Original Research

Acute Effects of Combination Dynamic Stretching and Warming Up on Functional Performance in Non-Athlete

Salsabila Zahroh[1], Lydia Arfianti[2], Arni Kusuma Dewi[1*], M Fathul Qorib[2], Sofiatun[1]
[1]*Department of Health, Faculty of Vocational Studies, Airlangga University, Surabaya, East Java, Indonesia*
[2]*Faculty of Medicine, Airlangga University, Surabaya, East Java, Indonesia*

*Corresponding Author:
Arni Kusuma Dewi, Department of Health, Faculty of Vocational Studies, Airlangga University, Surabaya, East Java, Indonesia
Email: arni-k-d@vokasi.unair.ac.id

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Abstract

Background: Warming up is an activity that is carried out before exercise to optimize performance and reduce the risk of injury. Dynamic stretching is a kind of stretching that is recommended to be applied as a part of warming up. Previous studies showed that combination dynamic stretching and warming up had an acute effect on functional performance in athletes but in non-athletes have not been studied yet.
Aim: This study aims to compare functional performance as acute effect after combine dynamic stretching and warming up in non-athlete young adults.
Material and Methods: This study uses an experimental method of randomized controlled trial posttest design on 44 physically active young adults at the non-athlete level who were divided into two research groups (Intervention and control group). The intervention group completed 5 minutes of jogging and dynamic stretching whereas the control group only completed 5 minutes of jogging. Each group performed a modified 20-m sprint run test to measure speed values and a triple hop for distance test to measure power values. Speed values and power values are variable that show functional performance.
Result: Data analysis showed that there is no statistically significant difference in comparison between groups. On speed showed that p values = 0.845 ($p > 0.05$) and on power showed that p values = 0.366 ($p > 0.05$).
Conclusion: Combination of dynamic stretching and warming up do not increase functional performance in acute effect non-athlete young adults.
Keywords: *Dynamic Stretching, Functional Performance, Power, Speed, Warming Up*

INTRODUCTION

Nowadays, around 31% of the global population aged≥15 years old practice less physical activity, and it is known that it contributes to mortality rates of around 3,2 million people every year.[1] The prevalence of sports injuries related to sprains and muscle injuries is known to be 71.2%, with 38% of them experiencing 1-2 injuries in one year and 13.2% experiencing more than 5 injuries in one year.[2] Kristine Carandang et al.[3] have researched functional scores of subjects aged between 18 to 30 years old with a different social activity, stating that students have higher functional performance ability compared to those with disabilities but lower than workers.[3] The statement above shows that young adults need to start exercising or engaging in physical activity to improve functional performance to obtain a better quality of life. Before doing exercise, it is necessary to perform a warm-up first to obtain optimal performance to reduce the risk of injury.[4]

The general purpose of warming up is to prepare a person mentally and physically, increase readiness, and maximize performance before training or a match.[(5,6)] The need to improve performance must be balanced with injury prevention, providing appropriate dynamic stretching is known to provide increased flexibility and a good increase in ROM to reduce the risk of injury.[7] Warming-up is recommended to consist of 2 main phases, a general warm-up which is 5 minutes of aerobic activity such as jogging, skipping, or cycling and usually followed by general stretching, and a specific warm-up, which is an activity that is similar to the next activity as an athlete would do before training or competition.[4] Before doing exercise, warming up must be able to produce increased blood flow, increased body temperature and increased elasticity of muscles and tendons which are known to be obtained through coordinated and continuous movements such as dynamic stretching.[8]

Dynamic stretching is a type of stretching that is recommended as pre-performance preparation because it has an acute effect that can increase ROM around the joints and increase functional performance consisting of speed and power.[9] Dynamic stretching is defined as performing a movement through full ROM by contracting the agonist muscle so that the antagonist muscle group lengthens or stretches without resistance at the end of the movement[9] which in its movements utilizes specific sports movements to prepare the body before carrying out an activity that focuses on movement patterns of a combination of muscles, joints and planes of motion.[10] Dynamic stretching is known to be an effective stretching method, which has benefits in the physiological performance of the muscles involved in training as well as estimating the effort and energy required by muscles for training.[11] When warming up, dynamic stretching is considered better than other stretching methods because it is similar to the movements that will be carried out in the next exercise and also because so far it has not been reported that dynamic stretching causes functional performance problems in activities or exercises.[12]

A study by Koya Mine et al.[13] states that dynamic stretching has a positive effect on maximum muscle performance, however, the differences in stretching movements and duration can be considered to produce differences in the acute effects.[13] Acute effect is an effect that is produced immediately after stretching is carried out, in previous research it was stated that the effect of stretching on functional performance as measured by power showed a decrease after 30 minutes after the stretching was carried out, this shows that the maximum functional performance measurement that can be observed is less than 30 minutes after stretching.[14] The application of dynamic stretching with a short duration is indicated to not affect performance, while the application of dynamic stretching with a long duration is indicated to facilitate performance.[15] Yamaguchi and Ishii[16] suggest that the optimal protocol for performing dynamic stretching to produce an acute effect on improving performance is to perform the movement as quickly as possible for about 1-2 sets of 10-15 repetitions.[16]

Turki et al.[17] stated that the effect of warming up combined with dynamic stretching can enhance sprint performance after 1 or 2 sets of dynamic stretching with 14 repetitions.[17] Similar to the study by Brad s Curry et al.,[18] who discovered power performance enhancement after 2 sets and 10 repetitions of dynamic stretching warm-up.[18] Previous research by Mohammadtaghi Amiri Khorasani et al.[19] stated that dynamic stretching produces a positive acute effect on performance after being applied to all subjects which a highly trained soccer player.[19] But, acute effects on functional performance in non-athletes have not been studied yet. Dynamic Stretching protocol applied in this research has different doses and different subject targets from previous studies.

This study aims to prove our hypothesis that the addition of dynamic stretching during warming up has an acute effect on speed and power values which are components of functional performance.

MATERIAL AND METHODS

Subject

Based on the sample size calculation,[20-22] it was estimated that a total of 44 subjects (22 per group) would be an adequate sample size. Participants were included if they were aged between 18 and 22 years old, engaged in physical activity (non-athlete level), and absent of injury that prevented the participant from performing research protocols. All procedures involved in this study were declared to be ethically appropriate by the Health Research Ethics Committee Universitas Airlangga School of Medicine No.273/EC/KEPK/FKUA/2023. Before participating in the study, each participant read and signed a consent form and was informed about the procedures, enabling them the right to withdraw.

Protocols

All participants were randomly divided into 2 groups, warming up followed by dynamic stretching and warming up only. The research protocol used for each group was randomly assigned. The evaluation was performed immediately after performing all the research protocols (posttest). The warming-up protocol consisted only of light aerobic activity which is 5-minute of jogging along a jogging track that has been provided. Subjects were allowed to walk around for 2 minutes to rest after jogging before continuing to carry out other research protocols. Dynamic stretching consisted of controlled movement through the active ROM for each of the six lower extremity muscle groups: gastrocnemius, hamstring, quadriceps, hip flexors, hip extensors, and hip adductors.[19] The procedures for performing dynamic stretching were adopted from Mohammadtaghi Amiri Khorasani et al.[19] and Shi Huang et al.[23] Subjects completed the six movements for two sets of 15 repetitions on each leg and a 10-second rest between sets. The dynamic stretching protocol is detailed in Table 1.

The primary outcome investigated in this research was functional performance. Modified 20-m sprint run test is a running-based test to evaluate speed ability which has a reliability coefficient (ICC=0,98) of functional performance measurement.[21,24] Speed is defined as how fast a person runs and also how fast they accelerate from a rest position.[25] There are ways to carry out this test, starting with 2 cones with a 10m distance. The subject stood 0,5m behind the first cone and used the non-dominant limb to start the movement acceleration, then the subject performed a sprint as fast as possible toward the second cone and turned around 180^{o} through the side of the nondominant limb, and returned to the first cone. A stopwatch is used to measure the time required to complete a sprint. Subjects may carry out 2 trials with a 2-minute rest in between, and the fastest test result was kept for data analysis.[21]

Table 1. Dynamic stretching protocol

Muscle Groups	Protocol
Gastrocnemius	Stand with one foot on the front, then move the front knee forward and keep the heel of the back foot on the ground so the gastrocnemius muscle on the back foot stretches.
Hamstring	Stand with the leg shoulder-width apart, then bend the trunk forward to touch each foot with your hands and keep the knee extended so the hamstring muscle stretches.
Quadriceps	Stand with one leg, then flex the knee on the other leg with the hip extended as far as the heel touches the glutes so the quadriceps muscle stretches.
Hip flexors	Stand with the leg shoulder-width apart, then swing one leg backward as far as possible and keep the knee extended so the hip flexors muscle stretches.
Hip extensors	Stand with the leg shoulder-width apart, then flex one knee and bring the thigh to the chest so the hip extensors muscle stretches.
Hip adductors	Stand with your feet shoulder-width apart, then alternately swing the legs to the side so the hip adductors muscle stretches.

Triple hop for distance test is used to evaluate power ability which has a reliability coefficient (ICC=0,99) of functional performance measurement because the movements represent the dynamic movement of athletic activity.[21,26,27] In this test, power is defined as the effort to generate force in the legs to produce extension of the hip, knee and ankle joints to maximize horizontal distance when jumping.[28] This test was started from one starting point then the subject hopped forward 3 times with one non-dominant leg. The distance of the jump from the starting point to the endpoint was measured. Subjects may carry out 3 trials to consider balance disorders and other disorders while performing the test with 30s rest in between trials and the maximum distance among the test results was kept for data analysis.[21]

Statistical analysis

Statistical analysis was performed using the IBM SPSS Statistics Version 26. The Shapiro-Wilk test was used to evaluate the distribution of data and the homogeneity test was used to evaluate the variance of data between groups. Compare means test was used to identify the equality of means of the speed and power value and to evaluate if there were possible differences between groups. The method used for the Compare means test in this study is an independent sample t-test for parametric data and Mann Whitney test for non-parametric data.

RESULT

Forty-four subjects completed the study. Regarding the characteristics of the participants, it was found that there were statistically significant differences in age with the value of (p=0,008) but there were no differences in height with the value of (p=0,647), weight with the value of (p=0,135) and body mass index with the value of (p=0,272) between groups. Table 2 shows the mean±standard deviation of the characteristics of all research groups. Although there were significant age differences, all participants in both research groups in this study were in the same young adult age category. So, the characteristics of participants at baseline were considered similar. Therefore, these characteristics may not influence the result.

There was no statistically significant difference between groups found for the modified 20-m sprint run test. Independent sample t-test showed a significance value of (p=0,845). There was no statistically significant difference between groups found for the triple hop for distance test. Mann Whitney test showed a significance value of (p=0,366). Table 3 shows the mean±standard deviation of speed and power value of all research groups.

Table 2. Baseline characteristics of all groups

	Warming Up (n=22)	**Warming Up + Dynamic Stretching (n=22)**	
	Mean±SD	Mean±SD	*p Value*
Age (y)	21±0,84	20±0,57	0,008*
Height (cm)	162,9±8,73	161,6±10,15	0,647
Weight (kg)	62,9±15,33	56,5±15,51	0,135
BMI (kg/m^2)	23,5±4,59	22±4,48	0,272

BMI = Body Mass Index, *p<0,05

Table 3. Within-group difference post-intervention of modified 20-m sprint run test, and triple hop for distance test

	Warming Up	**Warming Up + Dynamic Stretching**	
	***Mean*±SD**	***Mean*±SD**	***p Value***
Modified 20-M Sprint Run	7,21±0,81	7,26±1,05	0,845
Triple Hop for Distance Test	3,57±0,89	3,43±1,03	0,366

DISCUSSION

Decreases in muscle strength and power are associated with decreases in performance which occur with age, but decreases in performance are known not to occur in young adults, they are found in healthy individuals in the adult age range because the sensorimotor system tends to deteriorate with age.[29,30] During warming up, there is movement of several muscle groups simultaneously which causes neuromuscular activation and increases muscle performance because central output to motor neurons increases, then reflexes in the spinal cord and myofilament sensitivity also increase, accompanied by an increase in the cross-bridge cycle, that increases functional performance.[31] In contrast to warming up added with dynamic stretching, there is an increase in ROM after stretching caused by increases in tissue extensibility and also a stretch tolerance which is obtained from changes in the viscoelasticity of the muscle tendon unit (MTU) that increases functional performance.[9,32,33)]

The findings in this study indicate that the addition of dynamic stretching during warming up on functional performance (speed and power) in non-athlete young adults does not provide a difference and a better acute effect compared to warming up without dynamic stretching. This result is in line with Giorgos P Paradisis et al.[34] who found that dynamic stretching had no effect on sprint performance but reduced jump performance. Giorgos P Paradisis et al.[34] stated that the decrease in performance after stretching may be related to mechanical (peripheral) theory and neurological (central) theory mechanisms which are known to inhibit the eccentric and concentric phases of the Stretch Shortening Cycle (SSC)[34] which occur when jumping or sprinting.[34,35)] Mechanical (peripheral) theory occurs when the muscle experiences stretching, causing a decrease in Muscle Tendon Unit (MTU) stiffness so that elastic energy cannot be stored during the eccentric phase of SSC, while neurological (central) theory occurs when there is an obstacle because elastic energy cannot be stored properly during the eccentric phase so there is possible that myoelectric potentiation is not sufficient to produce a maximum response for the concentric phase.[34]

Dynamic stretching which involves contraction of the agonist muscle group shows a decrease in MTU stiffness[36] and the increase in Range of Motion (ROM) experienced after stretching is due to a decrease in MTU stiffness after stretching the antagonist muscle group.[37] Research conducted by Bruno et al.[38] on the immediate effects of dynamic stretching on performance concluded that when doing sports that require explosive power, the application of stretching (static, dynamic, PNF) can delay the time to reach maximum power capabilities and reduce speed, thereby causing changes in power kinetics and has a negative impact on performance.[38] Changes in power kinetics are related to changes in tension when the muscle lengthens due to the implementation of successive stretching procedures which can change the viscoelastic properties of the muscle.[38] Harvey et al.[39] also found that the acute effect of dynamic stretching did not have a significant increase in performance whereas in the group without stretching there was a significant increase in performance. Harvey et al.[39] stated that the increase in performance is probably due to the absence of stretching having an impact on increasing tendon stiffness which is related to the production of tendon pressure/force. The higher the level of the muscle-tendon unit stiffness, the higher the possibility of the contractile component reaching an optimal condition in producing pressure which increases the power performance.[39]

This contrasts with Mohammadtaghi Amiri Khorasani et al.[19] who investigated the acute effect of a combination of different stretching methods on acceleration and speed in soccer players, it is found that dynamic stretching was known to have a positive influence on performance. Mohammadtaghi Amiri Khorasani et al.[19] applied all the stretching protocols on highly trained athletes who were accustomed to regularly doing strengthening, endurance, sprint and soccer-specific training for about 3-6 days/week for more than 8 years.[19] Sonja and Derek[40] also found a positive influence on performance after 4 weeks of dynamic stretching warm-ups were applied to wrestling athletes and it is obtained due to neuromuscular adaptation and energy adaptation occurring from chronic application of dynamic stretching.[40] Positive changes that influence increased performance after completed dynamic stretching may occur due to movement training in specific patterns.[9] The increase in performance obtained is related to muscle coordination after doing dynamic stretching movement routines.[41]

Brad S Curry et al.[42] found power performance enhancement after completing 2 sets and 10 repetitions of dynamic stretching.[42] Similar findings were obtained from Turki et al.[17] states that warming up with a combination of dynamic stretching for about 1-2 sets and 14 repetitions obtained an increase in sprint performance.[17] Jules Opplert and Nicolas Babault[9] declared that the duration of dynamic stretching does not seem to affect performance, progressive fatigue is a factor that can inhibit the positive effects of stretching so as long as the fatigue value is not assuredly known there is a possibility it influenced performance value.[9] Based on research by Yamaguchi and Ishii,[16] the optimal dynamic stretching protocol to improve performance is to perform movements as quickly as possible for 1-2 sets with 10-15 repetitions of the movement. However, the application of the protocol must still consider environmental conditions such as temperature and humidity, and pay attention to the physical condition of the subject such as level of fatigue and history of injury and must be applied differently depending on a person's level of physical activity.[16] Differences in the magnitude of the force resulting from each subject's stretching maneuvers can produce different soft tissue responses, and stretching intensity within the limits of the comfort zone can interfere with motor neuron performance and facilitate muscle relaxation provided by stretching.[14] It should be noted that in our research, the application of dynamic stretching was carried out with predetermined sets and repetitions, but there might be differences in the stretching intensity, it is not assuredly known whether the subjects performing stretching within the limits of their comfort zone or not.

Limitations in this study are that an assessment of the subject's level of fatigue was not carried out before treatment was given, so there is a possibility that this could influence the research results. This study did not control variables such as gender, body mass index, and specific level of physical activity which could be confounders in the research results. Further research is required to identify other stretching methods that can provide a better acute effect on functional performance.

CONCLUSION

Combination of dynamic stretching and warming up do not increase functional performance in acute effect non-athlete young adults. Future researches are recommended include confounder variable to study the mechanism of warming up influence the functional performance.

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