International Journal of Physical Education

DOI : 10.15740/HAS/IJPE/8.2/77-81
e ISSN-0976-7924 ■ Visit us : *www.researchjournal.co.in*

Research Paper

Volume **8** | Issue 2 | October, 2015 | 77-81

Effect on flexibility and vertical jump in children through warm up protocol

■ **C. KIRAN CHAKRAVARTHI**

Received : 27.07.2015; **Revised :** 10.08.2015; **Accepted :** 15.09.2015

Author for correspondence

C. KIRAN CHAKRAVARTHI
Department of Physical Education and Sports Sciences, Sri Krishnadevaraya University, ANANTAPURAMU (A.P.) INDIA
Email: kiranchakravarthi9@gmail.com

■ ABSTRACT

This study assessed the acute impact of warm up protocol on children's flexibility and vertical jump performance. Forty, year 6 children (Mean age, stature and mass ± S. D. = 10.75 ± 0.4 years, 1.46 ± 0.7m and 37.1 ± 7.2 kg, respectively) participated in the study and participated in 3 experimental conditions: no warm up, static warm up and dynamic warm up in a randomized order. Low back and hamstring flexibility was assessed using the sit and reach test and vertical jump height was assessed using a digital jump mat following each condition. Results indicated no significant differences in sit and reach scores across conditions (P>0.05). Significant differences were evident in vertical jump scores across conditions (P<0.01). Sit and reach scores (m) were 0.189 ± 0.05, 0.186 ± 0.05 and 0.193 ± 0.05 following no warm up, static warm up and dynamic warm up, respectively. Vertical jump height was significantly higher following the dynamic warm up protocol compared to the static warm up protocol. Vertical jump scores (m) were 0.276 ± 0.04, 0.254 ± 0.03 and 0.284 ± 0.04 following no warm up, static warm up and dynamic warm up, respectively. These results indicate that an acute dynamic warm up can enhance children's fitness performance in activities that require a high power output whilst maintaining joint range of motion. However, participation in an acute static warm up is detrimental to performance of activities where high power output is needed.

■ **KEY WORDS :** Performance, Stretching, Dynamic, Vertical jump, Sit, Reach

■ **HOW TO CITE THIS PAPER :** Chakravarthi, C. Kiran (2015). Effect on flexibility and vertical jump in children through warm up protocol. *Internat. J. Phy. Edu.*, **8** (2) : 77-81.

Within the context of physical education and children's sport participation, young people are often encouraged to undertake some form of warm up before participation in physical activity. General recommendations for young people include several minutes of low intensity aerobic exercise followed by static stretching. Pre-event static stretching is generally prescribed as it is thought to promote better performance, improve posture and reduce the risk of injury. As a result, static stretching has become a generally accepted pre-event routine for both children and adults. However, convincing evidence documenting the performance enhancing or injury reducing effects of pre-event static stretching is limited and there has been growing confusion amongst Physical Education teachers and coaches over the issue of stretching. It is clear that static stretching is a safe and appropriate physical activity that has been shown to increase the range of motion at a particular joint and prepare children for physical activity. However, scientific evidence in adult populations has documented a deleterious effect of acute static stretching on performance of tasks where success is related to maximal force development. Further studies with younger populations have evidenced impairment in jumping performance in teenagers and reduction in vaulting speed in young gymnasts following acute bouts of static stretching.

This study was designed to examine the acute effect of different warm up protocols on the sit and reach test and vertical jump performance in children. It was hypothesized that dynamic warm up would positively influence vertical jump and sit and reach test performance in children and that a static stretching warm up protocol would decrease vertical jump performance in children.

■ METHODOLOGY

Subjects :

Fifty children (30 boys and 20 girls) aged 10-11 years (Mean age ± S.D. = 10.75 ± 0.4 years) in a primary school in Primary School, Papampeta, Anantapuramu, volunteered to participate in this study following informed consent from the school, parents and the children themselves. The children were not from a particular sporting background. Ten children did not complete all study procedures due to absence on one or more occasions when testing took place. The final sample consisted of 40 children (Mean stature and mass ± S. D. = 1.46 ± 0.7m and 37.1 ± 7.2kg, respectively) who completed all study procedures. The study was approved by the authors' institutional ethics committee.

Procedures :

Prior to data collection, all children participated in an introductory session where they were introduced to the various warm up procedures and fitness tests to be used in the study. Each child was asked to participate in 3 experimental conditions: No warm up, static warm up and dynamic warm up. Participation in these conditions was randomised and performed between 1300 and 1400 hours on non-consecutive days. Each warm up protocol lasted approximately 10 minutes in accordance with recommended guidelines for pre-event warm up.

Static warm up :

The static warm up protocol consisted of 5 minutes of walking and 5 minutes of static stretching focusing on the lower body. Children walked at normal walking pace and then performed 4 static stretches. Each stretch was performed twice for each leg (Table A) Participants performed each stretch in a slow deliberate manner with proper body alignment. Each stretch was held for 10 seconds at a point of mild discomfort, relaxed for 5 seconds and then performed for another 10 seconds before moving onto the opposite leg or next stretch. The stretching protocol used in this study was consistent with general flexibility recommendations for children and representative of general warm up routines used within physical education.

Dynamic warm up :

The dynamic warm up condition consisted of 10

Table A : Static warm up exercises

1.	Modified hurdler stretch. In a seated position with one leg straight, place the other leg on the inside of the straight leg and reach forward.
2.	Bent-over toe raise. From a standing position with the heel of one foot slightly in front of the toes of the other foot, dorsiflex front foot towards shin while leaning downward with upper body.
3.	Quadriceps stretch. In the standing position with an erect spine, bend one knee and bring heel towards buttocks while holding the foot with one hand.

Table B : Dynamic warm up exercises

1.	High-knee walk. While walking, lift knee towards chest, raise body on toes, and swing alternate arms.
2.	Straight-leg march. While walking with both arms extended in front of the body, lift one extended leg towards hands then return to starting position before repeating with other leg.
3.	Lunge walks. Lunge forward with alternating legs while keeping torso vertical.
4.	Backward lunge. Move backwards by reaching each leg as far back as possible.
5.	High-knee skip. While skipping, emphasize height, high-knee lift and arm action.
6.	Lateral shuffle Move laterally quickly without crossing feet
7.	Heel-ups. Rapidly kick heels towards buttocks while moving forward.
8.	High-knee run. Emphasize knee lift and arm swing while moving forward quickly.

minutes of 8 dynamic stretching that progressed from low to moderate intensity (Table B). Children performed each exercise over a distance of 12m, rested 10 seconds, and then repeated the same exercise as they returned to their starting position. Children were continually instructed to maintain proper form (e.g. vertical torso, up on toes) during the performance of the dynamic warm up. This protocol is similar to warm up protocols used with younger participants.

Fitness tests :

The impact of warm up protocol on children's fitness was assessed using 2 methods widely used within physical education. The sit and reach test was used as a measure of low back and hamstring flexibility using a traditional sit and reach box. The counter movement vertical jump was employed as a measure of lower body power using a digital jump mat. Standardized protocols for fitness testing in children were followed. Each child was given 3 trials on each test with the best score being taken as the performance measure. Order of fitness tests was randomized to avoid the possibility that performance on one test would influence subsequent performance on the next test.

On completion of each warm up protocol, children walked at a comfortable pace for 2 minutes prior to fitness testing and in accordance with the protocol. In order to facilitate fitness testing, children were tested in groups of 7 to 10. The same researcher tested the participants following warm up protocols and all children completed the two sets of fitness tests within 10 minutes of completing the warm up protocols.

Statistical analyses :

The scores on the sit and reach test and the countermovement vertical jump were analysed using two, one way repeated measures analysis of covariance (ANCOVA) with baseline sit and reach and vertical jump scores used as covariates. When significant differences were found, Bonferroni multiple comparisons was used to determine the location of the difference. Descriptive statistics (Mean ± S.D.) for fitness test scores were also calculated. The co-efficient of variation between warm up conditions was also determined to provide an indicator of the variability in children's fitness test performance. Statistical significance was set at ($P<0.05$) and all data were analysed using the Statistical Package for Social Sciences.

■ OBSERVATIONS AND DISCUSSION

Descriptive statistics for fitness test scores in the three conditions (no warm up, static warm up, dynamic warm up) are presented in Table 1. Results of the repeated measures ANCOVA for the sit and reach test controlling for baseline sit and reach scores at 0.19m indicated no significant differences in low back and hamstring flexibility across conditions ($F_{1, 38} = 0.463$, $P>0.05$). Mean sit and reach values indicated that flexibility scores were relatively stable across warm up conditions although scores on the sit and reach test were lowest following the static warm up protocol and highest following the dynamic warm up protocol (Table 1).

Results of the repeated measures ANCOVA for the vertical jump test controlling for baseline vertical jump scores at 0.27m indicated a significant difference in countermovement vertical jump height across warm up protocols ($P<0.01$). Bonferroni post hoc, multiple comparisons revealed that there was a significant difference between the static warm up and the dynamic warm up (Mean Diff = -0.032, $P<0.01$). Mean vertical jump values indicated that vertical jump height was considerably lower following static warm up compared to the no warm up protocol. Conversely, vertical jump scores were significantly greater following the dynamic warm up protocol compared to the no warm up and static warm up protocols. The co-efficient of variation was 17.8 per cent for the sit and reach test and 9.1 per cent for the vertical jump test.

The results of this study demonstrate that warm up procedures can significantly influence fitness performance in children. An acute pre-event static warm up appears to be detrimental in preparing children for activities that require a high power output whereas an acute dynamic warm up may be more advantageous in

Table 1 : Dynamic warm up protocol

Test	No warm up	Static warm up	Dynamic warm up
Vertical jump (m)	0.276±0.04	0.254±0.03*	0.284±0.04*
Sit and reach (m)	0.189±0.05	0.186±0.05	0.193±0.05

* indicate significance of value at P< 0.01 Mean Diff = -0.032 between conditions

preparing children for activities that require higher power outputs. However, warm up protocol does not appear to influence hamstring and low back flexibility. In this investigation, vertical jump height increased by 2.9 per cent following dynamic warm up compared to the no warm up condition, but decreased by 7 per cent following the static warm up compared to the no warm up condition.

Vertical jump performance :

These findings support a range of previous studies with adults and children that reported a reduction in power performance following an acute bout of static stretching Nelson *et al.* (2005) recently found that 20 meter sprint time increased by 2 per cent following static stretching and Cornwell *et al.* (2001) reported that pre-event static stretching significantly reduced vertical jump height by 4.4 per cent. The results of the current study also support the findings of McNeal and Sands who detailed a 9.6 per cent reduction in vertical jump height following an acute bout of static stretching in a group of teenage gymnasts. The data from the current study supported the assertions that 10 minutes of pre-event moderate dynamic stretching can positively enhance power production in children.

The precise reasons for a reduction in power output following static stretching have not yet been explained. However, researchers have proposed that static stretching results in a decrease in muscle activation or a reduction of passive or active stiffness of the musculo-tendinous unit decrease in musculo-tendinous stiffness may place the contractile elements of a muscle in a less than optimal position for generating force rapidly. This may, therefore, inhibit the muscle from functioning within the most desirable segment of its length:tension relationship. Faigenbaum *et al.* (2005 and 2006) have also suggested that pre-event dynamic warm up protocols may create an optimal environment for explosive force production by enhancing neuromuscular function. This occurrence has been termed the 'postactivation potentiation' (PAP) and is believed to increase the rate of force development, thereby increasing speed and power production. Dynamic warm up activities used in the present study (e.g. skipping) may have influenced the excitability of fast twitch motor units and, therefore, readied these units to play a more significant role during the vertical jump testing. This explanation is consistent with previous studies, however, no tests of neuromuscular activation were performed in this study.

Sit and reach test performance :

Additionally, there was no significant difference in low back and hamstring flexibility following the three conditions (no warm up, static warm up, dynamic warm up). Previous authors have highlighted that static stretching can increase the range of motion at a joint. However, the results of the current study are consistent with other studies of dynamic warm up protocols and suggest that dynamic warm up protocols may be as effective in increasing joint range of motion as static warm up protocols. It is not known why there was no change in flexibility following the warm up protocols although this finding may be due to a number of reasons. The acute nature of the warm up protocols may have been insufficient to ensure a meaningful change in flexibility, neurological mechanisms may have resulted in a stretch induced decline in performance or it may be that the sit and reach test was not sensitive enough to detect possible acute changes in flexibility following completion of the warm up protocols.

The results of the current study suggest that there may be some advantage to performing a low to moderate dynamic warm up protocol prior to activities that require high power outputs. Although, the increase in vertical jump height following dynamic warm up compared to the no warm up condition could be practically questioned, the increase in vertical jump height following dynamic warm up compared to static warm up is considerable. However, further research examining the impact of warm up protocol on performance in children is needed to strengthen these conclusions. The underlying neuromuscular mechanisms that explain the performance enhancing effects of pre-event dynamic stretching also require further examination. The current study employed two measures of fitness; it would be of interest to examine both the acute and chronic effects of different types of pre-event warm up on different parameters related to children's health and fitness. The chronic effects of pre-event dynamic stretching on children's health and performance do not appear to have been examined in previous literature.

Conclusion :

The findings of the current study suggest that an acute dynamic warm up significantly improved vertical jump performance in a group of primary school children compared to a static warm up condition. No differences in hamstring and low back flexibility were found across warm up protocols. Therefore, a dynamic warm up may be more effective as a pre-event warm up routine when enhancement of children's power output is of interest.

■ REFERENCES

Andersen, J.C. (2005). Stretching before and after exercise: Effect on muscle soreness and injury risk. *J.Athlet., Train.*, **40** (3) : 218-220.

Badsow, Elsonaf R.W. (2007). *Essentials of strength and conditioning* (3rd). Human Kinetics: Champaign, IL.

Baechle, T.R. and Earle, R.W. (2010). *Essentials of strength and conditioning* (2nd). Human Kinetics: Champaign, IL.

Bishop, D. (2008). Warm up II: Performance changes following active warm up and how to structure the warm up. *Sports Med.*, **33** (7) : 483-498.

Bloom, J., Magnatta, J.M., Ratamess, J., Faigenbaum, N.A., Kang, A.D., McFarland, J. and Hoffman, J.R. (2006). Acute effects of different warm-up protocols on anaerobic performance in teenage athletes. *Pedagogi Sci.*, **17** : 64-75.

Chiu, Loren Z.F., Fry, Andew C., Weiss, Lawrence W., Schilling, Briank, Brown, Lee E. and Smith, Stacey L. (2003). Postactivation potentiation response in athletic and recreationally trained individuals. *J. Stren. & Cond. Res.*,**17**(4) : 671–677.

Cornwell, A., Nelson, A. G., Heise, G. D. and Sidaway, B. (2001). Acute effects of passive muscle stretching on vertical jump performance. *J. Human Movement Stud.*, **40** : 307-324.

Duncan, M.J. and Woodfield, L.A. (2006). Acute effects of warm up protocol on flexibility and vertical jump in children. *JEPonline*, **9**(3) : 3-16.

Duthie, G.M., Young, W.B. and Aitken, D.A. (2002). The acute effects of heavy loads on jump squat performance: An evaluation of the complex and contrast methods of power development. *J Stren. Cond Res.*, **16**(4) : 530-538.

Faigenbaum, A.D., Bellucci, M., Bernieri, A., Bakker, B. and Hoorens, K. (2005). Acute effects of different warm-up protocols on fitness performance in children. *J. Stren.& Cond. Res.*, **19** : 376-381.

Faigenbaum, A.D., Kang, J., McFarland, J., Bloom, J.M., Magnatta, J., Ratamess, N.A. and Hoffman, J.R. (2010). Acute effects of different warm-up protocols on anaerobic performance in teenage athletes. *Ped. Ex. Sci.*, **17** : 64-75.

Faigenbaum, A.D., McFarland, J.E., Schwerdtman, J.A., Ratamess, N.A., Kang, J. and Hoffman, J.R. (2006). Dynamic warm-up protocols, with and without a weighted vest and fitness performance in high school female athletes. *J. Athl Train*, **41**(4) : 357- 363.

Gleim, G.W. and McHugh, M.P. (2012). Flexibility and its effects on sports injury and performance. *Sports Med.*, **24**(5) : 289-299.

Golhoffer, A., Schopp, A., Rapp, W. and Stronik, V. (2012). Changes in reflex excitability following isometric contractions in humans. *Eur. J. Appl. Occup. Physiol.*, **77** : 89-97.

Gullich, A. and Schmidtbleicher, D. (2010). MVC-induced short-term potentiation of explosive force. *New Stud Athletics*, **11** : 67-81.

Karvonen and lt. Hr Owne (2010). MVC-induced short-term potentiation of explosive force. *New Stud Athlet.*, **11** : 67-81.

Knudson (2011). Acute effects of stretching are not evident in the kinematics of the vertical jump. *J. Strength Cond. Res.*, **15** (1) : 98-101.

Nelson, A.G., Driscoll, N.M., Landin, D.K., Young, M.A. and Schexnayder, I.C. (2005). Acute effects of passive muscle stretching on sprint performance. *J. Sports Sci.*,**223** : 449-454.

Paston, R. and Bishop, D. (2010). Warm Up II: Performance changes following active warm up and how to structure the warm up. *Sports Med.*, **33** (7) : 483-498.

Rassier, D.E. and MacIntosh, B.R. (2000). Coexistence of potentiation and fatigue in skeletal muscle. *Braz. J. Med. Biol. Res.*, **33** : 499-508.

Young, W.B. and Behm, D.G. (2014). Effects of running, static stretching and practice jumps on explosive force production and jumping performance. *Sports Med Phys Fitness*,**43**:21-27.

8th Year
★★★★★ of Excellence ★★★★★