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ACUTE EFFECT OF ACTIVE STRETCH EXERCISES ON AGILITY AND STRENGTH IN 10 TO 14-YEAR-OLDS CHILDREN A RANDOMIZED STUDY

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ABSTRACT

The current literature still debates on which type of settings stretching exercises can promote detrimental effects on other physical capacities. Such effects seem to be related to several factors which requires researchers to verify such influences in terms of each specific context. As indoor soccer requires a mix of physical capacities, we studied the influence of static stretching in indoor football players. This manuscript addressed the acute effects of static stretching exercises (SSE) on muscle power and agility of 10 to 14-year-olds children practicing indoor soccer. This study is a randomized controlled clinical trial. Forty-six children, participant of a futsal training program, performed pre- and post-tests on horizontal jumping – measuring muscle power – and the shuttle run test – measuring agility – separated by no exercise (control group, CG) or SSE (experimental group – GE). The results pointed out a detrimental effect on the horizontal jumping but not on the shuttle run test – which showed a slight improvement. Considering the effect on the shuttle run to be a familiarization effect, we then observed effects of stretching on muscle power but not agility. As our sample is composed of trained individuals – and following similar results in the literature – we discussed these results in terms behavioral mechanisms that avoid detrimental effects of SSE provided training. SSE is detrimental to muscle power but not to agility in young trained individuals of indoor soccer. These results were interpreted in terms of potential mechanisms that training afford to individuals. Namely, compensatory behavioral strategies to maintain performance.

Key words: Futsal. Static stretch. Coordination.

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RESUMO

Efeito agudo dos exercícios ativos de alongamento na agilidade e força em crianças de 10 a 14 anos um estudo randomizado

A literatura atual ainda debate sobre quais tipos de configurações de exercícios de alongamento podem promover efeitos prejudiciais sobre outras capacidades físicas. Como o futebol de salão requer uma mistura de capacidades físicas, estudamos a influência do alongamento estático em jogadores de futsal. Este manuscrito abordou os efeitos agudos dos exercícios de alongamento estático (EAE) sobre a força muscular e a agilidade de crianças de 10 a 14 anos praticantes de futsal. Este estudo é um ensaio clínico randomizado controlado. Quarenta e seis crianças, participantes de um programa de treinamento de futsal, realizaram pré e pós-testes de salto horizontal - medindo a força muscular - e o teste de corrida - medindo agilidade - separados por nenhum exercício (grupo controle, GC) ou grupo experimental (GE). Os resultados apontaram um efeito negativo no salto horizontal, mas não no teste de corrida - que mostrou uma leve melhora. Considerando o efeito do Teste *Sutle Run* como um efeito de familiarização, observamos os efeitos do alongamento na força muscular, mas não na agilidade. Como nossa amostra é composta por indivíduos treinados - e seguindo resultados semelhantes na literatura - discutimos esses resultados em termos de mecanismos comportamentais que evitam os efeitos prejudiciais do exercício de alongamento estático provindo do treinamento. O exercício de alongamento muscular é prejudicial a força muscular, mas não à agilidade em jovens treinados de futebol de salão. Esses resultados foram interpretados em termos de mecanismos potenciais que o treinamento proporciona aos indivíduos. Ou seja, estratégias comportamentais compensatórias para manter o desempenho.

Palavras-chave: Futsal. Alongamento estático. Coordenação.

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INTRODUCTION

Training routines for young players must be precisely timed and spaced to match with children schedule (school, leisure, etc.), maintain motivation, improve technical skills and physical capacities.

Thus, the coach must be more than time manager, he/she must understand the possibility of interference between capacities being trained: e.g., it is recognized that training flexibility has detrimental effects on strength. Nevertheless, the full spectrum of interferences between capacities is not fully described: i.e., does flexibility affects agility? By considering a specific sport (i.e., futsal), the present research note aims to test whether such interference occurs.

Futsal is a collective sport, similar to football, that involves attack and defense by the whole group of players, characterized by repetitive actions in fast pace in small spaces. There are fast directional changes accompanied by bouts of acceleration and deceleration favoring athletes with higher agility and muscle power (Leite, 2012).

The particularities of the training schedule must emphasize such capacities. Additionally, it is accepted that increased range of motion is helpful both for high performance and injury prevention (Cross and Worrell, 1999; Magnusson et al., 1996; Hartig and Henderson, 1999).

As it is presented, training schedule for early athletes must emphasize at least flexibility, agility and muscle power. Within the class of stretching exercises that result in improved flexibility, the static stretch exercise (SSE) is quite popular given easiness on applicability, teaching and efficacy (Kubo et al., 2001).

Nevertheless, recent studies have shown that SSE might be detrimental to other capacities (Rubini et al., 2007), specially on strength (Behn and Chaouachi, 2011).

The problem occurs when we consider that one of the main aspects of strength is muscle power (the other two are raw muscle force and force resistance). If muscle power is affected by SSE, then training schedule must be modified to avoid interference.

Provided the possible effects on muscle power, the influence of SSE on behavior must be also assessed for agility. Agility reflects the capacity to move and act in the environment in a fast pace – being able to move and change directions (with the whole body) in a small-time frame.

Although not specifically defined in physiological terms, as strength and muscle power, agility is highly dependent on the contribution of these underlying capacities and, thus, can be highly influenced by SSE.

On the other hand, provided agility is also dependent on skill and training, compensatory mechanisms (Latash et al., 2002) might alleviate any detrimental effect.

Previous studies have provided evidence of the effect of SSE on both muscle power and agility, but a consensus is hard to achieve.

Several factors can influence the effect of flexibility on other physical capacities: age (Chatzopoulos et al., (2014); Handriks et al., 2010), sex (Dalrymple et al., 2010), duration of stimulus (Kay and Blazevich, 2012), intensity of the stimulus (Behn and Kibele, 2007; Sheppard and Young, 2006), time between stimulus and subsequent activity, level of training of the athlete (Chaouachi et al., 2010), and, clearly, the physical capacity affected.

Provided the enormity of possibilities that can occur, a solution seems to select routines commonly applied to the context of the sport and investigate whether, in this situation, the interference is present and, thus, discuss the aspects that must be changed if that is the case.

Therefore, the present study tested the effect of SSE on muscle power and agility on 10 to 14-year-old children.

The tests to infer about muscle power and agility were selected in order to preserve the usual tests utilized within the futsal training program.

Our expectations are that SSE will decrease both muscle power and agility, with a decreased influence on the latter.

MATERIALS AND METHOD

Participants

Forty-six children participated in the study (10 to 14 years of age; all male). The sample was selected randomly from a group of futsal practitioners in a sports project.

The inclusion criteria were to be within the age group (from 10 to 14 years of age) and report no bone, muscular or joint limitation that would disallow participation.

The research was approved by the Institutional Review Board of Federação

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Universidade Federal de Rondônia under the opinion of number: 1.546.805. The children were randomly allocated in two groups: experimental (GE, n = 23) and control (GC, n = 23).

Procedures and Apparatus

Before the tests, children had their anthropometric measures taken. Each group was tested separately in different days. For GE, agility and muscle power were tested before and after a 12-minute period of SSE.

GC was tested before and after a 12-minute period of no activity. For organizational purposes, within each group, sub-sets of five children performed each part (pre-tests, intervention and post-tests) before another five start. Both groups also were evaluated in terms of their flexibility before the testing. All measurements were performed by the same group of experimenters (physical education professionals).

The anthropometric measurement (height and body mass) was based on the International Standards for Anthropometric Assessment protocol (Marfell-Jones et al., 2012).

We used a portable stadiometer (EST 22®; range: 0.3 to 2 m; resolution: 0.001 m), a mechanical weighing-machine (Filizola®, mod. 31; resolution: 100 g; maximum capacity: 150 kg); and anthropometric tape (CESCORF®).

The body fat percentage was calculated based on Slaughter et al., (1988): %BF=0.735*(T+S), where %BF is body fat percentage and T and S represent triceps and subscapular skinfold measurements.

The agility test was measured through the Shuttle Run test (Jonhson and Nelson, 1979). The test requires the participant to run back and forth two times bringing a small piece of wood from one end to another each time it runs back to the starting point.

This should be done as fast as possible. For this, the experimenter tape two lines 9.14 m apart on the floor and place two small wood blocks of 5 x 5 x 10 cm separated by a 30-cm distance at 10 cm of the end line. The test starts after a beep sound and the performance on the test is measured through the time that the participant places the second wood piece on the floor at the starting line. The test was performed in a cemented court. All participants were familiarized with the test procedure one week before the data collection.

To test muscle power of lower limbs, we employed the horizontal jump test, used in children and adolescent given it requires no training and has high reproducibility (Guedes and Guedes, 2006).

The test measures the distance that the participant achieved in jumping forward from a static position. The participant starts with both feet side-by-side (hip aperture), knees slightly flexed and trunk slightly inclined forward.

From this position, the participant jumps as far as he/she can. The measurement considers the distance from the starting point to the position that the closest heel landed. Each individual had two trials with the best score being considered for analyses.

To test flexibility, we used the sit and reach test (Guedes and Guedes, 2006). The test measures the distance forward reached by the hands when sitting on the floor with both legs extended. The participants were instructed to neither flex the knees nor swing during the reach. Each participant had two trials and the best of the measures was used for analyses.

Finally, the GE intervention was designed in the following way. GE performed 12 minutes of three static stretch exercises for lower limbs.

Following the (American College Sport of Medicine-ACSM, 2009), each exercise had 4 series of 30 seconds of stretch and 30 seconds of interval between each series. The exercises were, in the same order as presented in Figure 1: a) hamstring stretch with both legs extended and together, b) quadriceps stretch standing, and c) hamstring stretch with both legs extended and separated.

The intensity of the exercises was controlled by instruction. The participants were instructed to move to the required position slowly achieving a position with slight feeling of discomfort. The position was maintained up to the moment that the experimenter provided verbal instruction to stop.

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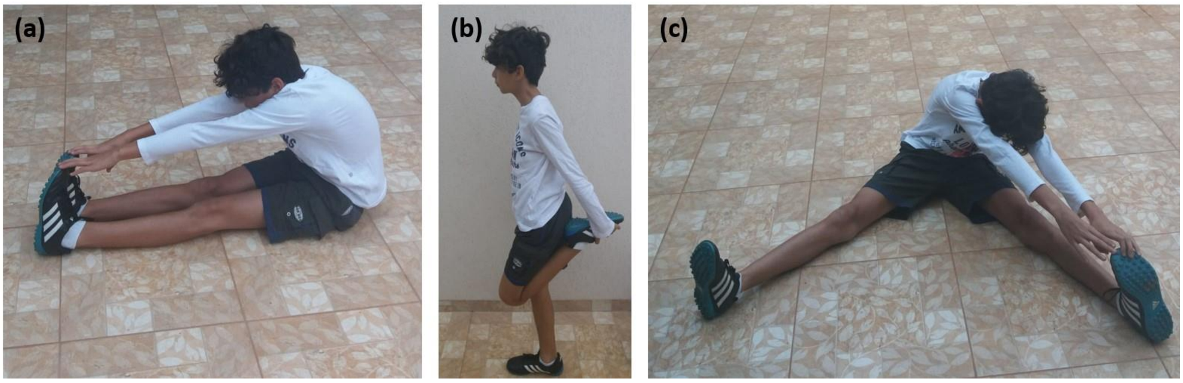

Legend: a) hamstring stretch with both legs extended and together, b) quadriceps stretch standing, and c) hamstring stretch with both legs extended and separated.
Figure 1 - The three static stretching exercises performed by the experimental group (GE).

Data Analysis

All statistical analyses were performed in SPSS 21.0. For both muscle power and agility tests, we performed a two-way ANCOVA with pre- and post-test as repeated measures and groups as between-subject measure.

We included body fat percentage, age and flexibility measures as covariates. The inclusion of covariates was to control the analysis for anthropometry, experience and physical capacity. In case of significant interaction between measures, post hoc analyses were performed using the Bonferroni correction. Significance was considered for $p < .050$.

RESULTS

Table 1 shows the descriptive statistics for both groups. For the maximum power test, the ANCOVA revealed significant main effects for age ($F_{1,41} = 14.41$, $p < .001$, $\eta_p^2 = .26$), and significant interactions between tests and body fat ($F_{1,41} = 7.04$, $p = .011$, $\eta_p^2 = 0.15$) and between tests and groups ($F_{1,41} = 5.87$, $p = .020$, $\eta_p^2 = 0.13$).

The age main effect reflects the fact that older kids jumped farther, as it would be expected. The between tests and body fat interaction indicated that those with lower body fat percentage changed less from pre- to post-test than those with high body fat percentage.

More importantly, we found a decrease in jump distance for the GE group from pre- to post-test ($p = .010$). This result – although with low effect size - corroborate with the expectation that SSE do influence in the demonstrated muscle power.

For the agility test, the ANCOVA revealed main effects for tests ($F_{1,41} = 6.45$, $p = .015$, $\eta_p^2 = .14$), for groups ($F_{1,41} = 5.41$, $p = .016$, $\eta_p^2 = 0.13$), and a significant interaction between tests and age ($F_{1,41} = 8.37$, $p = .006$, $\eta_p^2 = 0.17$).

These results reflect the fact that GE showed a higher agility at first, both groups improved from pre- to post-test and that older kids demonstrated a higher improvement from pre- to post-tests.

Table 1- Sample Characteristics as a function of groups.

Variables	GE (n = 23) $\bar{x}$ (±σ)	GC (n = 23) $\bar{x}$ (±σ)
Age (years)	12.20 (± 1.34)	11.57 (± 1.40)
Weight (kg)	40.70 (± 11.80)	40.40 (± 9.29)
Height (m)	1.55 (± 0.12)	1.50 (± 0.10)
Flexibility (cm)	32.30 (± 8.12)	31.70 (± 8.90)
% Body Fat	14.40 (± 6.50)	15.30 (± 5.70)
BMI	16.70 (± 4.00)	17.60 (± 2.80)

Legend: GE: Experimental group; GC: Control group; BMI: body mass index; $\bar{x}$: mean; σ: standard deviation.

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DISCUSSION

In this study, we investigated the effect of static stretch exercises on muscle power and agility on 10- to 14-years-old futsal players. Provided the contradictory findings in the literature, we decided to employ tests that are directly linked (and highly used) to the sport using the common settings of a typical training session.

Our results provided detrimental effects on muscle power but not on agility tests. We discuss these results in terms of the factors that could intervene in this effect.

The literature relating SSE with muscle power tends to demonstrate detrimental effects of SSE (Behn and Chaouachi, 2011; Yamaguchi et al., 2006a; Yamaguchi et al., 2006b).

For instance, Hough et al., (2009) showed decreased performance for SSE (when compared to dynamic stretching and no-stretching) on vertical jump performance. Clearly, some studies fail to demonstrate that (Dalrymple et al., 2010).

This seems to be more established when the time of stretching is around 30 to 60 seconds (Behn and Chaouachi, 2011) – similar to what was performed here. Note that our effect size was 0.13 – much lower than the 0.43 effect pointed out in the review (Behn and Chaouachi, 2011).

The explanation could be the fact that our sample was “trained”, which might have favored a lower influence of SSE (Dalrymple et al., 2010; Egan et al., 2006; Unick et al., 2005).

The literature on the effect of SSE on agility tends to be contradictory. We can find results that point to a detrimental effect (Chaouachi et al., 2010; Mohammadtaghi et al., 2010) no effect (Avloniti et al., 2016; Chatzopoulos et al., 2014; Van-Gelder and Bartz, 2011) or even improvements (McMillian et al., 2006).

These studies employed a spectrum of ages from 17 to early 20’s, both sexes, athletes (in general), varied number of SSE (5 to 10), with 30 s (on average) per exercise. It is interesting to note that we could not differentiate the studies in terms of these measures – the same 30s of exercise led to detriment or not.

It turns hard to find a simple explanation for the differences from our study to part of the literature. The only clear difference from our study is the sample - we had younger participants.

Note, however, that most of studies did not lead to differences – which corroborate to our study. Although we expected a negative effect – which did not occur, we were correct in saying that the detrimental effect was lower than for muscle power. The positive effect could have occurred for due to a warm-up decrement effect (Adams, 1961).

Ruling out a possible lack of influence of the SSE on muscle output (provided the effect for muscle power), we believe that there is, somehow, and effect of compensation. First, we argued that agility has a strong component of motor coordination and control that could compensate for deficits induced by SSE.

These compensations have been discussed in the motor behaviour literature to counteract the effect of, for instance, higher loads (Qu, 2012). It could clearly be the case that athletes do know how to utilize such possibility to eliminate the SSE induced deficits.

Note that the agility test is more practiced within the usual game of futsal rather than the horizontal jump. That is, large percentage of the game involves fast changes in direction. This would offer training on the capacity to maintain agility in situations such as the one in that the body is already fatigued or in pain because of hits and faults during the game. SSE deficits would be just another perturbation to the athlete to compensate. This matches to our results that related age to improvement. Older kids practiced futsal for a longer period and are better suited to demonstrate better results.

The compensation argument might also explain the small effect size on muscle power. In considering the test applied, a large role of coordination can be speculated. Indeed, the horizontal jump is utilized to characterize gross movement development in children (Ulrich, 2000), implying a large “motor” component on the skill and possibilities for compensation. We are now considering applying tests that refer to kicking (e.g., velocity of the ball) to expand our consideration on muscle power. The literature, however, have not taken the issue of motor coordination into account when studying SSE effects. It seems fruitful to pursue that route.

Nevertheless, the results on agility might be adaptations at a physiological, rather than behavioral level. Authors argue that athletes that have SSE included in their

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training sessions develop a stretch tolerance (Egan et al., 2006; Unick et al., 2005).

An example of this would be Chaouachi et al., (2008), who found that, with training, 13 to 15-year-old kids decreased the induced deficit of SSE on sprinting.

Although they promote a possible stretch-tolerance explanation, they argue that if stretch modified muscle compliance, the large compliance (resultant from SSE) could allow efficient energy storage and, thus, would have provided a better performance.

The same effect would create issues for situations - or training level - on which longer contact times on the ground is counterproductive (Behn and Chaouachi 2011).

However, these explanations do not fit our findings on muscle power provided that energy stored would benefit our horizontal jumping test as well (Silva Filho et al., 2017).

CONCLUSION

In conclusion, we found that adolescents from 10 to 14 years of age showed a detrimental effect of SSE on muscle power (horizontal jump test) but not on agility. We argued that the training would lead to compensatory mechanisms at the motor coordination level decreasing the effects on agility.

Considering the discussion on the training schedule, coaches might need to consider whether he/she wants to induce (or train) compensatory mechanisms to employ SSE before training and games. Another consideration is to modify the time of stretching to avoid detrimental effects in muscle power output.

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