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EFECTO DE UN PROGRAMA DE FUERZA Y ESTIRAMIENTO, COMBINADO O AISLADO, SOBRE LA FLEXIBILIDAD ACTIVA EN EDUCACIÓN FÍSICA. UN ESTUDIO PILOTO

EFFECT OF A STRENGTH AND STRETCHING PROGRAM, COMBINED OR ISOLATED, ON ACTIVE FLEXIBILITY IN PHYSICAL EDUCATION SETTING. A PILOT STUDY

Miguel Perera-Zurita[1]; Daniel Mayorga-Vega[2] and Rafael Merino-Marban[3]
1 Instituto de Educación Secundaria La Rosaleda, Malaga, Spain
miguelperera@ieslarosaleda.com
2 Facultad de Ciencias de la Educación, Universidad de Jaen (UJA), Jaen, Spain
dmayorga@ujaen.es
ORCID: 0000-0002-4494-4113
3 Facultad de Ciencias de la Educación, Universidad de Malaga (UMA), Malaga, Spain
rmerino@uma.es
ORCID: 0000-0002-0606-6487

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Correspondencia del autor: Miguel Perera, miguelperera@ieslarosaleda.com

Resumen

Introducción. El propósito de este estudio fue examinar los efectos de un programa de fuerza y estiramiento, de dos sesiones por semana, en las marcas del test sentarse y alcanzar entre estudiantes de secundaria en el ámbito de la educación física.
Método. Una muestra de 75 estudiantes de secundaria (26 chicas y 49 chicos) de 12 a 14 años de edad pertenecientes a cuatro grupos naturales se asignaron al azar a un grupo de estiramiento (n = 21), un grupo de fortalecimiento (n = 18), un grupo de fortalecimiento + estiramiento (n = 20) o a un grupo control (n = 16). Durante las clases de educación física, los estudiantes de los grupos experimentales realizaron un programa de 1-minuto de estiramiento, de 1-minuto de fortalecimiento o de 1-minuto de fortalecimiento + 1-minuto de estiramiento dos veces por semana, un total de 20 semanas. Los estudiantes de grupo control realizaron las mismas clases de educación física, pero no siguieron ningún programa de fortalecimiento y/o estiramiento. La flexibilidad activa (estimada por la prueba clásica de sentarse y alcanzar) se evaluó al principio y al final del programa de intervención.
Resultados. Los resultados de la prueba de Wilcoxon mostraron que los estudiantes que realizaron un programa combinado de fortalecimiento y estiramiento aumentaron estadísticamente de manera significativa sus niveles de flexibilidad activa desde la pre-

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intervención hasta la post-intervención (Δ = 1,8 ± 3,2 cm; p < 0,05). Sin embargo, para los estudiantes que realizaron un programa aislado) y los estudiantes del grupo de control no se encontraron diferencias estadísticamente significativas (grupo de fortalecimiento, Δ = 0,6 ± 0,7 cm; grupo de estiramiento, Δ = 0,3 ± 2,3 cm; grupo control, Δ = 0,7 ± 1,5 cm; p > 0,05).
Conclusiones. Dado que en la educación física es necesario desarrollar muchos contenidos curriculares cada año académico y que la asignatura también está restringida por su limitada asignación de tiempo curricular, los profesores podrían mejorar la flexibilidad de los estudiantes combinando los estiramientos y el entrenamiento de fuerza. Por lo tanto, además de mejorar los niveles de flexibilidad de los estudiantes, este programa de intervención podría permitir el desarrollo regular de otros contenidos curriculares de educación física. Este conocimiento podría ayudar y guiar a los profesores a diseñar programas que garanticen un desarrollo factible y efectivo de la flexibilidad en el entorno de la educación física.

Palabras claves: Test de sentarse y alcanzar, isquiosurales, educación física, estudiante de secundaria.

Abstract

Introduction. The purpose of this study was to examine the effects of a two-session-per-week strength and stretching program, on sit and reach score, among high-school students in the physical education setting.
Methods. A sample of 75 high-school students (26 girls and 49 boys) aged 12-14 years from four classes were clustered and randomly assigned to a stretching group (n = 21), a strengthening group (n = 18), a strengthening + stretching group (n = 20) or a control group (n = 16). During physical education classes, the experimental students performed a 1-minute stretching, a 1-minute strengthening or a 1-minute strengthening + 1-minute stretching program twice a week a total of 20 weeks. Control students performed the same physical education classes, but they did not follow any strength and/or stretching program. Active flexibility (estimated by the classic sit-and-reach test) was assessed at the beginning and at the end of the intervention program.
Results. The Wilcoxon test results showed that students that performed a combined strengthening and stretching program increased statistically significantly their active flexibility levels from pre-intervention to post-intervention (Δ = 1.8 ± 3.2 cm; p < 0.05). However, for students that performed an isolated) program and control group students statistically significant differences were not found (strengthening group, Δ = 0.6 ± 0.7 cm; stretching group, Δ = 0.3 ± 2.3 cm; control group, Δ = 0.7 ± 1.5 cm; p > 0.05).
Conclusions. Since in physical education many curricular contents need to be developed each academic year and the subject is also restricted by its limited curriculum time allocation, teachers could improve students' flexibility combining stretching and strength workout. Therefore, in addition to the improvement of students' flexibility levels, this intervention program might permit regular development of other physical education curricular contents. This knowledge could help and guide teachers to design programs that guarantee a feasible and effective development of flexibility in the physical education setting.

Key words: sit and reach, hamstring, physical education, high-school student.

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INTRODUCTION

Nowadays physical fitness is considered to be one of the most important health markers in childhood and adolescence (Ortega, Ruiz, Castillo & Sjöström, 2008), with flexibility as an essential component of health-related physical fitness (National Association for Sports and Physical Education, 2005). Particularly, adolescents with an inadequate hamstring extensibility seem to have a higher risk of current low back pain (Jones, Stratton, Reilly, & Unnithan, 2005), as well as a higher risk of low back pain later during adulthood (Hestbaek, Leboeuf-Yde, Kyvik, & Manniche, 2006) and neck tension (Mikkelsson, et al., 2006).

Unfortunately, in Spain over one in five adolescents have limited hamstring extensibility (Castro-Piñero et al., 2013). Therefore, health promotion policies should also be designed to identify adolescents with low hamstring extensibility, as well as to encourage them to achieve health-enhancing levels (Ortega, et al., 2008). For instance, the subject of physical education (PE) might play an important role in this public health issue. Shortened hamstring muscles could be addressed proactively by a systematical performance of stretching exercises in high-school students during PE sessions (Becerra-Fernandez, Mayorga-Vega & Merino-Marban, 2020). In this line, PE teachers in most countries are nowadays required to develop and maintain students' health-enhancing flexibility levels (European Commission/EACEA/Eurydice, 2013).

Previous studies have found that a PE-based stretching program, carried out twice a week, improves hamstring extensibility in high-school students (e.g. Becerra-Fernandez, Merino-Marban & Mayorga-Vega, 2016; Mayorga-Vega, Merino-Marban, Real, & Viciana, 2015). However, nowadays PE teachers must face several planning related problems for developing students' flexibility levels (Viciana, Mayorga-Vega, & Merino-Marban, 2014). For instance, apart from the fact that many curricular contents must be developed each academic year, PE is usually restricted by its limited curriculum time allocation. Moreover, this restriction is especially accented when the number of PE sessions a week is limited to only two, which is the norm in most European countries (European Commission/EACEA/Eurydice, 2013).

Since stretching programs cannot be allocated a large part of PE time, the application of a combination stretching + strengthening program could be more suitable. Unfortunately, to our knowledge there are no studies examining the effect of a combination stretching + strengthening program in high-school students and related studies with adults are really scarce (Leite, de Souza Teixeira, Saavedra, Leite, R, Rhea, & Simão, 2015; Simão, Lemos, Salles, Leite, Oliveira, Rhea, & Machado Reis, 2011). Currently, there is a lack of scientific information about the effects of this kind of programs among high-school students and, therefore, research in this area is required. Consequently, the purpose of the present study was to examine the effects of a combination stretching + strengthening program on hamstring extensibility among high-school students in the PE setting.

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MATERIAL AND METHODS

Participants

The study protocol was first approved by the Ethical Committee of the University of Malaga. After the high school approval had been obtained, students and their legal guardians were fully informed about all the features of the study and were required to sign an informed consent document. All 75 high-school students, 26 girls and 49 boys, from four first grade level courses of one public secondary school were invited and agreed to participate in the present study. For practical reasons and the nature of the present study (i.e. intervention focused on natural groups in a school setting) a cluster-randomized controlled design was used (Merino-Marban, Mayorga-Vega, Fernandez-Rodriguez, Vera Estrada, & Viciana, 2015). Natural classes were assigned randomly to form one of the following study groups: 1-minute stretching group (SchG, *n* = 21), 1-minute strengthening group (SgthG, *n* = 18), 1-minute stretching+1-minute strengthening group (Sch+SgthG, *n* = 20) and control group (CG, *n* = 16).

All the participants were free of orthopedic disorders such as episodes of hamstring and/or lumbar injuries, fractures, surgery or pain in the spine or hamstring and/or lumbar muscles over the past six months (Lopez-Miñarro et al., 2009). The inclusion criteria were: a) correct performance of all the flexibility evaluations, and b) attendance rate of 90% or higher at PE classes during the intervention period. Finally, although all the 75 invited high-school students agreed to participate, only 46 (16 girls and 30 boys) participants met the inclusion criteria. And the groups were comprised of the following participants: SchG (*n* = 12), SgthG (*n* = 8), Sch+SgthG (*n* = 16) and CG (*n* = 10).

Measures

All the measures were performed during the regularly scheduled PE classes. Prior to the intervention, information about participants`gender and age was collected. Then, anthropometric measures were also taken during the same class. Afterward, the flexibility test was applied at the beginning (pretest, week 0) and at the end of the intervention development program (posttest, week 21) in order to examine possible changes produced. One week before the baseline flexibility measure, a familiarization session was also carried out for all participants.

Anthropometric measures

Participants' body mass and height were measured and then the body mass index (BMI) was calculated as body mass/height squared (kg/m2). During the measurement of body mass and height participants were in shorts and T-shirts and barefoot. For the body mass measure, once the scale was reading zero, the participant stood in the centre of the scale without support and with the weight distributed evenly on both feet. For the body height measurement, the student stood with the feet together and the heels, buttocks and upper part of the back touching the scale, and with the head placed in the Frankfort plane. The average of two measurements for both body weight and height was retained (ISAK, 2001).

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Hamstring extensibility testing

Students' flexibility was assessed by the classic SR test (Mayorga-Vega et al., 2014). The SR test was applied by the same tester using the same equipment. The measures were performed in an indoor sports facility under the same environmental conditions, on the same day of the week and at the same time for each student. No warming up exercises were performed prior to the flexibility measurements.

The SR test was administered using a wooden box with a ruler at the top (the score 15 cm corresponded to the tangent of the feet; accuracy 1 cm). At the beginning of the test, students stood in front of the box, sat with their hips flexed, knees extended and both hands on the top of the ruler. The feet were placed to the width of the hips and ankles at 90°. The knees were fixed in extension with the help of the tester. The hands with the fingers extended were placed parallel. From this position, the children had to bend the trunk forward slowly and progressively (no rebounds) in order to reach the furthest possible distance and to remain still for at least 2 seconds. Two trials were performed 1 minute apart, and the average was retained.

Procedures

A stretching, strengthening or stretching+strengthening intervention programs were applied to the SchG, the SgthG and the Sch+SgthG during the PE classes, respectively. These groups participants performed a stretching intervention program twice a week on nonconsecutive days for 20 weeks. The programs were conducted and supervised by the same PE teacher for all the groups. The SchG students performed 1-minute of stretching at the end of the warm-up, the SgthG students performed 1-minute of strengthening exercise at the end of the warm-up and the Sch+SgthG students performed 1-minute of stretching + 1-minute of strengthening at the end of the warm-up.

Familiarization session. The PE teacher was responsible for implementing the program. To standardize the implementation of the program, PE students performed a training session in order to obtain a proper familiarization with the stretching and strengthening exercises, the test, and the organization of the program. Such familiarization was carried out one week before the intervention program in a total of one session per group. When they did not perform well, the students repeated the stretching or strengthening exercises and SR test twice.

Stretching program

Four different stretching exercises were performed during the intervention. One bidopal exercise was performed in each session. Standing and sitting stretching exercises were also alternated between sessions. The PE teacher alternated stretches in the two weekly sessions so that students did not repeat exercises within the same week. Each intervention session included two sets of one stretching exercise. Participants completed two repetitions of one exercise, for 30 s per repetition and with a five second break between repetition. For all the stretching exercises, the children flexed forward at the hip, maintaining the spine in a neutral position until a gentle stretch was felt in the hamstrings. The knees were fully extended and toes pointed to the ceiling with no hip rotation. The stretched positions were held gently until the end point of the range was reached (i.e. stretch to the point of feeling the tightness of the hamstring muscles

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but no pain). Once this position was achieved, the children held it for 30 seconds (static passive technique).

All the participants were urged to maintain their normal levels of physical activity outside of the supervised setting during the intervention period. During the stretching program period all the students participated in their standard PE lessons. However, the CG followed the standard PE program without performing hamstring stretches. Furthermore, the participants in the CG were unaware of the purpose of the study.

Strengthening program

Four different strengthening exercises were performed during the intervention. Exercises with toe or knee support were also alternated between sessions. The PE teacher alternated strengthening exercises in the two weekly sessions so that students did not repeat exercises within the same week. Each intervention session included two sets of one strengthening exercise. Participants completed two repetitions of one exercise, for 30 s per repetition and with a five second break between repetition. The strengthening exercise consisted of performing the ventral plank with forearm support. Placing the elbows just below the shoulders and keeping the trunk as straight as possible during the exercise.

Statistical analysis

Descriptive statistics (means and standard deviations or median and interquartile range) for age, body mass, body height, body mass index, and SR scores were calculated. The Wilcoxon test was used to compare the pre-intervention and post-intervention SR scores independently in each group. Rosenthal´s r effects sizes were calculated (Field, 2017). All statistical analyses were performed using the SPSS version 20.0 for Windows (IBM® SPSS® Statistics 20). The statistical significance level was set at $p < 0.05$.

RESULTS

Table 1 shows the effect of the strengthening and stretching programs, combined or isolated, on the SR scores. The Wilcoxon test results showed that students that performed a combined strengthening and stretching program increased statistically significantly their active flexibility levels from pre-intervention to post-intervention ($p < 0.05$). However, for students that performed the isolated programs and CG students statistically significant differences were not found ($p > 0.05$).

Table 1. Effect of the strength and stretching programs, combined or isolated, on the classic sit-and-reach scores

	Pre-intervention	Post-intervention	Wilcoxon test		ES
Group	Median (IQR)	Median (IQR)	*Z*	*p*	*r*
Combined (*n* = 16)	9.5 (6.5)	11.5 (10.0)	2.147	0.032	0.38
Strength (*n* = 8)	9.0 (6.0)	9.0 (6.0)	1.890	0.059	0.47
Stretching (*n* = 12)	6.0 (5.0)	7.0 (4.8)	0.725	0.469	0.15
Control (*n* = 10)	6.0 (3.3)	6.0 (1.5)	1.354	0.176	0.30

Note. ES = Effect size; IQR = Interquartile range.

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DISCUSSION

The students that performed a combined strengthening and stretching program increased statistically significantly their active flexibility levels. However, students who did an isolated strengthening or stretching program did not improve their active flexibility levels. As well as the CG that maintained the levels of flexibility.

One might think that 1-minute of stretching two days per week, for 20 weeks, is insufficient to improve the flexibility of the SchG students. As in the present study. However, in a previous study with school-children who performed 1-minute of stretching in PE classes, over 8 weeks, they found improvements on SR score (Merino-Marban et al., 2015). Perhaps the negative results of this study are due to the very small sample of students who completed the intervention. In general, the school-age flexibility programs developed during Physical Education's classes improve flexibility. Even more, the systematic review title “Effect of PE-based stretching programs on hamstring extensibility in high school students” of Becerra et al. (2020) suggested that stretching programs of a volume per session from 30-60 s produced improvements on hamstring extensibility.

According to Carrasco, Sanz-Arribas, Martínez-de-Haro, Cid-Yagüe & Martínez-González-Moro (2013) the SR test is conditioned by the strength generated in the hip and trunk flexion for the rectus femoris and the rectus abdominal. And it could be expected that iliopsoas developed the same behavior. For all the above reasons, it is possible to consider that a program of strengthening that musculature could improve the score in the SR test. However, the isolated strengthening program in this study did not improve active flexibility measured with the SR test. Although for the SgthG there was a tendency towards significance (p = 0.059) and the effect size was high (d = 0.47). It is likely that 1-minute of ventral planck two days per week during the intervention was insufficient to improve the strength of these muscles. And consequently the active flexibility measured with the SR test.

Isolated strengthening or stretching programs have confirmed their effectiveness in improving SR score in several studies. But the weekly frequency was higher, the volume of training per session much greater, and the samples were different (Hwang & Koo, 2019; Lee, Kim & Back, 2009, Sung-Ho, Jin-Seok, & Chang-Jyun, 2018).

Only students from Sch+SgthG increased statistically significantly their active flexibility levels measured with the SR test. It is plausible, that the improvement of the combined group was due to perform 2 minutes of training. While the isolated groups only performed 1-minute of stretching or strengthening. In the same line, Moreira, Akagi, Wun, Moriguchi & Sato (2012) conducted a school based combined, strength and stretching, program in school children. After six week of training they found improvement on SR score, but the training sessions were much more diverse and longer.

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CONCLUSIONS

Since in PE many curricular contents need to be developed each academic year and the subject is also restricted by its limited curriculum time allocation, teachers could improve students' flexibility combining stretching and strengthening workout. Therefore, in addition to the improvement of students' flexibility levels, this intervention program might permit regular development of other physical education curricular contents. This knowledge could help and guide teachers to design programs that guarantee a feasible and effective development of flexibility in the PE setting.

LIMITATIONS OF THE STUDY

A small sample. This was because at the end of the intervention period 29 participants did not satisfy the second inclusion criterion. That is, their attendance rate was less than 90% and they were eliminated from the study.

Another limitation of the study was that the isolated experimental groups performed 1 minute of training (strengthening or stretching), while the combined experimental group performed 2 minutes of training (strengthening plus stretching).

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