Original Article

Dynamic exercise versus tag game warm up: the acute effect on agility and vertical jump in children

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ABSTRACT

Coledam DHC, Paludo AC, Oliveira AR, Dos-Santos JW. Dynamic exercise versus tag game warm up: the acute effect on agility and vertical jump in children. *J. Hum. Sport Exerc.* Vol. 7, No. 1, pp. 243-253, 2012. Although dynamic and stretching exercises have been widely investigated, there is little information about warm up performed by tag games. Thus, the purpose of the present study was to verify the acute effect of dynamic exercises compared to a tag game warm up on agility and vertical jump in children. 25 boys and 24 girls participated in this study and performed the agility and vertical jump tests after warm up based on dynamic exercises or as a tag game lasting 10 min each in two different days randomly. Dynamic exercises warm up consisted in a run lasting 2.5 min followed by 2 series of 8 dynamic exercises lasting 10 seconds each interspersed with 20s of light run to recovery. Tag game warm up was performed by a tag game with two variations lasting 5 min each. The first variation there was a single cather, which aimed to get the other participants by touching hands. In the second part of the game, the rules were the same except that the participant that was caught had to help the catcher forming a team of catchers. Warm up intensity was monitored by OMNI perceived exertion scale. ANOVA 2x2 for repeated measures (Warm up x Sex) demonstrated no significant differences between dynamic exercises and tag game for agility and vertical jump (P>0.05) for boys and girls. Perceived exertion was significantly higher in tag game compared to dynamic exercises on girls (P<0.05). Both warm up models showed similar acute effects on agility and vertical jump in children. **Key words**: MOTOR PERFORMANCE, PHYSICAL FITNESS, PRE ACTIVITY.

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INTRODUCTION

Warm up is a very common practice prior to the school physical education classes, training sessions and competitions in children. The main objectives of the warm up are to prevent musculoskeletal injuries and increase subsequent performance (Bishop, 2003). Warm ups models based on dynamic exercises (Duncan & Woodfield, 2006; Faigenbaum et al., 2006a, 2006b; Gelen, 2011), running (Coledam et al., 2009), jumps (Faigenbaum et al., 2005) and dynamic stretching exercises (Needham et al., 2009), improve the performance of agility, vertical jump and other motor tests in children and adolescents.

Warm up based on dynamic exercises have better effect compared to walking (Duncan & Woodfield, 2006; Faigenbaum et al., 2005), running (Gelen, 2011), or running when performed prior to static stretching (Needham et al., 2009). In addition, dynamic exercises, when performed at the end of warm up, can reverse the negative effect caused by the execution of static stretching (Faigenbaum et al., 2006a; Taylor et al., 2009). Thus, dynamic exercise is a model of warm up efficient to increase the acute motor performance of children and adolescents.

Recently, ball games have been used as a strategy for warm up in different sports. Small sided soccer game increases the performance of long jump (Coledam & Dos-Santos, 2010) and has a similar effect compared to dynamic exercise on the agility with and without ball (Coledam & Dos-Santos, 2011) in children soccer practitioners. In addition, the effects of warm up with specific exercises and games of basketball on the agility, vertical jump and speed do not differ from warm up with dynamic exercises in adolescents (Gabbet et al., 2008).

Warm-up based on games are widely used by sports teams because are similar to actions taken during training and competitions. On the other hand, in school physical education classes warm up is carry out based on fun games, such as tag games (Braga et al., 2006; Kovács et al., 2009), which there is one or more “catchers” for a group of participants. This game allows the participation of all students and is motivating for children, resulting in a higher number of movements during warm up.

Despite warm up based on tag game be a common practice in physical education classes, there are no studies in the literature reporting the acute effect of this type of game on motor tasks in children. Thus, the objective of this study was to verify the acute effect of warm up based on dynamic exercises compared with a tag game on agility and vertical jump in children.

MATERIAL AND METHODS

Sample

Voluntarily participated in the study 49 children (25 boys and 24 girls) regularly enrolled in the fifth year of an elementary school from Nova Europa, São Paulo, Brazil. The sample was selected intentionally and all participants attending regular school physical education classes twice a week for 50 min each class. The inclusion criteria adopted was not having any restrictions that would prevent the performance of warm ups and motor tests. The research project was approved by an ethics committee and research of the Universidade Estadual Paulista - UNESP (Protocol number 11018/46/01/10) and parents or guardians of participants signed a term of informed consent after being informed of the objectives and procedures of the study.

Procedures

All study procedures were carried out at the school where the students were enrolled. Anthropometric measurements were taken of body mass, using a digital scale with 100g precision, and height using a portable stadiometer fixed on a wall with an accuracy of 0.1 cm. Students were divided into two mixed groups randomized and balanced by gender (Group 1 = 12 boys and 12 girls, Group 2 = 13 boys and 12 girls) who performed agility and vertical jump tests after dynamic exercises or tag game warm ups randomly on two different days. The best of three attempts in each test was considered for the analysis of results. The group 1 performed dynamic exercises warm up and agility test in the first test day, tag game warm up and agility test in the second test day. Conversely, the group 2 performed on the first day tag game warm up and agility test and the dynamic exercises warm up and agility test on the second day. The same order was performed for the vertical jump test (Figure 1), with only one test performed per day in each group. It maintained a 48 h interval between each test day.

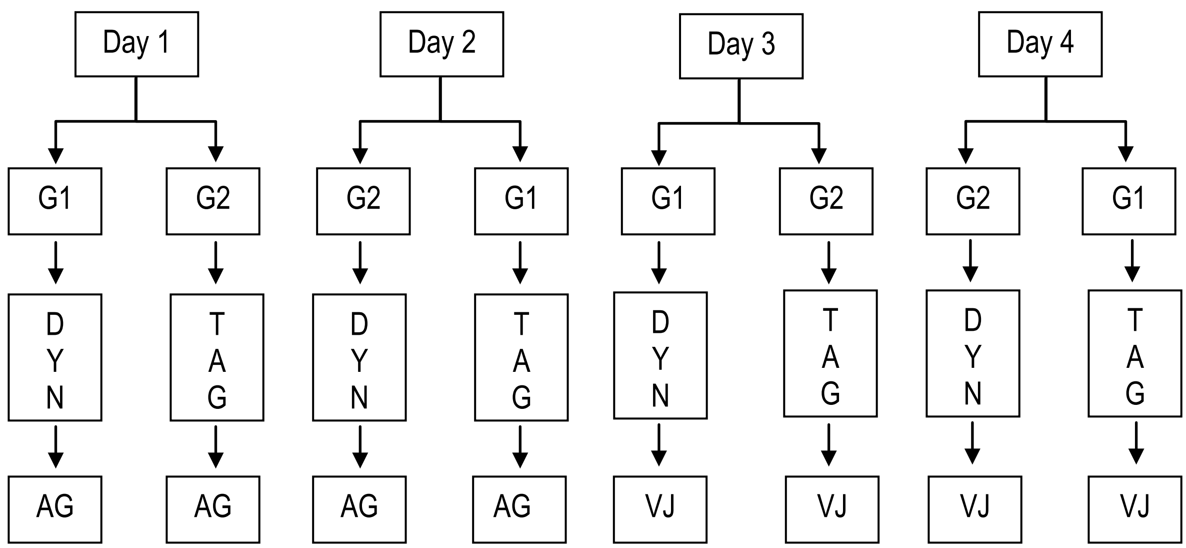

Figure 1. *Study design of the four days (Day 1 - 4) in groups 1 and 2 (G1 and G2). Dynamic exercise warm up (DYN), "Tag game" warm up (TAG), agility test (AG) and vertical jump test (VJ).*

Before the beginning of data collection, participants were informed about the procedures of the study and observed one researcher demonstrate the standardization of agility and vertical jump tests and received instructions of the perceived exertion scale. After that on the same day, the participants performed the two models of warm up and three trials of both tests for learning.

All study procedures were performed by the same researcher, the participants wore clothes for physical education classes (shirt, shorts and sneakers) and did not performed any physical effort prior to data collection. The procedures for data collection were performed in the same sports field, used in classes. Data collection was done between 9 and 10 am and the study lasted 3 weeks. The ambient temperature was monitored during the days of data collection by a Portable digital thermometer (Incoterm®, Porto Alegre, Brazil), with accurate of 0.1°C. The average temperature in the days of assessment was 22.8° C with 5% variation between days.

Warm ups

The duration of dynamic exercises and tag game warm ups were 10 min. Agility and vertical jump tests were performed 3 min after the end of each warm up.

Dynamic exercises warm up: Dynamic exercises warm up used in this study is similar to others previously described, which demonstrated to be effective in increasing the subsequent motor performance (Faigenbaum et al., 2010). Dynamic exercises warm up consisted in a run in low intensity (jogging) lasting 2.5 min followed by 2 sets of 8 dynamic exercise lasting 10s each, interspersed with 20 s of running at low intensity for the recovery. Dynamic exercises used are described according to the order of execution in Table 1.

Table 1. *Description of the dynamic exercises warm up.*

1. Moving sideways forward: rapidly moving forward diagonally, alternating the direction (left and right) every two steps.
2. Moving sideways backward: rapidly moving backward, diagonally, alternating the direction (left and right) every two steps.
3. High Knee Lift: moving forward, bringing your knees alternately to the waist level.
4. Anfersen: moving forward, flexing the knees and elevating the heels at the gluteus.
5. Low kick forward: moving forward alternately kicking in front, with the leg extended.
6. Low kick backward: moving forward alternately kicking in back, with the leg extended.
7. *Skipping*: running with emphasis on knees flexion alternately and rapidly.
8. Hopserlauf: jumping forward by impulse on one foot only and elevating the knees at the waist level.

Tag game warm up: Tag game warm up was performed using a tag game with two variations, which are traditionally used in physical education classes (Braga et al., 2006; Kovács et al., 2009). The duration of tag game warm up was 10 min, divided into two sets of games with 5 min each. The playing area was enclosed in 24 x 15m. In the first part of the warm up, the game had a single "cather", which aimed to get the other students by touching hands. If one participant was caught, it became the catcher. In the second part of the game, the rules were the same except that the participant that was caught had to help the catcher forming a team of catchers. If all players were caught before the end of 5 min, the game restarted with a new catcher to complete 5 min.

Measurement

Vertical jump Test: A tape measure with an accuracy of 1 mm (Profield®, São Paulo, Brazil) was set at a wall for the vertical jump test. The participant was positioned laterally at the graded surface, with the soles of feet flat on the ground, one arm fully extended above the head, where it was marked the highest point reached with the middle finger. To facilitate the marking was used chalk dust on the fingertips. From the standing position, the execution was to flex the knees and perform a countermovement jump with arms movement, and touch the highest point possible on the wall. The appointment was made with an accuracy of 0.5 cm. The value was calculated by subtracting the greatest height reached performing the jump and the measure without jump, with the values expressed in centimeter. Vertical jump test has a high reproducibility as described previously r = 0.93 (Faigenbaum et al., 2010).

Agility test: The agility test used was the Shuttle run agility test, which consists of running the distance of 9.14 m going back and forth two times (4 x 9.14 m) in the shortest time possible. The participant should seek two blocks, one at a time, which was 9.14 m from the line of departure / arrival (Johnson & Nelson, 1979). For the measurement we used a stopwatch Casio® with tenth of a second precision. The agility test has high reproducibility r = 0.90 (Coledam & Dos-Santos, 2011).

Warm up intensity: Warm up intensity was determined by the perceived exertion (PE) scale obtained by OMNI (running and walking) validated for children (Robertson et al., 2000), 15 min after the end of warm up.

Statistical analysis

The sample size was calculated based on results of previous studies with similar sample used in this study. It was considered the mean difference of 0.82 and 3.2, standard deviation 0.62 and 4.0 for AG (Coledam & Dos-Santos, 2011) and IV (Duncan & Woodfield, 2006) respectively. The calculation was performed using the program G * Power 3.0 (Faul et al., 2007), adopting a significance of 5% and power = 80%. The normality of data was assessed by the Shapiro Wilk test and Sphericity of the data was checked by Mauchly's test. Since the assumption of normality and Sphericity was accepted, the characteristics of boys and girls were compared using the Student t-test for independent samples and analysis of the results of agility and vertical jump was performed by ANOVA - analysis of variance for repeated measures with warm ups (Dynamic exercises and tag game) and sex (boys and girls) as independent variables and agility and vertical jump tests as dependent variables. To analyze the perceived exertion was used the Friedman test and Wilcoxon test as post hoc. The results of the agility and vertical jump are presented as mean and standard deviation values and the perceived exertion are presented as median and interquartile range. In all cases we adopted the 5% significance.

RESULTS

The anthropometric characteristics are presented in Table 2. There were no significant differences for the variables analyzed, according to sex (P> 0.05).

Table 2. *Characteristics of the sample expressed as mean (standard deviation).*

Variable	Boys n=25	Girls n=24
Age (y)	9.2 (0.7)	9.4 (0.7)
Height (cm)	133.0 (9.0)	132.0 (6.0)
Body mass (kg)	32.0 (5.6)	33.1 (8.1)
BMI (kg/m^2)	18.1 (1.8)	18.9 (3.8)

The results of agility and vertical jump tests after the dynamic exercise and tag game warm up are presented in Table 3. No significant differences were observed for agility and vertical jump tests after tag game compared to dynamic exercises warm up for both sexes (P>0.05).

Table 3. *Results of agility (AG) and vertical jump (VJ) tests after dynamic exercises (DYN) and tag game (TAG) warm ups of boys and girls.*

		DYN	TAG
AG (s)	Boys (n=25)	10.86 (0.67)* †	10.81 (0.58)* †
	Girls (n=24)	11.67 (0.74)	11.59 (0.75)
VJ(cm)	Boys (n=25)	28.10 (4.89)	28.30 (5.31)
	Girls (n=24)	25.40 (5.72)	25.54 (5.55)

Note. P<0.01 vs. DYN girls and † P<0.01 vs. TAG girls in agility test.

Table 4 presents the results of the perceived exertion after dynamic exercises and tag game warm ups. There was verified significant difference in perceived exertion between the two warm up models only for the girls. Furthermore, the response of perceived exertion in the dynamic exercises and tag game warm ups for boys were significantly higher compared to dynamic exercises in girls.

Table 4. *Perceived exertion after dynamic exercise (DYN) and Tag game (TAG) warm ups, expressed as median and interquartile range of boys and girls.*

	DYN	TAG
Boys (n=25)	5 (5-7)*	7 (5-7)*
Girls (n=24)	4 (3-5)	6 (5-9)*

*Note. Values expressed in arbitrary units. *P<0.05 vs. DYN girls.*

DISCUSSION

The aim of this study was to verify the acute effect of warm up based on dynamic exercises compared with tag game on the agility and vertical jump in children. The main finding was that there was no significant difference in tests of agility and vertical jump after the tag game compared to dynamic exercise warm up in children of both sexes.

Warm-up based on dynamic exercises improves the performance of agility, vertical jump and long jump compared to static stretching in children and adolescents (Duncan & Woodfield, 2006; Faigenbaum et al., 2005; Faigenbaum et al., 2006[a], 2006b; Faigenbaum et al., 2010; Gelen, 2011). In addition to dynamic exercises, running also increases the performance of the vertical jump and agility of adolescent soccer athletes (Coledam et al., 2009). Similar to results with dynamic exercises and running, the tag game used in this study can be use as warm up since there were no significant differences between agility and vertical jump tests compared to dynamic exercise warm up.

There are few studies demonstrating the effect of warm up based on games on agility and vertical jump in children. The warm up model that is generally used in studies are specific to sports (Coledam & dos-Santos, 2010, 2011; Gabbet et al., 2008) differently of the present study which used a recreational game. Warm ups models based on small sided games have a similar effect to dynamic exercises on agility, vertical jump and speed in basketball (Gabbet et al., 2008) and agility in soccer (Coledam & dos-Santos, 2011, 2010) in children and adolescents.

Despite the different characteristics between warm up based on games, sport or recreational, with or without the ball, both warm up models have similar effects compared dynamic exercise warm up on performance in motor tasks, such as agility and vertical jump tests in children. However, the specificity of motor task should be considered when choosing a warm up model. Warm up in sports, for example, must provide situations similar to those required during the game or training. From the standpoint of sensory-motor the performance of a specific warm-up can provide the readjustment of the precision of fine movements which is decreased during the time that are performed only rudimentary movements between the last training session and competition (Ajemian et al., 2010).

The intensity is a parameter that also influences the warm up effect since the warm up performed at high intensity decrease the subsequent performance due to the early onset of fatigue (Stewart & Sleivert 1998; Tomaras & Macintosh, 2011). In studies that investigated the warm up intensity observed an increase of agility and vertical jump performance at intensities between 57 and 72% HRmax (Coledam & dos-Santos 2010, 2011; Coledam et al., 2009; Faigenbaum et al., 2005), activities classified as low to moderate intensity (Position Stand of the American College of Sports Medicine, 2011).

In the present study, the intensity was monitored by the perceived exertion, with median values of 5-7 for boys and 4-6 a.u. for girls in dynamic exercise and tag game warm ups respectively. In two previous studies it was found that heart hate in children during walking and running in arbitrary units 4, 5, 6 and 7 of the OMNI scale of perceived exertion were 60.9, 69, 76 and 83% of HRmax respectively (Rutkowski et al., 2004; Utter et al., 2002). Thus, possibly dynamic exercises warm up was performed at moderate intensity and tag game warm up at high intensity for boys and girls (American College of Sports Medicine, 2011).

Although the perceived exertion does not present significant difference between the two models of warm up in boys, the perceived exertion for tag game was significantly higher in girls compared to dynamic exercise warm up. Tag game up demands intermittent runs in high intensities, since it always have a "catcher" running trying to catch someone, while on the dynamic exercises warm up there is recovery intervals between the exercises. Possibly, the relationship between lower aerobic fitness of girls compared to boys (Pelegrini et al., 2011) and more intense stimuli of the tag game warm up may explain why only the girls had significantly higher perceived exertion on tag game compared to dynamic exercises warm up.

In addition, girls could have been easy to be caught during the game for boys since they presented significantly higher agility compared to girls. Nevertheless, in the present study the warm up was carried out with mixed classes because it represents the reality of classes at schools in Brazil. Thus, as in small sided games of soccer, the intensity can be decreased by changing the number of players, size of the playing area and adding intervals to recovery during the game (Hill-Haas et al., 2011). Nevertheless, the boys had significantly higher perceived exertion compared to dynamic exercises warm up in girls, possibly by performing dynamic exercises (Coledam & dos-Santos, 2011) and other types of exercise (Bringolf-Isler et al., 2009) in a higher intensity compared to girls.

Warm up acute effect on increase performance may be due to two physiological mechanisms, the elevation of body temperature and postactivation potentiation. The elevation of muscle temperature increases muscle power (Binkhorst et al., 1977) increases the speed of muscle contraction (Davies & Young, 1983), the allosteric activation of key enzymes of anaerobic pathways, the rate of degradation and resynthesis of ATP and rate of anaerobic glycolysis (Febbraio et al., 1996; Gray et al., 2006). In addition, the warm up may delay intracellular acidosis (Raymer et al., 2007) and increase perfusion and oxygen availability in anticipation of the mitochondrial enzyme activation resulting in faster kinetics of oxygen (Gurd et al., 2006).

The other physiological mechanism of warm up on increase the performance is the postactivation potentiation (PAP), which can be explained by two mechanisms. According to Sale (2002) PAP increases the phosphorylation of myosin regulatory light chain, responsible for the increased sensitivity of calcium on actin-myosin interaction, resulting in increased number of activated cross bridges and, consequently, increased force production. Another mechanism that may explain the PAP is an increased phosphorylation of myosin regulatory light chain, which alters the conformation of cross-bridges and leaves the globular heads closer to actin thin filaments, increasing the actin-myosin interaction, which causes generating a higher muscular tension (Rassier & Macintosh, 2000). Thus, PAP has more effect on type II fibers, which have greater capacity to generate force and speed (Sale, 2002).

The analysis and quantification of physiological responses and the external load during warm ups are limitations of this study. The measurement of these parameters could help to understand the difference on perceived exertion between the two warm up models only among girls, even with similar responses of agility and vertical jump tests after dynamic exercises and tag game warm ups. Furthermore, the intensity of both warm up models was assessed using the perceived exertion. This method, although it is a valid to assess the intensity of exercise (Barkley & Roemmich, 2011), is not precise as the physiological indices. Despite these limitations, we found that the warm up based on tag game, showed the same effect of the dynamic warm-up exercises, which is performed frequently in many sports, before training and competitions.

According to the results of this study, both the dynamic exercises and game warm ups can be used prior to tasks that require agility and vertical jump. Tag warm up may be an option for physical education classes and for sports, because it has similar effect to dynamic exercise and due to its playful feature can help diversify and break the routine into teams who train or classes frequently, like this study sample. Nevertheless, further studies should be conducted in order to verify the effect of warm up using other types of games on motor performance in individuals of different age.

CONCLUSIONS

In conclusion, tag game warm-up had a similar effect compared to dynamic exercises on agility and vertical jump tests, so it can be a good option for warm up in children prior to tasks that require agility and vertical jump.

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