSS® Inc., Chicago, IL). The statistical significance level was set at $p<.05$.

Results

Seventy participants completed the development training program and 68 the maintenance training program according to the previously established norms (no more than two classes missed the training program, and none missed the maintenance training). Five participants' data were rejected after the strength program, and two more were excluded after the maintenance. The EG participants finally considered for analysis obtained a participation of 94% and 100% in the development training program and maintenance training program, respectively.

Results for SUA. The EG had significantly greater gains in SUA compared to the CG [$F(2, 64)=5.03$; $p<.05$; $\eta^2_p=.073$; $p=.765$] (Table 4). The ANOVA with the Bonferroni adjustment for each group showed that the EG increased significantly

Table 3. Maintenance training program during the last four weeks

Week	Session	Circuits	Stations	Work (s)	Rest (s)
1	1st	2	8	20	40
	PE session	Basketball			
2	2nd	2	8	25	35
	PE session	Basketball			
3	3rd	2	8	30	30
	PE session	Volleyball			
4	4th	2	8	35	25
	PE session	Volleyball			

Note. PE session = conventional physical education session as the control group (introduction to basketball and volleyball); Circuits = number of circuits in each session; Stations = number of stations (exercises) in each circuit, Work = time of work in each station (seconds); Rest = time of rest between each station (seconds).

Table 4. Strength performance for the development and maintenance resistance training program

Group	Test	Development Training Program			Maintenance Training Program			
		Pre-test (Mean ± SD)	Post-test (Mean ± SD)	Effect size[a] (Pre-postest)	Re-test (Mean ± SD)	Effect size[a] (Post-retest)	Effect size[a] (Pre-retest)	p[b]
EG CG	SUA (nº)	20.17±4.33 18.25±4.64	21.89±3.83* 18.11±5.34	.42	22.94±3.92†† 18.09±4.95	.23	.65	<.05
EG CG	FAH[c] (s)	11.90±10.17 17.15±18.99	14.92±12.91** 14.35±14.30	.37	20.76±19.03††† 16.43±16.10	.28	.61	<.01
EG CG	SLJ (cm)	125.36±25.82 124.87±21.97	126.58±25.30 128.31±25.49	-.14	- -	- -	- -	>.05

Note. SD = standard deviation; EG = experimental group; CG = control group; SUA = sit-up abdominal 30-second test; FAH = flexed arm hang test; SLJ = standing long jump test; Effect size[a], effect size was calculated according to Hedges (1981); p[b], significance level from ANOVA; FAH[c], statistical analysis of the data were transformed by the logarithm.
Change from pre-test to post-test significantly (*p<.05, **p<.01); Change from pre-test to re-test significantly (††p<.01, †††p<.001)

from pre-test to post-test ($p<.05$) and from pre-test to re-test ($p<.01$). No significant differences were found for the CG ($p>.05$). The test-retest reliability for the SUA was .86 (.73-.93).

Results for FAH. Significantly greater gains were found for the EG compared to CG [$F(2, 63) =5.99$; $p<.01$; $\eta^2_p=.087$; $p=.842$]. The participants of the EG significantly increased FAH from pre-test to post-test ($p<.01$) and from pre-test to re-test ($p<.001$). No differences were found for the CG ($p>.05$). The test-retest reliability for the FAH was .95 (.90-.97).

Results for SLJ. There were no significant differences in SLJ between the groups [$F(1, 70) =.514$; $p>.05$; $\eta^2_p=.007$; $p=.109$]. For the intra-group analysis, the ANOVA with the Bonferroni adjustment did not show any significant changes for the EG ($p>.05$) or for the CG ($p>.05$). The test-retest reliability either for the SLJ was .93 (.86-.96).

Discussion and conclusions

The results show that it is possible to develop strength endurance in the school environment by means of a program consisting of 14 sessions in eight weeks. Previous studies of eight-week strength training programs in children found similar results (Faigenbaum, et al., 1996, 1999, 2001, 2002, 2005, 2011). However, the majority of these studies used the maximum repetitions method, but due to the necessary material and supervision, this method was not feasible in the Spanish PE setting. Whereas the design of the present study depended on many aspects related to the school context, as previously discussed, it is supported by other research such as the study carried out by Weltman et al. (1986), who obtained significant gains in strength using circuit training instead of the maximum repetitions method, confirming the present results.

Likewise, one of the main objectives of the PE teachers at these educational levels is to encourage pupils to be active as long as possible during classes. With the circuit method, pupils can easily reach a good level of motor engagement time (Lozano, 2005) at the same time they execute many types of exercises. This is the best way to make the most of the time at a PE teacher's disposal, especially when classes are few and short and there are many curricular activities to introduce (Ministerio de Educación y Ciencia, 2006). Thus, the present results regarding the strength training indicate that the design proposed in this manuscript could be effective and suitable for PE classes.

One of the most important outcomes of this study was that an intermittent reinforcement of one day per week in four weeks could be effective to maintain the gains previously obtained. As explained before, the majority of studies coincide in setting eight weeks as the period of inactivity determining the complete loss of previous strength gains (Faigenbaum, et al., 1996; Isaacs, et al., 1994; Tsolakis, et al., 2004). In the present study, the sum of the periods of detraining and maintenance was eight weeks, thus an unsatisfactory design of the intermittent reinforcement should have matched a decrease (or the complete dissipation) of the strength benefits. Nevertheless, the results were positive since the arm and core muscular endurance was maintained after these weeks.

In line with the present study, DeRenne et al. (1996) found in their study that a maintenance program carried out once a week with pubescent basketball players was sufficient to retain strength. However, the research that used the maintenance program applied it after the training program, that is, without a period of inactivity between the development and maintenance. In the present study, maintenance was applied after a period of detraining because it is the most common situation in normal PE planning (due to the typical alternation of holidays, academic periods and the need to teach other curricular contents in the PE classes). Consequently, this design should be suitable in the school environment since it respects all the features and norms established for it. Moreover, it should be effective for increasing the strength endurance values and then maintaining them during larger periods.

Nevertheless, in the present study explosive strength of the legs did not undergo any change during the training. One reason for this result could be found in the incongruence between the test used and its relation to the training method. Participants were asked to perform the exercises slowly and with controlled movements, being the typical training for strength endurance (American Academy of Pediatrics, 2008). This quality is different from muscular explosive strength, which is the capacity of generating the maximum force in the shortest time (American Academy of Pediatrics, 2008). Explosiveness is the muscular characteristic evaluated with the SLJ (Council of Europe Committee for the Development of Sport, 1988). In explosive exercises, participants must collect all their muscular strength in just a few seconds to overcome a high resistance; the intensity and the action velocity are at the maximum (American Academy of Pediatrics, 2008). Even though both refer to strength, they affect different physiological and metabolic characteristics (Behm, Faigenbaum, Falk, & Klentrou, 2008; Faigenbaum, et al., 2009). This could have determined the lack of gain found.

The decision to select this test depended on its presence in the EUROFIT battery, probably the most used battery of tests for children in Europe (Castro-Piñero, et al., 2009). SLJ is a test validated and commonly applied in the school environment, therefore, it was appropriate for the context in which this research took place. Nevertheless, the aforementioned incongruence could have affected the evaluation process and the final results. In line with this result, all of the previously mentioned studies that used similar designs did not encounter significant differences in the power of the legs, measured by a SLJ or a vertical jump (Faigenbaum, et al., 1996, 2002, 2005).

More favorable findings about explosive strength of the legs were found in research based on programs of longer duration, higher weekly frequency, greater intensity, and/or with exercises performed at a higher velocity (Ingle, et al., 2006; Weltman, et al., 1986). These improvements were greater when the strength training was combined with a plyometric program (Ingle, et al., 2006). However, with regard to the program duration and the session frequency, intervention had to be adapted to the school settings on account of the main objective of this research. As already mentioned, the Spanish Ministry of Education (2006) has established a frequency of twice a week for PE classes; moreover, due to the high number of contents to develop in each academic course, PE teachers cannot devote too many hours to any single activity.

As regards the possibility of using body weight plyometric exercises, they had to be rejected because of the high risk of injuries at that age (American Academy of Pediatrics, 2008). Even if it had been possible to adapt this kind of training to the age of the participants, it is recommended that they have a good level of 'wellness' in order to lower this risk. With this in mind, a typical school class could be composed of children with a large variety of physical fitness levels (Ortega, et al., 2005), from sedentary and overweight/obese to those participating in extra-curricular sports activities and competitions (Izquierdo, Rodrigo, Majem, Roman, & Aranceta, 2008). PE teachers have to consider this factor in their task planning as much as we did for designing the present intervention. One of the aims of this research was to provide the PE teachers with a tool for developing strength in classes, hence the exclusion of body weight plyometric exercises was an obligatory choice in order to respect the individualities of the children and make the program within the reach of every pupil.

In conclusion, the present study suggests that it is possible to maintain muscular endurance in the PE setting through a program carried out once a week during four weeks. These programs appear to be necessary in the school context to make the strength training effective and feasible within an academic plan, permitting at the same time the regular development of other activities. Such utilization could facilitate PE teacher-designed programs that guarantee the maintenance of previous strength gains in a few sessions, at the same time warranting the simultaneous carrying out of other tasks contemplated for the academic course. Even though more research is needed to confirm these results, in the future the intermittent reinforcement could become a principal element to regular PE planning. Future interventions should focus on the effect of the combination of different frequencies and durations of maintenance training sessions as well as the effect of a school-based training program on other important health-related physical fitness components such as cardiovascular endurance.

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UČINCI ODRŽAVAJUĆEG PROGRAMA TRENINGA S OPTEREĆENJEM NA MIŠIĆNU JAKOST UČENIKA OSNOVNE ŠKOLE

Nastavnici tjelesne i zdravstvene kulture provode programe treninga s opterećenjem na početku školske godine kako bi djeca bila u stanju sigurno izvoditi ostale zadatke tijekom školske godine. Međutim, nakon nekoliko tjedana bez treninga s opterećenjem, jakost se kod djece vraća na početnu razinu. Cilj ovog istraživanja bio je utvrditi učinke održavajućeg programa treninga s opterećenjem na mišićnu jakost djece, koji je realiziran tijekom nastave tjelesne i zdravstvene kulture. U istraživanje je bilo uključeno ukupno 75 djece u dobi od 10 do 12 godina iz četiri različita odjeljenja 6. razreda koji su slučajnim klaster-odabirom bili raspoređeni u eksperimentalnu (EG=38) ili kontrolnu (CG=37) grupu. Nakon 8-tjednog razvojnog programa i 4-tjednog razdoblja bez treninga s opterećenjem, EG je provela 4-tjedni održavajući program trenirajući jednom tjedno. Program treninga je uključivao kružni oblik rada, a trening se sastojao od izvođenja dva kruga po 8 stanica s periodima rada i odmora koji su varirali od 15/45 do 35/25 sekunda. Mišićna izdržljivost ruku i trbuha te eksplozivna snaga nogu bila je mjerena prije i nakon razvojnog programa te na kraju održavajućeg programa treninga. Nakon razvojnog i održavajućeg programa treninga, mišićna izdržljivost ruku i trbuha bila je veća u EG ($p<,05$), dok se u ispitanika iz CG nije mijenjala. Nije zabilježena značajna razlika između grupa u razini eksplozivne snage nogu ($p<.05$). Rezultati su pokazali da trening s opterećenjem koji se provodi jednom tjedno tijekom razdoblja of četiri tjedna, može zadržati razinu mišićne izdržljivosti školske djece. Ovi rezultati mogu pomoći nastavnicima tjelesne i zdravstvene kulture pri izradi programa treninga kojima je cilj održavanje zadovoljavajuće razine jakosti/snage učenika.

Ključne riječi: *trening snage, trening jakosti, naizmjenično poboljšanje, mišićna izdržljivost, osnovna škola, djeca, područje tjelesne i zdravstvene kulture*