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Original Article

Effect of sex differences in sports groups on hamstring flexibility based on the sit-reach test: new parameters for Chilean athletes

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Abstract:
Although the SR test does not satisfactorily measure lower back flexibility and is only a moderately valid measure of hamstring flexibility, it is still the only field test that is practical and easy to administer. Therefore, the aims of the study were: i) to find optimum values which would characterize the SR test for different sports; ii) to evaluate changes in SR test parameters to measure the hamstring flexibility for specific sport groups; and iii) to indicate gender-related differences in different sport groups. The sample was composed for 424 athletes, 181 male and 243 female separated in water sports (n=45), artistic performance sports (n=75), track and field (n=113), target sports (n=10), team sports (n=98), combat sports (n=35) and radical sports (n=48).All them performed the sit and reach test in three trials. Regression analysis and a two-way ANOVA followed by Bonferroni post hoc were used, $p \leq .05$. Results demonstrated significand differences between female vs. male athletes in artistic performance sports (53.5±6.2cm vs. 48.2±8.9cm), team sports (46.3±6.7cm vs. 40.9±7.7cm), combats (48.3±10cm vs. 39.9±8.2cm) and radical sports (53.5±6.6cm vs. 48.0±8.1cm); artistic performance sport and radical sports groups presented higher values of SR than track and field, target sports and team sports. Regression analysis demonstrated sex dependence in SR values of radical, combat, artistic and team sports. In conclusion, female and male Chilean athletes achieved above-average results by the standards of the sit-and-reach test for all sport group, finding new optimum values for this respective group.
Key Words: - Fitness; Health; Exercise test; Sports Medicine; Range of Motion, Articular.

Introduction

The sit and reach (SR) test is a field test used to measure hamstring and lower back flexibility of the population [1, 2], but also widely used in athletes [3]. This test is used in fitness test batteries because it is believed that maintaining hamstring and lower back flexibility may prevent acute and chronic musculoskeletal injuries and lower back problems, postural deviations, gait limitations, and risk of falling [4-6]. Many populational studies on the validity and reliability of SR test protocols have been reported, and a number have been proposed [4-6]. However, only one was found for older women in the Chilean population [2]. Moreover, to the author's knowledge, no study has conducted an epidemiological comparison between athletes from different sports. This information could give new parameters for Chilean athletes, since the normative classification of the SR test could be based on a logical analysis of sports requirements.

Authors have primarily examined the relations between the SR test and criterion measures of hamstring and lower back flexibility in students [7-9], with validity coefficients (r=.64) between the SR test and the hamstring flexibility, and lower back flexibility (r=.28). In fact, the most common assumption when interpreting SR flexibility test results is that subjects with better scores possess a higher degree of trunk and hip flexibility than those with lower scores [10]. Although SR is considered a discriminatory test, for gymnasts by competitive level [11], little is known about their own parameters, and the same incoherence happens in other sports. Since the SR test has a populational non-athlete classification, the criteria is not discriminatory for different sports demanding training (Dallas et al., 2014). For instance, wrestlers demonstrated a mean of ~38cm [12], while gymnastic athletes had higher values with ~42cm [13] and both are considered excellent.

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Although the SR test does not satisfactorily measure lower back flexibility and is only a moderately valid measure of hamstring flexibility, it is still the only field test that is practical and easy to administer. Therefore, the aims of the study were: i) to find optimum values which would characterize the SR test for different sports; ii) to evaluate changes in SR test parameters to measure the hamstring flexibility for specific sport groups; and iii) to indicate gender-related differences in different sport groups.

Material & methods

Participants

The sample was composed for 424 athletes, 181 male and 243 female separated in water sports (n=45, age = 15.8±3.43 years-old, weight = 63.9±14kg, height = 168.4±27.1 cm, and body index = 21.35± 2.98), artistic performance sports (n=75, age = 17±4.6 years-old, weight= 53.8±15.9kg, height = 161.5±11.2 cm, and body index = 20.17± 3.71), track and field (n=113, age = 20.4±4.3 years-old, weight = 64.6±10kg, height = 173.9±7.8 cm, and body index = 21.3±2.1), target sports (n=10, age = 21.6±3.6 years-old, weight = 74.2±3.5kg, height = 178.6±1.8 cm, and body index = 23.3± 1.2), team sports (n=98, age = 19.6±5 years-old, weight = 72.7±9.4kg, height = 176.1±8.5 cm, and body index = 23.4± 2.3), combat sports (n=35, age = 21.6±8.4 years-old, weight = 66±9.4kg, height = 172.2±7.9 cm, and body index = 22.3± 2.7) and radical sports (n=48, age = 23.6±8.4 years-old, weight = 69.9±5.9kg, height = 176.7±4.9 cm, and body index = 22.4±1.5). All participants had more than 3 years training and competition experience, participating in training 6 days per week, >2 hours per day.

Also, the participants were instructed not to intake alcohol or drugs for at least 24 hours before the evaluations, and were maintaining normal diets. All participants attended a briefing meeting before the experiment, and signed an informed consent document to ensure their understanding of the testing parameters and the risks and benefits associated with the study. Parental consent was obtained for athletes under 18 years of age, and the study was previously approved by the local Ethics and Research Committee. The inclusion criteria were no musculoskeletal limitations or lower back pain which would limit their performance in these tests, and that they agreed to sign a statement of informed consent. Next, the data were collected from Chilean high level athletes, between 14:00 and 18:00 with temperature ranging between 23.5 ºC and 25.5 ºC in the Biomechanics Laboratory of the Chilean High Performance Center.

Procedures

All participants performed a three min warm-up and static stretching routine before testing, emphasizing the lower body. The flexibility tests were performed immediately after the stretching. After a demonstration of the SR test, one practice trial and three test trials were performed for each of the measures, and the best value was used. Participants were reminded to exhale as they were bending forward to avoid bouncing or rapid forceful movement.

Measures

SR test

The SR test was performed using the procedures outlined in the American College of Sports Medicine manual, following preceding reports [4-6]. A standard SR box was placed on the floor by placing tape at a right angle to the 38 cm mark. The participant sat on the floor without shoes, and fully extended both legs so that the soles of the feet were flat against the end of the box. The athlete then extended his/her arms forward, placing one hand on top of the other. With palms down, they reached forward sliding their hands along the measuring scale as far as possible without bending the knee of the extended leg. The evaluators checked to ensure that the heel remained at the 45 cm mark throughout testing. Three trials were performed for each athlete.

Statistical Analysis

Descriptive data is presented as mean (X) and standard deviation (SD) values and the two-way ANOVA followed by Bonferroni post hoc compared the mean differences between gender (male vs. female) and sport groups (water vs. artistic vs. track and field vs. target vs. team vs. combat vs. radical sport). Effect size was calculated using Eta squared ($\eta 2$). Furthermore, logistic regression analysis was used to confirm the dependence of gender in each sport group on the SR values. The significance level of $p \leq .05$ was used. All analyses were conducted using SPSS 20.0 for Windows.3.

Results

Table 1 presents SR descriptive and inferential gender comparisons between sports groups.

Table 1. Descriptive and inferential sex comparisons between sports groups of SR test, cm.

Group	Female		Male		total		Sex comparisons		
	X	SD	X	SD	X	SD	t	df	p-value
water sports	47.9	7.7	45.1	9.7	46.2	9.0	.546	79	.587
artistic performance sports	53.5	6.2	48.2	8.9	51.7	7.6	2.870	79	.005
track and field	45.7	7.3	43.5	8.1	44.3	7.8	1.318	123	.190
target sports	55.0	3.7	42.1	8.8	43.4	9.2	1.341	9	.213
team sports	46.3	6.7	40.9	7.7	44.0	7.6	3.237	261	.001
combat sports	48.3	10.0	39.9	8.2	40.6	8.5	2.830	142	.005
radical sports	53.5	6.6	48.0	8.1	49.6	8.0	4.234	103	.001

A significant main effect of sport group was observed (F1, 410= 16.662; p≤.001; η2=0.039), where the artistic performance and radical sports groups presented higher values of SR than track and field (p≤.001 for the both comparisons), target sports (p≤.001 for the both comparisons), and team sports (p≤.001 for the both comparisons). A logistic regression analysis was conducted for each sport group to verify SR performance associated with gender, and is shown in Table 2.

Table 2. SR performance probability vs. sex dependence in each sport group model.

Group	Models	B	S.E.	Wald	df	p-value	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Aquatic sports	SR	.018	.033	.302	1	.582	1.018	.955	1.085
	Constant	-1.592	1.558	1.044	1	.307	.203		
Artistic performance	SR	.092	.035	6.861	1	.009	1.096	1.023	1.174
	Constant	-3.866	1.783	4.703	1	.030	.021		
Athletism	SR	.035	.027	1.698	1	.193	1.035	.983	1.091
	Constant	-2.121	1.209	3.075	1	.080	.120		
Target sports	SR	.168	.136	1.517	1	.218	1.183	.906	1.545
	Constant	-9.379	6.783	1.912	1	.167	.000		
Team sports	SR	.051	.016	9.697	1	.002	1.053	1.019	1.087
	Constant	-1.948	.735	7.019	1	.008	.143		
Combat sports	SR	.068	.025	7.318	1	.007	1.070	1.019	1.124
	Constant	-3.981	1.181	11.371	1	.001	.019		
Radical sports	SR	.142	.040	12.991	1	.000	1.153	1.067	1.246
	Constant	-8.056	1.993	16.338	1	.000	.000		

The artistic performance model demonstrated a significant impact of gender on this group (X^2=7.63, df=1, p=.006, Nagelkerke R^2=0.127) with the probability of 70% impact on SR results. The team sports model showed a significant effect of gender on this group (X^2=10.29, df=1, p≤.001, Nagelkerke R2=0.052) with probability of 58% to influence the hamstring flexibility test. Regarding the combat sports model, significant effects of gender on this group were observed in the SR test values (X^2=8.08, df=1, p=.004, Nagelkerke R^2=0.078) with a probability of 71% to influence this factor. For the radical sports model, significant effects of gender were verified in SR values (X^2=17.61, df=1, p≤.001, Nagelkerke R^2=.229) with 75% probability to impact the SR flexibility test.

Dicussion

The present study found optimum values which could characterize the SR test for different sports between Chilean athletes, evaluating SR test parameters to measure the hamstring flexibility due to the specific sport group. In addition, the results demonstrated gender-related differences in each sports group. The SR results of groups (presented in Table 1) were considered excellent within the population classification for the SR test. Table 1 also shows specific gender effect in artistic performance, team, combats and radical sports. Therefore, differences between sports were observed, in which the artistic performance and radical sports groups presented greater effects on hamstring flexibility than track and field and team sports.

Flexibility is considered by gymnasts and trainers as the most important physical capacity after strength and its various manifestations in order to be able to perform artistic gymnastic routines with the highest technical quality [14]. Artistic performance sports showed 70% gender impact, preceding articles with the SR test in artistic performance sports which indicated that the sit and reach test is a valid and reliable test which accesses the hamstrings and lower back flexibility for physically active people, however it did not prove an association with competitive performance[15]. This may be explained by the fact that rhythmic and artistic gymnasts have already acquired a high level of hamstrings and lower back flexibility, and the sit and reach test is not sensitive to detect changes in hip flexibility associated with complex types of movement.

To the author's knowledge, this is the first time that a study with team sports demonstrated ~60% of significant gender dependence in hamstring flexibility. Even though the SR tests of the team sports group were worse than the other sports groups in the present study, they were considered excellent compared with the standard classification. When using the tests to check the athletes' flexibility, it is important to be aware of the complexity of team sport motor abilities [16]. A limitation of the present article is the fact that the specific role of the players on the team can influence the player's flexibility. For instance, in soccer the midfielders often have to run backwards , and so they were more successful in the SR test than the players in other positions (defenders and attackers) in having had to adapt to a specific positional task [17].

The present study has other limitations; the first is the influence of personal and environmental factors in hamstring flexibility. Longitudinal studies are necessary in ascertaining the long-term effects of sport training in flexibility. Future studies are necessary to test the sit reach test related with the time of specific sports training. Another limitation was the selected sample size , as it was a non-random sample and analysis of only high level

athletes limits the ability to make definitive conclusions on a causal relationship between sports groups and the SR values. A prospective study with a large sample size is necessary to further clarify this potential causal relationship.

The SR is often administered under the assumption that it gives a composite accounting of lumbar and hamstring flexibility. From the 34 studies included in a preceding meta-analysis, 99 correlational values across eight SR tests and 51 across seven SR tests were retrieved for hamstring and lumbar extensibility, respectively [18]. The overall results showed that all sit-and-reach tests had a moderate mean criterion-related validity for estimating hamstring flexibility (rp = 0.46-0.67), but they had a low mean for estimating lumbar extensibility (rp = 0.16-0.35) [18]. Generally, women, adults and participants with high levels of hamstring flexibility tended to have greater mean values of the criterion related validity for estimating hamstring flexibility. When the use of angular tests is limited such as in a school setting or in large scale studies, scientists and practitioners could use the SR test as a useful alternative for hamstring flexibility estimation, but not for estimating lumbar flexibility [18].

Concerning radical sports, preceding reports indicated that ~6% on the flexibility performance changes during a weeklong high-altitude alpine ski-racing training camp in young athletes [19]. The present findings support this statement with significantly better results of radical sports than team and track and field sports. In addition, our results demonstrated an increase to 75% gender dependence in radical sports. Moreover, combat sports also demonstrated 71% gender dependence on hamstring flexibility, while general Chilean high level athletes demonstrated higher SR values in combat sports than preceding studies with male mixed martial arts athletes with ~30cm [20, 21] and similar results of male grappling athletes, with ~35cm [22], while female Croatian taekwondo athletes demonstrated higher values of ~56cm [23]. Lower limb flexibility allows athletes to kick higher, which is needed for scoring higher points in taekwondo [24]. The present study demonstrated excellent general SR results for combat sports. Preceding authors on tai chi practitioners found that there were improvements in upper and lower body flexibility, balancing, upper and lower body muscular strength, and endurance after 12 weeks of training in older Chinese adults [25].

Conclusions

The goal of the present study was to verify the greatest values that would characterize the SR test for high level Chilean athletes in different sports, an evaluation of SR test parameters to measure the hamstring flexibility due to the specific sport group, and at the same time it indicated the gender-related dependence and differences of each sports group. Artistic sports and radical sports demonstrated greater effect on flexibility than track and field, target sports and team sports. This sports-type effect is interesting for people interested in improving flexibility. In addition, the regression analysis suggested an increased impact in SR values of 58% to 75% in the female group of artistic, team, combat and radical sports, which must be considered in practical applications of exercises or contextual tests.

Conflicts of interest - none.

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