



Original/Deporte y ejercicio

# A physical education-based stretching program performed once a week also improves hamstring extensibility in schoolchildren: a cluster-randomized controlled trial

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## Abstract

**Introduction:** physical education teachers are required to carry out intervention programs for students to achieve health-enhancing flexibility levels. Unfortunately, to our knowledge, there are no studies examining the effect of a stretching program carried out only once a week on schoolchildren.

**Objectives:** the purpose of the present study was to compare the effects of a short-term stretching intervention program performed once and twice a week on hamstring extensibility among schoolchildren in the physical education setting.

**Methods:** a sample of 180 high school students aged 12-14 years old was randomly assigned (by natural groups) to a control group, experimental group 1 and experimental group 2. During physical education classes, experimental group students performed a stretching program for eight weeks. The experimental group 1 and 2 performed the stretching program once and twice a week, respectively.

**Results:** the analysis of variance results showed that the students of both experimental groups improved statistically significantly their hamstring extensibility when compared with the control group students ( $p < 0.01$ ). Nevertheless, no statistically significant differences between the two experimental groups were found ( $p > 0.05$ ).

**Conclusions:** a short-term stretching program performed only once a week improves hamstring extensibility in schoolchildren. When the stretching program is performed twice a week, the improvement in students' hamstring extensibility is not statistically higher.

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## UN PROGRAMA DE ESTIRAMIENTO EN EDUCACIÓN FÍSICA REALIZADO UNA VEZ A LA SEMANA TAMBIÉN MEJORA LA EXTENSIBILIDAD ISQUIOSURAL EN ESCOLARES: UN DISEÑO CONTROLADO ALEATORIO POR GRUPOS

### Resumen

**Introducción:** los profesores de educación física deben llevar a cabo programas de intervención para que los estudiantes alcancen niveles de flexibilidad saludables. Lamentablemente, no se conocen estudios que examinen el efecto de un programa de estiramiento llevado a cabo solo una vez por semana en escolares.

**Objetivos:** el objetivo del presente estudio fue comparar los efectos de un programa de intervención de estiramiento a corto plazo realizado una y dos veces por semana sobre la extensibilidad isquiosural en escolares en el contexto de la educación física.

**Métodos:** una muestra de 180 estudiantes de educación secundaria de 12-14 años fue asignado aleatoriamente (por grupos naturales) a los grupos control, experimental 1 y experimental 2. Durante las clases de educación física, los estudiantes experimentales realizaron un programa de estiramiento durante ocho semanas. El grupo experimental 1 y 2 realizaron el programa de estiramiento una y dos veces por semana, respectivamente.

**Resultados:** los resultados del análisis de varianza mostraron que los estudiantes de ambos grupos experimentales obtuvieron una mejora estadísticamente significativa de la extensibilidad isquiosural, comparado con los estudiantes del grupo de control ( $p < 0,01$ ). Sin embargo, no se encontraron diferencias estadísticamente significativas entre los dos grupos experimentales ( $p > 0,05$ ).

**Conclusiones:** un programa de estiramiento a corto plazo realizado una vez por semana mejora la extensibilidad isquiosural en escolares. Cuando el programa de estiramiento se lleva a cabo dos veces por semana, la mejora en la extensibilidad isquiosural de los estudiantes no es estadísticamente mayor.

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Palabras clave: Escuela. Rango de movimiento. Estiramiento estático. Condición física. Adolescentes.

## Abbreviations

PE: Physical education.

CG: Control group.

EG1: Experimental group 1 (students that performed the intervention once a week).

EG2: Experimental group 2 (students that performed the intervention twice a week).

SR: Sit-and-reach.

ANOVA: Analysis of variance.

## Introduction

Hamstring extensibility is a physical fitness component widely recognized as an important marker of health and quality of life<sup>1</sup>. Hamstring extensibility plays an important role in protecting the spine from potential disorders<sup>2</sup> and thereby allowing people to execute their normal daily activities<sup>3</sup>. Particularly, young people with adequate hamstring extensibility seem to have a lower risk of current low back pain<sup>4,5</sup> and neck tension<sup>6</sup>, as well as a lower risk of low back pain later during adulthood<sup>7,8</sup>.

Unfortunately, hamstring extensibility decreases significantly during youth<sup>9</sup>. Moreover, nowadays the number of young people with shortened hamstring extensibility is particularly alarming, since over one in five Spanish schoolchildren has a hamstring extensibility level indicative of health risk<sup>10</sup>. Therefore, in Spain health promotion policies should also be designed to promote the achievement of health-enhancing levels among childhood and adolescence<sup>11</sup>. In many circumstances, schools could play an important role in combating this important public health issue<sup>11</sup>. In this line, for instance, Spanish physical education (PE) teachers are required to carry out intervention programs for students to achieve health-enhancing flexibility levels<sup>12</sup>.

Previous studies have found that a PE-based stretching program carried out twice a week improves hamstring extensibility in schoolchildren<sup>13-15</sup>. Additionally, other studies have analyzed the positive effect of increasing the number of weekly sessions from two to four<sup>16</sup>. However, apart from the many curricular contents that PE teachers must teach each academic year, currently the subject is too restricted by its limited curriculum time allocation<sup>17</sup>. Therefore, since stretching programs cannot be allocated a large part of the PE time, including a one-session-per-week stretching program could be more feasible.

Unfortunately, to our knowledge there are no studies examining the effect of a stretching program carried out only once a week in young people, the number of related studies on adults is scarce as well<sup>18</sup>. Consequently, the purpose of the present study was to compare the effects of a short-term stretching intervention program performed once and twice a week on hamstring extensibility among schoolchildren in a PE setting.

## Methods

### *Participants*

A sample of 180 students, 94 boys and 86 girls, aged 12-14 years old from six different first/ second-grade PE classes at a private-public high school center participated in the present study. For practical reasons and due to the nature of the present study (i.e., intervention focused on natural groups in a school setting) a cluster randomized controlled design was used<sup>14,19</sup>. The six natural classes balanced by grade were assigned randomly to form one of the following study groups: a control group (CG), experimental group 1 (EG1) and experimental group 2 (EG2).

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<sup>20</sup>. The inclusion criteria were: (a) correctly performing the two flexibility evaluations, (b) and having an attendance rate of 90% or higher for PE classes during the intervention period. Adolescents and their legal guardians were fully informed about all the features of the study and were required to sign an informed consent document. The study protocol respected the current agreement of the Declaration of Helsinki on ethical principles for research involving human subjects and it was approved by the Ethical Committee of the University of Granada.

### *Measures*

Evaluation was carried out during the PE classes at the beginning and at the end of the stretching intervention program (pre-intervention and post-intervention, respectively). Each evaluation was carried out by the same tester, instrument, and under the same conditions. Pre-intervention and post-intervention measures were taken in an indoor sports facility on the same day of the week and at the same time for each student. Prior to the test, the students completed a standardized warm-up consisting of three minutes of jogging.

The classic sit-and-reach (SR) test was used to estimate students' hamstring extensibility. The students were assessed in sportswear and barefoot. At the beginning of the test, the students stood in front of the box, sat with their hips flexed, knees extended and both hands on the top of the ruler. From this position, the adolescents had to bend their trunk forward slowly and progressively (without swings) in order to reach the furthest possible distance and to remain still for at least two seconds (the score 23 cm corresponded to the tangent of the feet; accuracy 0.1 cm). The students were allowed to perform the test twice, one minute apart, and then the average score in cm was recorded<sup>21</sup>. The SR test has demonstrated high reliability

and adequate criterion-related validity among young people<sup>22</sup>.

### Procedures

A stretching intervention program was applied to the EGs during their PE sessions. The EG students performed a stretching development program four minutes per session for eight weeks. While the EG2 students performed the stretching intervention program twice a week, the EG1 students performed it only once a week. Since one lesson of the EG2 could not be used, in the end the participants of the EG1 and EG2 completed a total of 8 and 15 sessions, respectively. During each intervention session, the EG students performed static hamstring stretches during the cool-down period<sup>23</sup>. In the PE setting, the stretching intervention has been called “intermittent teaching unit”<sup>24</sup>.

Each intervention session included two 30-second sets of four stretching exercises. Three bidopal exercises and one unipodal exercise were performed in each session (Fig. 1). In all the stretching exercises, the students were placed with their hips flexed and knees fully extended. The toes were pointed to the ceiling with no hip rotation. From this position, the students flexed forward at the hip, trying to maintain the spine in neu-

tral position as much as possible until a gentle stretch was felt in the hamstrings. The stretched position was held gently until the end point of the range of motion was reached (i.e., stretch to the point of feeling tightness, but no pain). Once this position was achieved, the adolescents held it for 30 seconds.

All the students were urged to maintain their normal levels of physical activity outside the supervised setting during the research period. During the intervention program period, all the students participated in their standard PE sessions. However, the CG students did not perform stretching exercises and were not aware of the purpose of the study. Both the standard PE sessions and the stretching intervention programs were carried out by the same PE teacher of the participating center for all the groups.

### Statistical analysis

Descriptive statistics (means  $\pm$  standard deviations/ frequency) for age, gender, body mass, body height, body mass index, extra-curricular sport practitioners, and SR scores were calculated. A one-way analysis of variance (ANOVA) was conducted to examine potential differences between the three groups in terms of body mass, body height, body mass index,

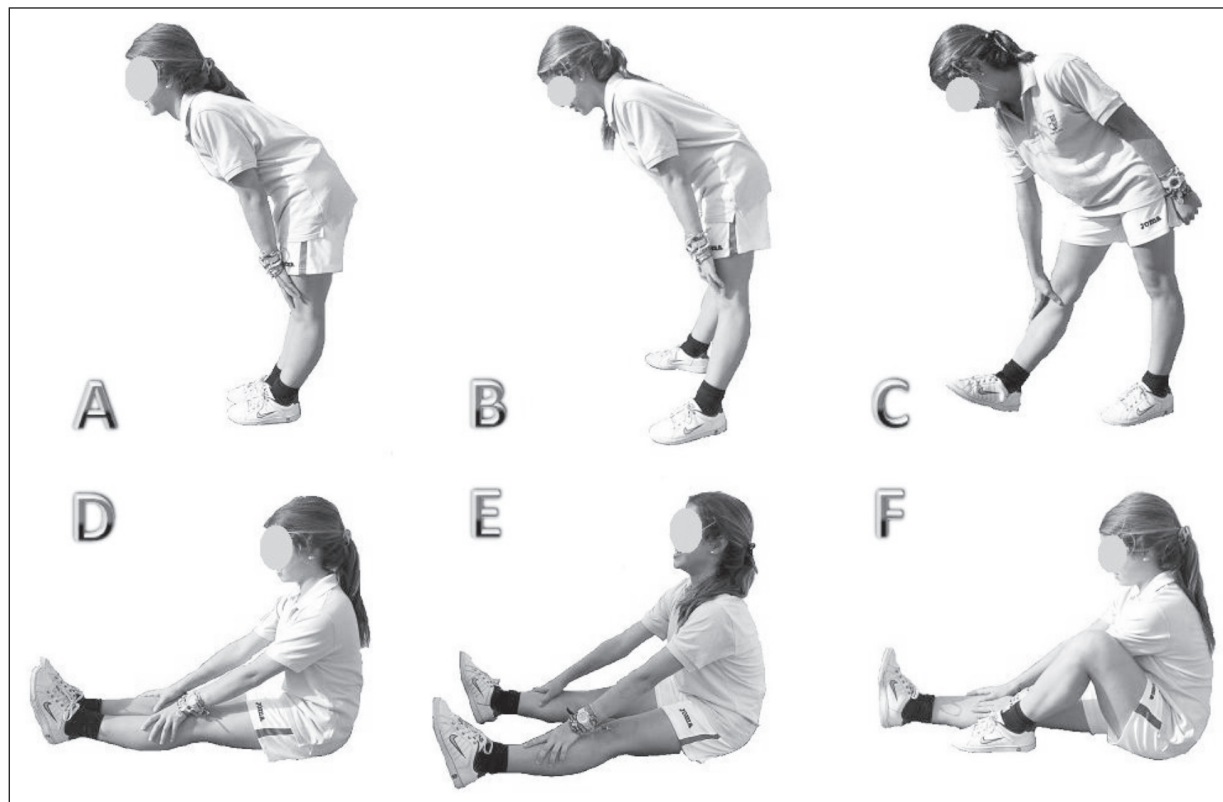


Fig. 1.—The six stretching exercises performed during the stretching intervention program: (a) standing with feet together; (b) standing with feet shoulder-width apart; (c) standing with only one leg extended; (d) sitting with feet together; (e) sitting with feet shoulder-width apart, and (f) sitting with only one leg extended. Session 1: (a), (b), (d) and (f); Session 2: (d), (e), (a) and (c).

and pre-intervention values of the SR test. Additionally, a chi-squared analysis was carried out to test the ratio differences of gender and extra-curricular sport practitioners between the three groups. Afterwards, the effect of the stretching intervention program on hamstring extensibility was examined using a one-way ANOVA, including *group* as a fixed factor (CG, EG1, EG2) and change pre-intervention - post-intervention as a dependent variable. Subsequently, the *post hoc* analyses with the Bonferroni adjustment were used for the pairwise comparisons. Moreover, the Hedges' *g* effect size was used to examine the magnitude of intervention effects<sup>25</sup>. The minimal detectable change was calculated in order to examine if the change score due to the intervention was true and reliable rather than due to measurement error<sup>26</sup>. Additionally, the test-retest reliability of the SR scores was estimated using the intraclass correlation coefficient from the two-way ANOVA<sup>27</sup>, as well as the 95% confidence interval. 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

Figure 2 shows the flow chart corresponding to the participants included in the present study. Although

all of the 180 invited students agreed to participate, only 163 participants completed the two evaluations and attended 90% or more of the intervention program sessions. Table I shows the general characteristics of the participants studied and the pre/ post-intervention SR scores. The one-way ANOVA results did not show statistically significant differences in body mass, body height, body mass index, and SR pre-intervention values between groups ( $p > 0.05$ ). Furthermore, the chi-square analyses showed that the three groups had a balanced representation of boys/ girls and extra-curricular sport practitioners/ non-practitioners ( $p > 0.05$ ). The test-retest reliability of the SR scores was 0.997 (0.994-0.998).

Figure 3 shows the effect of the stretching intervention program on hamstring extensibility levels. The results of the one-way ANOVA on the average obtained in the SR test showed a statistically significant effect [ $F(2, 160) = 11.192; p < 0.001; \eta_p^2 = 0.123; P = 0.991$ ]. Subsequently, the pairwise comparisons with the Bonferroni adjustment showed that both EG1 and EG2 obtained a statistically significant improvement compared to the CG (EG1,  $p = 0.005; g = 0.16$ ; EG2,  $p < 0.001; g = 0.23$ ). Nevertheless, no statistically significant differences between the EG1 and EG2 were found ( $p > 0.05; g = 0.07$ ). The minimal detectable change value of the SR score was 0.96 cm, when the average increase in the EG1 and EG2 was 1.41 and 1.93 cm, respectively.

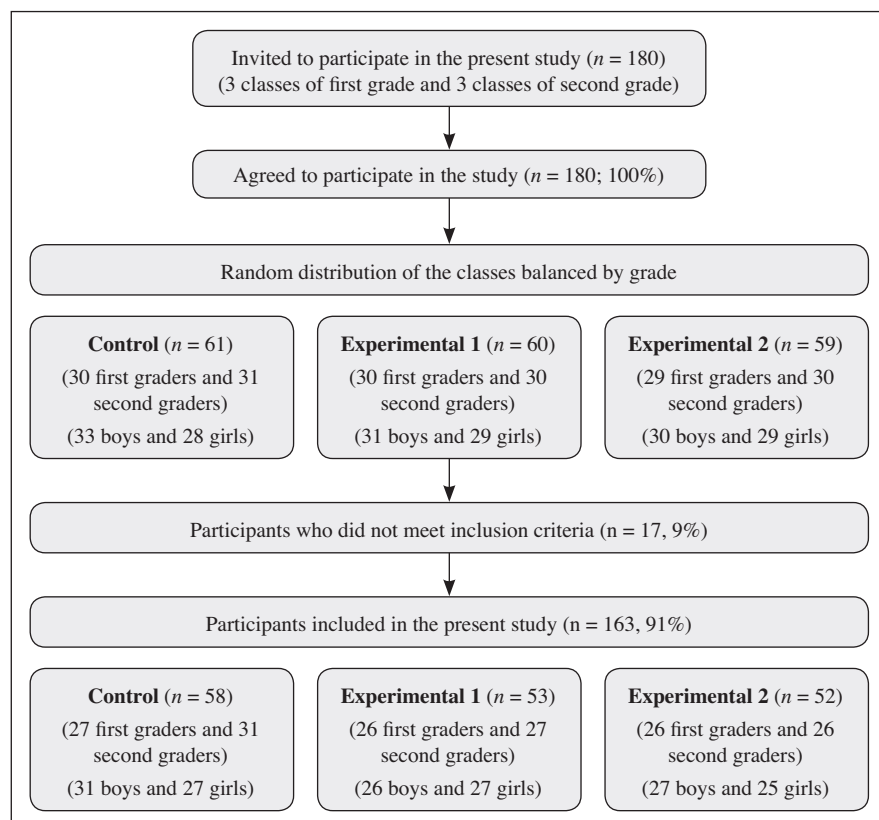


Fig. 2.—Flow chart corresponding to the participants included in the present study.

**Table I**  
General characteristics (mean  $\pm$  standard deviation/ frequency) of the participants and pre/ post-intervention sit-and-reach scores

	Control (n = 58)	Experimental 1 (n = 53)	Experimental 2 (n = 52)
Age (years)	12.6 $\pm$ 0.6	12.7 $\pm$ 0.7	12.7 $\pm$ 0.6
Gender (boys/ girls)	31/ 27	26/ 27	27/ 25
Body mass (kg)	49.8 $\pm$ 8.1	47.3 $\pm$ 8.5	49.2 $\pm$ 9.7
Body height (cm)	158.3 $\pm$ 7.0	157.7 $\pm$ 7.5	156.4 $\pm$ 7.1
Body mass index (kg/ m <sup>2</sup> )	19.8 $\pm$ 2.6	18.9 $\pm$ 2.2	20.0 $\pm$ 3.2
Extra-curricular sport (yes/ no) <sup>a</sup>	37/ 21	37/ 15	35/ 17
Pre-intervention SR score (cm)	20.4 $\pm$ 7.0	20.2 $\pm$ 6.7	20.7 $\pm$ 7.7
Post-intervention SR score (cm)	20.7 $\pm$ 7.4	21.7 $\pm$ 6.6	22.6 $\pm$ 8.2

Note. SR = Sit-and-reach.

<sup>a</sup> Children that regularly participated (yes) or not (no) at least twice per week in extra-curricular sport activities.

## Discussion

The purpose of the present study was to compare the effects of a short-term stretching intervention program performed once and twice a week on hamstring extensibility among schoolchildren in the PE setting. Spanish PE teachers are required to carry out intervention programs for students to achieve health-enhancing flexibility levels<sup>12</sup>. Previous studies have found that a short-term stretching program carried out twice a week improves hamstring extensibility in schoolchildren<sup>13-15</sup>. However, apart from the many curricular contents that PE teachers must teach each academic year, currently the subject is too restricted by its limited curriculum time allocation<sup>17</sup>. Consequently, including a stretching program performs only once a week would be more feasible.

The results of the present study showed that a short-term stretching program performed only once a week improves hamstring extensibility in schoolchildren. Additionally, when the stretching program is performed twice a week, the improvement in students' hamstring extensibility is not statistically different. To our knowledge there are no studies examining the effect of a one-session-per-week stretching program on schoolchildren. However, Santonja et al.<sup>16</sup> compared the effects of a stretching program performed two and four times a week on hamstring extensibility in schoolchildren. Contrary to the present results, these authors found that children performing a stretching program four sessions per week obtained statistically greater improvements on hamstring extensibility compared with two sessions per week. However, apart from the difference in frequency, the fact that

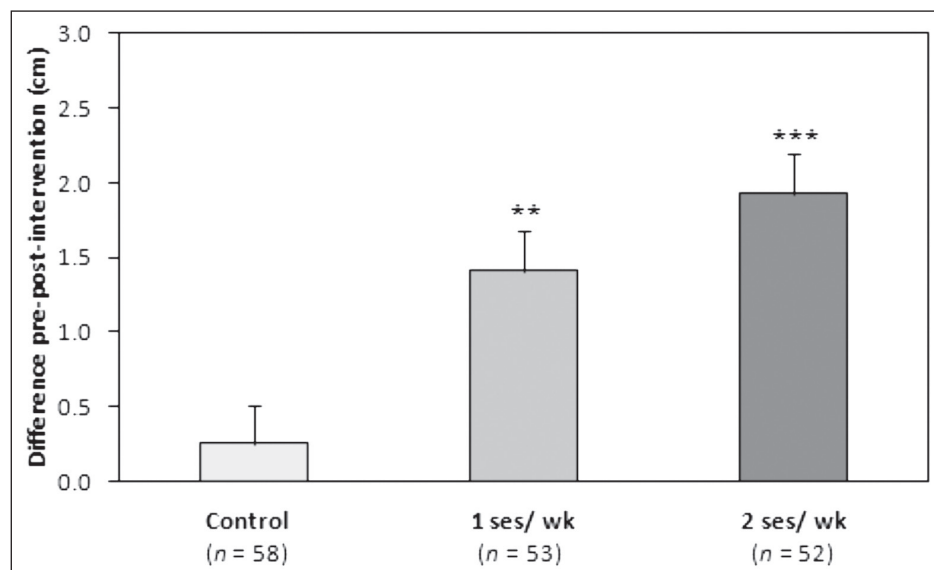


Fig. 3.—Effect of the stretching intervention program on hamstring extensibility (sit-and-reach scores, cm).

Note. Values represent the mean and error bars the standard error. Significance level from the one-way analysis of variance ( $p < 0.001$ ) followed by the pairwise comparisons with the Bonferroni adjustment: Change statistically significant one session/ week-control group (\*\*  $p < 0.01$ ) and two sessions/ week-control group (\*\*\*)  $p < 0.001$ ).



a long-term program instead of a short-term one was performed as in the present study must also be highlighted.

As far as we know there is only one related study carried out on adults<sup>18</sup>. Marques et al.<sup>18</sup> compared the effects of a short-term stretching program performed one, three and five times a week on hamstring extensibility in apparently healthy adults. Similar to the present study, these authors found that a stretching intervention program carried out once a week improves adults' stand-and-reach scores. Nevertheless, when adults stretched three times a week, their improvement was statistically higher than those who stretched once a week. Participants who stretched five times a week, however, did not find any difference with those who stretched once or three times. Moreover, statistically significant differences were not found on the angular test scores for any group. Additionally, since the previous authors did not follow a controlled design, we have to be aware of these results.

As regards to the magnitude effects of the intervention, the effect size of the present stretching program was small. However, according to Valentine and Cooper<sup>28</sup>, we have to be aware that in educational interventions even these values of effect size could be considered as of practical relevance. In order to interpret the magnitude of an educational intervention, we must also consider the ratio cost/ benefit<sup>29</sup>. Therefore, if an educational intervention produces even a slight increase in a key issue of a students' health marker such as hamstring extensibility and it is not a major cost (i.e., economic, labor and effort of the teacher, etc.). it may be worth keeping that intervention<sup>29</sup>. In addition, the results of the minimal detectable change analyses showed that the increase in the SR scores due to the intervention program was true and reliable rather than the measurement error.

Previous studies examining the effect of a short-term stretching program (5-10 weeks) carried out twice a week obtained similar or higher effect sizes than the current study ( $g = 0.24-0.67$ )<sup>13-15,23,30,31</sup>. Increasing training factors such as the frequency or duration of the intervention program could have a positive outcome on the magnitude effects. Regarding the frequency, Santonja et al.<sup>16</sup> found that when schoolchildren performed four sessions per week instead of two, the magnitude effect doubled ( $g = 0.85$  vs.  $1.53$ ). Although in the present study the stretching program performed twice a week was slightly greater than when it was performed once a week, that difference was trivial ( $\Delta g = 0.07$ ). However, as mentioned above, a long-term intervention program could show a greater difference as in the Santonja et al.<sup>16</sup> study. In this line, as regards the duration of the program, while the median effects size of previous studies for short-term was 0.43, the magnitude was higher for the mid-term stretching programs (16 weeks) ( $g = 0.86$ )<sup>32</sup>, and even higher for those with long-term stretching programs (whole school year, 31-32 weeks) ( $g = 0.94$ )<sup>16,33-35</sup>.

In conclusion, to our knowledge this is the first study that compares the effects of a stretching intervention program performed once and twice a week on hamstring extensibility among schoolchildren in a PE setting. The main result of the present study suggests that a short-term stretching program performed only once a week improves hamstring extensibility in schoolchildren. Additionally, when the stretching program was performed twice a week, the improvement in students' hamstring extensibility was not significantly statistically higher. This knowledge could help and guide teachers to design programs that guarantee a feasible and effective development of students' flexibility in the PE setting. Future research studies should compare the effect of long-term stretching programs with one and two sessions per week, as well as the research into the effectiveness of stretching intervention programs with other frequencies and volume per session is also required.

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## Conflict of interest

None.

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