Journal of Physical Education and Sport ® (JPES), 14(3), Art 54, pp. 355 - 359, 2014
online ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES

Original Article

Effect of a short-term static stretching training program followed by five weeks of detraining on hamstring extensibility in children aged 9-10 years

DANIEL MAYORGA-VEGA[1]; RAFAEL MERINO-MARBAN[2]; ENRIQUE SÁNCHEZ-RIVAS[3]; JESÚS VICIANA[1]
[1]Department of Physical Education and Sport, University of Granada, SPAIN.
[2]Faculty of Educational Sciences, University of Malaga, SPAIN.
[3]Department of Physical Education, Primary Education School of Tartessos, Junta de Andalucía, SPAIN.

Published online: September 30, 2014
(Accepted for publication September 05, 2014)

DOI:10.7752/jpes.2014.03054;

Abstract:
The objective of the present study was to determine the effects of a short-term stretching training program followed by five weeks of detraining on hamstring extensibility among children aged 9-10 years. A total of 45 children aged 9-10 years, 24 boys and 21 girls, participated in the present study. Participants were clustered randomly assigned to a stretching group (n = 22) or a control group (n = 23). Hamstring extensibility was estimated by the classic sit-and-reach test, which it was applied at the beginning and at the end of the stretching training program, as well as after five weeks of stretching detraining. The stretching group participants performed a five-minute stretching training program twice a week for eight weeks. Afterward, these stretching group children underwent a detraining period of five weeks. The results of the two-way ANOVA showed that the stretching training program significantly increased the children´s hamstring extensibility ($p < 0.001$). Nevertheless, after five weeks of stretching detraining, the flexibility levels reverted back to the baseline. For the control group participants no statistically significant differences were found ($p > 0.05$). The most important contribution of the present study was to test that after five weeks of stretching detraining children´s flexibility reverts back to its baseline level. Therefore, because physical activity programs for children are frequently interrupted by various vacations, children should be encouraged to continue training their flexibility during these periods.
Key Words: Flexibility training, stretching training, flexibility detraining, retention of flexibility, sit-and-reach, kids.

Introduction

Hamstring extensibility is a physical fitness component widely recognized as an important marker of health and quality of life (Garber et al., 2011). For instance, the lack of hamstring extensibility has been associated with several ailments such as different spinal disorders (Fisk, Baigent, & Hill, 1984; Harvey & Tanner, 1991; López-Miñarro & Alacid, 2009; Sjölie, 2004; Standaert & Herring, 2000), gait limitations, increased risk of falls, and susceptibility to musculoskeletal injuries (Erkula, Demirkan, Kilic, & Kiter, 2002; Funk, Swank, Adams, & Tredo, 2001). Particularly among children, low hamstring extensibility seems to contribute to the increase in the risk of suffering present low back pain (Feldman, Shrier, Rossignol, & Abenhaim, 2001; Jones, Stratton, Reilly, & Unnithan, 2005; Sjölie, 2004) as well as future low back pain (Hestbaek, Leboeuf-Yde, Kyvik, & Manniche, 2006; Kujala, Taimela, Salminen, & Oksanen, 1994).

Low hamstring extensibility affects a large amount of children (Brodersen, Pedersen, & Reimers, 1994; Castro-Piñero et al., 2013; Ferrer, 1998; Harreby et al., 1999). Fortunately, a shortened hamstring might be addressed proactively through different physical activity programs for children by systematically performing stretching exercises. In this line, previous studies found that stretching training programs develop hamstring extensibility among children (Coledam, Arruda, & Ramos de Oliveira, 2012; Rodríguez et al., 1999; Rodríguez, Santonja, López-Miñarro, Sáinz de Baranda, & Yuste, 2008; Sainz de Baranda et al., 2006; Santonja, Sainz de Baranda, Rodríguez, López, & Canteras, 2007). Therefore, physical activity programs for children such as physical education or organized recreational sports should develop hamstring extensibility (Kanásová, 2008; Sainz de Baranda et al., 2006; Santonja et al., 2007).

Unfortunately, although hamstring extensibility is expected to decrease after a period of detraining (Rancour, Holmes, & Cipriani, 2009; Willy, Kyle, Moore, & Chleboun, 2001), these kinds of programs are frequently interrupted by various vacation periods such as summer or Christmas. Therefore, since children stop attending their physical activity classes during vacation periods, their flexibility levels could revert back to the previous baseline level of flexibility. In this line, previous studies carried out with adults found a significant loss

Corresponding Author: DANIEL MAYORGA-VEGA, E-mail: dmayorgavega@gmail.com

of hamstring extensibility after four weeks (Rancour et al., 2009; Willy et al., 2001). However, to our knowledge there are no studies examining the effect of hamstring extensibility detraining among children. Therefore, since there currently is a lack of scientific information about stretching detraining effects among children, research in this area is required. Consequently, in addition to evaluating the effects of a short-term static stretching program, the main purpose of the present study was to examine the effects of five weeks of stretching detraining on hamstring extensibility in children aged 9-10 years.

Material and method

Participants

A total of 45 children aged 9-10 years, 24 boys and 21 girls, from two different physical education classes participated in the present study. According to previous studies performed in the same setting (Mayorga-Vega, Viciana, & Cocca, 2013) a cluster randomized controlled trial was used. Classes were cluster randomized into either a control group (CG) or a stretching group (SG). The inclusion criteria were to not have had any of the following orthopedic disorders over the past six months: (a) episodes of hamstring injuries; (b) fractures; (c) surgery or pain in the spine; and/ or (d) surgery or pain in the hamstring muscles (López-Miñarro, Sainz de Baranda, & Rodríguez-Garcia, 2009). Then, the exclusion criterion was to have an attendance rate lower than 90% for the stretching training program during the intervention period and/ or not to participate in some of the assessment sessions.

All the participants were urged to maintain their normal levels of physical activity outside of the supervised setting during the research period. In addition to the physical education classes, nine children in the SG (41%) and nine children in the CG (39%) regularly participated (at least twice per week) in organized sport programs. The study protocol was approved by the Ethical Committee of the University of Malaga. In addition, children and their parents or legal guardians were fully informed about all the features of the study, and a signed informed-consent document was obtained from all the parents.

Hamstring extensibility testing

Hamstring extensibility was estimated by the classic sit-and-reach (SR) test. This test was applied because when the use of the angular tests is limited as in the present study, the classic SR test has shown to be the best field-based test alternative to estimate hamstring extensibility (Mayorga-Vega, Merino-Marban, & Viciana, 2014). The SR test was performed at the beginning and at the end of the stretching training program (pre-intervention and post-intervention, respectively), as well as after five weeks of stretching detraining (post-detraining). The test was applied by the same tester, using the same instruments and under the same conditions during each evaluation (i.e., pre-intervention, post-intervention, and post-detraining). The SR test was administered using a wooden box with a ruler at the top in which the score 15 cm corresponded to the tangent of the feet (accuracy = 1 cm). The test was 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 child.

Because time constrictions prior to the SR test no warming-up exercises were performed. Each child stood in front of the box, sat with his/ her 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 90º. The knees were fixed in extension with the help of the tester. The hands with the fingers extended were placed parallel to each other. From this position, the participant 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 two seconds. Two attempts were performed one minute apart, and then the mean was retained for the posterior statistical analyses (Mayorga-Vega , Merino-Marban, & Garcia-Romero, In press)

Training procedures

All the children participated in their standard physical education classes. Additionally, a stretching-based intervention program was also applied to the SG participants during the cool-down period. Firstly, the SG participants performed the stretching training program twice a week on nonconsecutive days for eight weeks. Afterward, the SG participants underwent a detraining period of five weeks. On the other hand, the CG participants followed the same standard physical education classes without performing hamstring stretches and were not aware of the purpose of the study.

During each session of the intervention program, the SG participants performed hamstring stretches using the static technique for five minutes. Each intervention session included three sets of four stretching exercises (three bidopals exercises and one unipodal exercise). Overall, six different stretching exercises were designed and alternated during the intervention program: (a) standing with feet together; (b) sitting with feet together; (c) standing with feet shoulders width apart; (d) sitting with feet shoulders width apart; (e) standing with only one leg extended, and (f) sitting with only one leg extended.

For all the stretching exercises, the participants flexed forward at the hip, maintaining the spine in a neutral position as much as possible 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 stretching positions were held gently until the point of feeling the tightness of the hamstring muscles (but no pain) was reached. Once this position was achieved, the children held it for 20 seconds.

Statistical analysis

Means and standard deviations for age, body mass, height, body mass index, and SR scores were calculated. A one-way analysis of variance (ANOVA) was used to examine the differences in the general characteristics (body mass, height, and body mass index) and baseline SR scores between the SG and CG. In addition, chi-squared analyses were carried out to test the ratio differences of sport practitioners and gender between the two groups. Afterward, the effect of the stretching training program and its posterior detraining on hamstring extensibility was examined using a two-way ANOVA, using group as the independent variable (SG, CG) and time as the dependent variable (pre-intervention, post-intervention, post-detraining). Subsequently, for the post hoc analyses, α values were corrected using the Bonferroni adjustment. Furthermore, the Hedges´ g effect size was used to examine the magnitude of intervention effects (Hedges, 2007). The test-retest reliability of the SR test was estimated by using the intraclass correlation coefficient from the two-way ANOVA (Shrout & Fleiss, 1979), as well as the 95% interval of confidence. 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

All the participants met both the inclusion and exclusion criteria. Table 1 shows the general characteristics and the SR scores of the participants. The one-way ANOVA results did not show statistically significant differences in the general characteristics and the SR baseline values between SG and CG ($p > 0.05$), except for in the height variable ($p < 0.05$). Additionally, the chi-square analyses showed that the two groups had a balanced representation of boys and girls (SG, 12 boys and 10 girls; CG, 12 boys and 11 girls) and sport practitioners and non-practitioners (SG, 9 practitioners and 13 non-practitioners; CG, 9 practitioners and 14 non-practitioners) ($p > 0.05$). The estimation result of the test-retest reliability for the SR test was 0.99 (0.97-0.99).

Table 1. General characteristics and sit-and-reach scores (mean ± standard deviation) of the participants.

	Sample (n = 45)	Control group (n = 23)	Stretching group (n = 22)
Age (year)	9.89 ± 0.32	9.87 ± 0.34	9.91 ± 0.29
Body mass (kg)	38.56 ± 5.70	37.17 ± 5.36	40.00 ± 5.82
Height (m)	1.40 ± 0.07	1.37 ± 0.06	1.42 ± 0.06
Body mass index (kg/m^2)	19.77 ± 2.35	19.74 ± 2.51	19.80 ± 2.24
Pre-intervention	15.58 ± 5.11	14.17 ± 4.20	17.05 ± 5.64
Post-intervention	16.56 ± 5.33	14.57 ± 4.14	18.64 ± 5.71
Post-detraining	15.94 ± 5.09	14.26 ± 3.99	17.69 ± 5.59

Figure 1 shows the effect of the stretching training program on hamstring extensibility (sit-and-reach scores, cm). The results of the two-way ANOVA on the SR scores showed interaction effects between the group and time variables [$F(2, 86) = 6.791$; $p = 0.005$; $\eta^2_p = 0.136$; $P = 0.832$]. Subsequently, the ANOVA with the Bonferroni adjustment showed a statistically significant increase for the SG from pre-intervention to post-intervention ($p < 0.001$; $g = 0.24$). Nevertheless, for the SG flexibility levels from post-intervention to post-detraining showed a statistically significant decrease ($p < 0.001$; $g = - 0.13$), and statistical differences between the baseline and post-detraining levels were not found ($p > 0.05$; $g = 0.11$). Finally, for the CG no significant differences were found ($p > 0.05$).

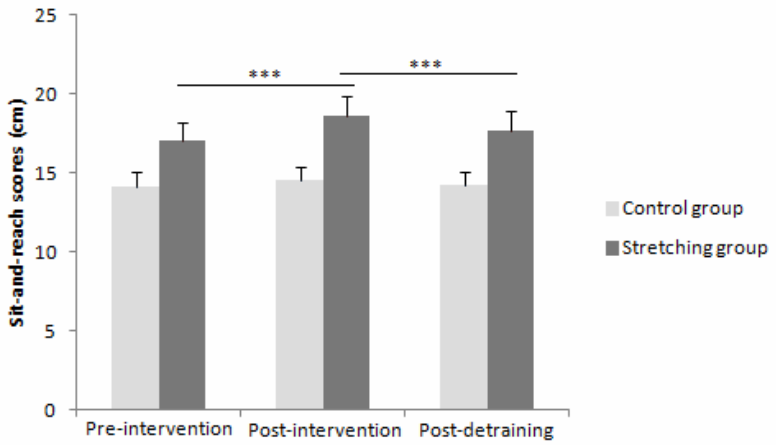

*Fig. 1. Effect of the stretching training program followed by five weeks of detraining on the classic sit-and-reach scores. Stretching group (n = 22) and Control group (n = 23). Values are mean and error bars represent standard error. *** p < 0.001.*

Discussion

One of the objectives of the current study was to evaluate the effects of a short-term static stretching program on hamstring extensibility in children aged 9-10 years. Previous studies found that systematically performed stretching programs develop children´s hamstring extensibility (Coledam et al., 2012; Rodríguez et al., 1999; Rodríguez et al., 2008; Sainz de Baranda et al., 2006; Santonja et al., 2007). However, in all the preceding studies children performed the intervention program during a substantially longer duration (16-32 weeks) (Coledam et al., 2012; Rodríguez et al., 1999; Rodríguez et al., 2008; Sainz de Baranda et al., 2006; Santonja et al., 2007). Unfortunately, to our knowledge there are no studies examining the effect of short-term stretching programs among children. The results of the present study showed that a five-minute stretching program carried out only twice a week and for eight weeks improves children´s hamstring extensibility. In this line, similarly previous studies carried out with adults found that short-term static stretching programs (12 weeks) performed three times a week improve flexibility levels (Ayala & Sainz de Baranda, 2008; Sainz de Baranda & Ayala, 2010).

On the other hand, the main purpose of the present study was to examine the effects of five weeks of stretching detraining on hamstring extensibility in children. Although flexibility levels are expected to decrease after a period of detraining (Rancour et al., 2009; Willy et al., 2001), physical activity programs for children are frequently interrupted by various vacation periods. Therefore, since children stop attending to their physical activity classes during vacation periods, their flexibility levels could revert back. In this line, the results of this study showed that the effects of a stretching development program are lost after five weeks of detraining on hamstring extensibility in children. Similarly, Rancour et al. (2009) and Willy et al. (2001) found that adults significantly lost hamstring extensibility levels after four weeks of cessation of their stretching development program. Regrettably, related studies carried out with children have not been found.

Conclusions

Children´s hamstring extensibility can be improved by means of an only eight-week stretching training program. Additionally, the most important contribution of the present study was to test that after five weeks of stretching detraining children´s flexibility reverts back to their baseline level. Therefore, physical education teachers, coaches, and other related sport instructors should encourage children to continue training their flexibility during long vacation periods. Unfortunately, this strategy mainly depends on the individuals' autonomy and, therefore, among children at these early ages it could be impractical. Future research studies should examine the effect of different detraining periods among children.

Acknowledgments

We thank Aliisa Hatten-Viciana for the English revision. The first author is supported by a research grant from the Spanish Ministry of Education, Culture and Sport (AP2010-5905).

References

Ayala, F., & Sainz de Baranda, P. (2008). Effect of duration and technique of hamstring stretching on hip flexion range of motion. *Cultura, Ciencia y Deporte*, *3*(8), 93-99.

Brodersen, A., Pedersen, B., & Reimers, J. (1994). Incidence of complaints about heel, knee and back related discomfort among Danish children, possible relation to short muscles. *Ugeskrift fot Laeger*, *156*(15), 2243-2245.

Castro-Piñero, J., Girela-Rejón, M. J., González-Montesinos, J. L., Mora, J., Conde-Caveda, J., Sjöström, M., & Ruiz, J. R. (2013). Percentile values for flexibility tests in youths aged 6 to 17 years: Influence of weight status. *European Journal of Sport Science*, *13*(2), 139-148.

Coledam, D. H. C., Arruda, G. A., & Ramos de Oliveira, A. (2012). Chronic effect of static stretching performed during warm-up on flexibility in children. *Revista Brasileira de Cineantropometria e Desempenho Humano*, *14*(3), 296-304.

Erkula, G., Demirkan, F., Kilic, B. A., & Kiter, E. (2002). Hamstring shortening in healthy adults. *Journal of Back Musculoskeletal Rehabilitation*, *16*(2), 77-81.

Feldman, D. E., Shrier, I., Rossignol, M., & Abenhaim, L. (2001). Risk factors for the development of low back pain in adolescence. *American Journal of Epidemiology*, *154*(1), 30-36.

Ferrer, V. (1998). *Repercusiones de la cortedad isquiosural sobre la pelvis y el raquis lumbar* [Impact of the shortened hamstring on the pelvis and lumbar spine] (Unpublished doctoral dissertation). University of Murcia, Spain.

Fisk, J. W., Baigent, M. L., & Hill, P. D. (1984). Scheuermann´s disease. Clinical and radiological survey of 17 and 18 year olds. *American Journal of Physical Medicine*, *63*(1), 18-30.

Funk, D., Swank, A. M., Adams, K. J., & Tredo, D. (2001). Efficacy of moist heat pack application over static stretching on hamstring flexibility. *Journal of Strength & Conditioning Research*, *15*(1), 123-126.

Garber, C. E., Blissmer, B., Deschenes, M. R., Franklin, B. A., Lamonte, M. J., Lee, I. M.,… Swain, D. P. (2011). Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: Guidance for prescribing exercise. *Medicine & Science in Sports & Exercise*, *43*(7), 1334-1359.

Harreby, M., Neergaard, K., Jessen, T., Larsen, E., Storr-Paulsen, A., Lindahl, A.,… Laegaard, E. (1999). Risk factors for low back pain in a cohort of 1389 Danish school children an epidemiologic study. *European Spine Journal*, *8*(6), 444-450.

Harvey, J., & Tanner, S. (1991). Low back pain in young athletes: A practical approach. *Sports Medicine*, *12*(6), 394-406.

Hedges, L. V. (2007). Effect sizes in cluster-randomized designs. *Journal of Educational and Behavioral Statistics*, *32*(4), 341-370.

Hestbaek, L., Leboeuf-Yde, C., Kyvik, K. O., & Manniche, C. (2006). The course of low back pain from adolescence to adulthood. Eight year follow up of 9600 twins. *Spine*, *31*(4), 468-472.

Jones, M. A., Stratton, G., Reilly, T., & Unnithan, V. B. (2005). Biological risk indicators for recurrent non-specific low back pain in adolescents. *British Journal of Sports Medicine*, *39*(3), 137-140.

Kanásová, J. (2008). Reducing shortened muscles in 10-12-year-old boys through a physical exercise program. *Medicina Sportiva*, *12*(4), 115-123.

Kujala, U. M., Taimela, S., Salminen, J. J., & Oksanen, A. (1994). Baseline anthropometry, flexibility and strength characteristics and future low-back pain in adolescent athletes and nonathletes. *Scandinavian Journal of Medicine and Science in Sports*, *4*(3), 200-205.

López-Miñarro, P. A., & Alacid, F. (2009). Influence of hamstring muscle extensibility on spinal curvatures in young athletes. *Science & Sports*, *25*(4), 188-193.

López-Miñarro, P. A., Sainz de Baranda, P., & Rodríguez-Garcia, P. L. (2009). A comparison of the sit-and-reach test and the back-saver sit-and-reach test in university students. *Journal of Sports Science & Medicine*, *8*(1), 116-122.

Mayorga-Vega, D., Merino-Marban, R., & Garcia-Romero, J. C. (in press). Validity of sit-and-reach with plantar flexion test in children aged 10-12 years. *Revista Internacional de Medicina y Ciencias de la Actividad Física y del Deporte*. Retrieved from http://cdeporte.rediris.es/revista/inpress/artvalidez602e.pdf

Mayorga-Vega, D., Merino-Marban, R., & Viciana, J. (2014). Criterion-related validity of sit-and-reach tests for estimating hamstring and lumbar extensibility: A meta-analysis. *Journal of Sports Science and Medicine*, *13*(1), 1-14.

Mayorga-Vega, D., Viciana, J., & Cocca A. (2013). Effects of a circuit training program on muscular and cardiovascular endurance and their maintenance in schoolchildren. *Journal of Human Kinetics*, *37*, 153-160.

Rancour, J., Holmes, C. F., & Cipriani, D. J. (2009). The effects of intermittent stretching following a 4-week static stretching protocol: A randomized trial. *Journal of Strength & Conditioning Research*, *23*(8), 2217-2222.

Rodríguez, P. L., Santonja, F., Canteras, M., Delgado, M., Fernández, J., & Balsalobre, J. (1999). Improvement of hamstring extensibility after school program of stretching. *Selección*, *8*(4), 157-164.

Rodríguez, P. L., Santonja, F. M., López-Miñarro, P. A., Sáinz de Baranda, P., & Yuste, J. L. (2008). Effect of physical education stretching program on sit-and-reach score in schoolchildren. *Science & Sports*, *23*(3), 170-175.

Sainz de Baranda, P., & Ayala, F. (2010). Chronic flexibility improvement after 12 week of stretching program utilizing the ACSM recommendations: Hamstring flexibility. *International Journal of Sports Medicine*, *31*(6), 389-396.

Sainz de Baranda, P., Rodríguez, P. L, Santonja, F. M., López, P. A., Andújar, P., Ferrer V., & Pastor, A. (2006). Effects of hamstring stretching exercises on the toe-touch test in elementary schoolchildren. *Journal of Human Movement Studies*, *51*(4), 277-289.

Santonja, F. M., Sainz de Baranda, P., Rodríguez, P. L., López, P. A., & Canteras, M. (2007). Effects of frequency of static stretching on straight-leg raise in elementary school children. *Journal of Sports Medicine and Physical Fitness*, *47*(3), 304-308.

Shrout, P. E., & Fleiss, J. L. (1979). Intraclass correlations: Uses in assessing rater reliability. *Psychological Bulletin*, *86*(2), 420-428.

Sjölie, A. N. (2004). Low back pain adolescents are associated with poor hip mobility and high body mass index. *Scandinavian Journal of Medicine & Science in Sports*, *14*(3), 168-175.

Standaert, C. J., & Herring, S. A. (2000). Spondylolysis: A critical review. *British Journal of Sports Medicine*, *34*(6), 415-422.

Willy, R. W., Kyle, B. A., Moore, S. A., & Chleboun, G. S. (2001). Effect of cessation and resumption of static hamstring muscle stretching on joint range of motion. *The Journal of Orthopaedic and Sports Physical Therapy*, *31*(3), 138-144.