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## PUBLICACIONES [PUBLICATIONS]

La presente memoria de Tesis Doctoral está compuesta por las siguientes publicaciones:

- I. **Becerra-Fernández, C. A.**, Mayorga-Vega, D., & Merino-Marban, R. How do students' hamstring extensibility levels change through an academic year? Submitted to *Journal of Physical Education and Sport*. SJR: 0.456 (Q2).
- II. **Becerra-Fernández, C. A.**, & Merino-Marban, R. (2015). Efficacy of hamstring stretching programs in schoolchildren. A systematic review. *Timisoara Physical Education and Rehabilitation Journal*, 8(15), 36–43. DOI: <https://doi.org/10.1515/tpelj-2015-0015>
- III. **Becerra-Fernández, C. A.**, Mayorga-Vega, D., & Merino-Marban, R. Effect of physical education-based stretching programs on hamstring extensibility in high school students: A systematic review. Submitted to *Journal of Physical Education and Sport*. SJR: 0.456 (Q2).
- IV. **Becerra-Fernández, C. A.**, Merino-Marban, R., & Mayorga-Vega, D. (2016). Effect of a physical education-based dynamic stretching program on hamstring extensibility in female high school students. *Kinesiology*, 48 (2), 258-266. JCR: 0.553 (Q4). DOI: <http://hrcak.srce.hr/168673>

**HOW DO STUDENTS' HAMSTRING EXTENSIBILITY LEVELS CHANGE  
THROUGH AN ACADEMIC YEAR?**

**[¿CÓMO CAMBIAN LOS NIVELES DE EXTENSIBILIDAD ISQUIOSURAL  
DE LOS ESTUDIANTES DURANTE UN CURSO ACADÉMICO?]**

Becerra-Fernández, C. A., Mayorga-Vega, D., & Merino-Marban

*Journal of Physical Education and Sport*

Submitted

**Abstract**

The main purpose of the present study was to examine the students' hamstring extensibility levels through an academic year. A sample of 128 students from four different 11th-grade of a public-private high school center was assessed by the classic sit-and-reach test in pre-, mid- and post-academic year. The results showed that students' hamstring extensibility level statistically significantly decreased from pre-academic year ( $22.1 \pm 8.5$  cm) to mid- ( $19.9 \pm 8.6$  cm;  $d = -0.26$ ) and post-academic year ( $18.6 \pm 9.3$  cm;  $d = -0.41$ ) ( $p < 0.001$ ) and from mid-academic year to post-academic year ( $d = -0.16$ ) ( $p < 0.001$ ). The results of the McNemar's test indicated that there was a statistically significant decrease on the proportion of students with normal hamstring extensibility level from pre-academic year to post-academic year ( $p < 0.05$ ). In conclusion, high-school students lost flexibility hamstring levels during an academic year. As a result of this decrease, the number of students with hamstring extensibility shortening increased by 10.9%. These findings may be interesting for physical education teachers in order to know the changes that occur naturally in the students' flexibility during an academic year and to implement stretching programs for preventing students' hamstring extensibility shortening.

**Key words:** Flexibility, shortened hamstring extensibility, classic sit-and-reach test, decrease, adolescents, high-school students.

**EFFICACY OF HAMSTRING STRETCHING PROGRAMS IN  
SCHOOLCHILDREN. A SYSTEMATIC REVIEW  
[EFICACIA DE LOS PROGRAMAS DE ESTIRAMIENTO ISQUIOSURAL EN  
ESCOLARES. UNA REVISIÓN SISTEMÁTICA]**

Becerra-Fernández, C. A., & Merino-Marban

*Timisoara Physical Education and Rehabilitation Journal*

2015, 8(15), 36–43.

**Abstract**

The main purpose of the present review was to examine the scientific literature on the effects of physical education-based stretching programs on hamstring extensibility in schoolchildren aged 6-11 years. For this purpose relevant studies were searched from ten electronic databases dated up through May 2015. Of the 25 potentially relevant articles identified and retrieved for more detailed evaluation, only eight studies were included in the present review because they met the inclusion criteria. The overall results showed that incorporating hamstring stretching as a part of physical education classes produces a significant improvement in the scores of the tests: straight leg raise and classic sit-and-reach, for the experimental groups, but not for control groups. Stretching programs can be included in Physical Education classes, specifically during the warm-up and the cool down periods in order to improve hamstring extensibility. Although it seems that the stretching exercises in the warm-up period could be less effective in gaining flexibility in school children. Studies that use a stretching volume between 4 and 7 minutes per session and 2-4 training classes per week, obtain statistically significant improvements on the levels of hamstring flexibility in the experimental groups. However, after a five-week detraining period, children revert back to their initial flexibility levels. Therefore, it seems appropriate that physical education teachers should implement stretching programs to improve the students' flexibility during the Physical Education classes.

**Key words:** *Hamstring stretching, primary students, stretching program, review.*

**EFFECT OF PHYSICAL EDUCATION-BASED STRETCHING PROGRAMS  
ON HAMSTRING EXTENSIBILITY IN HIGH SCHOOL STUDENTS: A  
SYSTEMATIC REVIEW**

**[EFECTOS DE PROGRAMAS DE ESTIRAMIENTO EN EDUCACIÓN FÍSICA  
SOBRE LA EXTENSIBILIDAD ISQUIOSURAL EN ESTUDIANTES DE  
SECUNDARIA: UNA REVISIÓN SISTEMÁTICA]**

Becerra-Fernández, C. A., Mayorga-Vega, D., & Merino-Marban, R.

*Journal of Physical Education and Sport*

Submitted

**Abstract**

The main purpose of the present review was to examine the scientific literature on the effects of physical education-based stretching programs on hamstring extensibility in secondary students aged 12-17 years. Relevant studies were searched from 10 electronic databases dated up through January 2016. The overall results showed that incorporating hamstring stretching as a part of physical education classes produces a significant improvement in the scores of the tests knee extension, straight leg raise and classic sit-and-reach. Stretching programs should be included in physical education classes, specifically during the warm-up and the cool down period in order to improve hamstring extensibility. Most studies obtained flexibility improvements using static techniques, although dynamic stretching exercises also produced benefits over hamstring flexibility and it may not be harmful when practiced in a soft way. Students that performed a stretching volume between 45 seconds and 7 minutes per session and a frequency of 2-5 sessions per week, obtained statistically significant improvements on the levels of hamstring extensibility. However, after a four-week detraining period, adolescents reverted back to their initial flexibility levels. Therefore, it seems appropriate that physical education teachers implement stretching programs to improve the students' flexibility during the physical education classes.

**Key words:** Hamstring muscles extensibility, range of motion, flexibility program, physical education, secondary students, adolescents.

**EFFECT OF A PHYSICAL EDUCATION-BASED DYNAMIC STRETCHING PROGRAM ON HAMSTRING EXTENSIBILITY IN FEMALE HIGH SCHOOL STUDENTS**

**[EFECTOS DE UN PROGRAMA DE ESTIRAMIENTO DINÁMICO EN EDUCACIÓN FÍSICA SOBRE LA EXTENSIBILIDAD ISQUIOSURAL EN CHICAS ADOLESCENTES DE BACHILLERATO]**

Becerra-Fernández, C. A., Merino-Marban, R., & Mayorga-Vega, D.

*Kinesiology, 48(2016)2:258-266*

**Abstract:**

The purpose of the present study was to examine the effects of a dynamic stretching development program followed by a four-week detraining period and maintenance program on hamstring extensibility in a physical education setting. A sample of 108 female high-school students aged 16-17 years from four classes were clustered randomly and assigned to either an experimental or a control group. During physical education sessions, the experimental group students performed a dynamic stretching program twice a week for eight weeks. Subsequently, after a four-week period of detraining, the experimental group students completed a maintenance program twice a week during four weeks. The results of the two-way analysis of variance showed that the physical education-based development program significantly improved students' hamstring extensibility ( $p < .001$ ). Although after four weeks of detraining students' flexibility reverted to its baseline levels ( $p > .05$ ), the gains obtained previously were recovered after a four-week maintenance program ( $p < .001$ ).

Hence, a physical education-based dynamic stretching intervention is effective in improving and maintaining hamstring extensibility among female high-school students. However, after four weeks of detraining, students' flexibility reverts to its baseline levels. These findings could help and guide teachers to design programs that guarantee a feasible and an effective development of flexibility in a physical education setting.

**Key words:** *flexibility program, bouncing technique, detraining, classical sit-and-reach test, adolescents, physical education setting*