



ACUTE EFFECT OF FOAM ROLLER, STATIC AND DYNAMIC STRETCHING ON AGILITY, BALANCE AND ANAEROBIC PERFORMANCE OF UNIVERSITY LEVEL TAEKWONDO PLAYERS.

Sarika Chaudhary^{1*}, Jash Desai²

^{1*} Assistant Professor, MYAS-GNDU Department of Sports Sciences and Medicine, Guru Nanak dev university, Amritsar, Punjab, India

² Masters In Physiotherapy (Sports Physiotherapy), MYAS-GNDU Department of Sports Sciences and Medicine, Guru Nanak dev university, Amritsar, Punjab, India

***Corresponding Author:** Sarika Chaudhary

* Assistant Professor, MYAS-GNDU Department of Sports Sciences and Medicine, Guru Nanak dev university, Amritsar, Punjab, India

ABSTRACT

Background and Aim: The warm-up phase consists of low to moderate intensity stretching exercises. Foam rolling has been a newly accepted technique in warm-up phase. A within-subject experimental study was designed to rectify the acute effects of foam roller, static and dynamic stretching on agility, balance and anaerobic performance of taekwondo players.

Materials and Methods: Sixteen male athletes of taekwondo sport were tested for balance, agility and anaerobic performance. All participants performed one of the following protocols: a) 3 min jogging followed by 14 min static stretching (SS), b) 3 min jogging followed by 17 min dynamic stretching (DS), c) 3 min jogging followed by 16 min foam rolling (FR), d) 3 min jogging followed by 17 mins of rest for 4 consecutive days. After the protocol participants performance was assessed using the Balance Error Scoring System (BESS), Star Excursion Balance Test (SEBT), Illinois Agility Test (IAT) and Running Based Anaerobic Sprint Test (RAST).

Results: Results of the repeated measure ANOVA revealed that DS ($P \leq 0.010$) considerably improved dynamic balance and static balance, whereas FR ($P \leq 0.006$) and DS ($P \leq 0.024$) significantly improved static balance. Agility and anaerobic performance showed no significant differences between the four protocols.

Conclusion: According to the results of the study, DS protocol showed better improvement in static and dynamic balance. Where as FR protocol has also been effective in improving static balance.

Keywords: Foam rolling, Static stretching, Dynamic stretching, Static and dynamic balance, Agility, Anaerobic performance

INTRODUCTION

A typical work out session consists of warm-up, stretching, conditioning or game related exercises and cool-down. The warm-up phase, which consists of 5 to 10 minutes of low to moderate intensity

exercise, is a widely accepted and advised strategy of getting the body ready for physically demanding activity. Stretching's effects have been linked to both mechanical and neurological mechanisms.^[1] Stretching is thought to improve flexibility, reduce muscular soreness, avoid injury, and improve athletic performance.^[2] By improving the compliance of the tendon and muscle fibres, static stretching has been recommended as a way to prevent injury to the musculotendinous unit (MTU). This increases the capacity for force transmission.^[3] According to recent research, static stretching sessions may actually result in declines in muscle strength, vertical jump performance, sprint speed, balance, and reaction.^[4] These beneficial effects of dynamic stretching (DS) are mostly attributed to increased body and muscular temperature, post-activation potentiation (PAP) in the stretched muscle brought on by voluntary contractions of the agonist, stimulation of the neurological system and reduced inhibition of antagonist muscles.^[2] Before a workout, foam rolling has been reported to restore the muscle tension for better warm-up.^[5] Myogenic and endothelial dilatation increases as well as nitric oxide levels rises due to foam rolling. It is proved that utilising a foam roller increases fascia flexibility and breaks down adhesions, improves the flexibility of soft tissues such as muscles, tendons, ligaments, and fascia.^[6,7] Few studies have reported that static or dynamic stretching does not impair balance in active middle-aged athletes.^[8,9] In contrast, studies have also stated that dynamic stretching in comparison to static stretching can improve balance, agility, flexibility and anaerobic performance.^[2,10] There are studies which have reported that foam rolling does have any effect on athlete's/athletic performance where as in contrast static or dynamic stretching increases flexibility without hampering muscle strength.^[1,5] Foam rolling has been shown to be more effective than static and dynamic stretching in increasing quadriceps and hamstrings flexibility without compromising muscle strength, making it a suitable warm-up activity rather than a recovery tool. Combining foam rolling with dynamic or vibration stretching as a warm-up exercise has been found to significantly enhance flexibility, power, ball speed, and agility. Both dynamic stretching and dynamic stretching with foam rolling improved flexibility and agility without affecting balance.^[1, 6, 11, 12] Since taekwondo game frequently involve the application of kick techniques to attack and defend (at least 90% of the time), as well as the capacity to execute quick rotations and footwork, excelling in taekwondo mostly rely on leg strength, agility, flexibility, and anaerobic alactic power.^[13] So, there is a controversy regarding the acute effects of various types of stretching and foam rolling on static and dynamic balance, agility and anaerobic performance in university level taekwondo players. So, our study aimed to rectify the acute effects of foam roller, static and dynamic stretching on agility, balance and anaerobic performance of university level taekwondo players.

MATERIALS AND METHOD

The within-subject experimental design was conducted at Guru Nanak Dev University, Amritsar. Sixteen male university level taekwondo athletes with the mean (SD) of age 19.75 (1.95), height 168.44 (8.10), weight 62.38 (10.69) and BMI 21.93 (3.01), involved in training with at least 3 sessions per week and volunteered to participate in the study were recruited for the study with the help of G*Power (version 3.0.10), setting effect size at 0.31, alpha(α) at 0.05, and power(1- β) at 0.80. Athletes who have history of soreness at the time of data collection or having any neurological, cognitive or muscular disorder are excluded from the study.

Protocol

Ethical clearance was obtained from the institutional ethical committee (330/HG; dated 12/4/2022). Prior to participation informed consent form was taken from the participants. All protocols were started with 3-minute jogging at a self-selected moderate intensity, with comfortable pace (Distance: 400 m approximately). Intensity was measured with the talk-test that means, if the participant can talk comfortably while jogging, he/she is jogging at a moderate intensity pace. When the participant can no longer speak comfortably, then the intensity of an activity is vigorous.^[10] After 3 mins of jogging participants performed the 14 mins of static stretching (SS) or 17 mins of dynamic stretching

(DS) or 16 minutes of foam rolling (FR) and one belongs to control group (CG) sits quietly for 17 minutes. The protocol for the SS, DS and FR is mentioned in the table 1.

Primary outcome measures were static balance, dynamic balance, agility and anaerobic performance. The static balance was measured with the help of balance error scoring system (BESS), dynamic balance with star excursion balance test (SEBT), agility with ilinois agility test (IAT) and anaerobic performance with running based anaerobic sprint test (RAST). The participants were given 2 min rest between the BESS and SEBT and SEBT and IAT and 5 min rest between the IAT and RAST.

Table 1: Protocol for foam rolling, static and dynamic stretching

Static Stretching Protocol ^[10]	Dynamic Stretching Protocol ^[10]	Foam Rolling Protocol ^[14]
Front deltoid and Pectoral stretch	Side/foot arm crossover	Pecs Major Roll
Side deltoid stretch	Walking lunge with rotations	Biceps Roll
Triceps and side bend stretch	Triceps and side bend stretch	Triceps Roll
Adductor stretch	Lateral shuffle	Trapezius Roll
Modified hurdles stretch	Frankenstein walks	Latissimus Dorsi Roll
Quadriceps wall stretch	Heel-ups	Quads and Hip Flexors Roll
Calf stretch	Inch worms (hand walk)	Hamstring Roll
	Modified shuttle run	Gastroc Roll

Table 2: Summary of the protocol

Static Stretching	Dynamic Stretching	Foam Rolling	Control Group
Aerobic Running	Aerobic Running	Aerobic Running	Aerobic Running
2 Min of Rest	2 Min of Rest	2 Min of Rest	2 Min of Rest
Static Stretching Exercise	Dynamic Stretching Exercise	Foam Rolling Exercise	-
2 Min of Rest	2 Min of Rest	2 Min of Rest	-
BESS	BESS	BESS	BESS
2 Min of Rest	2 Min of Rest	2 Min of Rest	2 Min of Rest
SEBT	SEBT	SEBT	SEBT
2 Min of Rest	2 Min of Rest	2 Min of Rest	2 Min of Rest
IAT	IAT	IAT	IAT
5 Min Rest	5 Min Rest	5 Min Rest	5 Min Rest
RAST	RAST	RAST	RAST

RESULTS

Outcomes were analysed for a normal distribution using the Shapiro-Wilk test and found that the distribution of data was equal to normal distribution ($P \geq 0.05$). In order to investigate differences between the four protocols, data were analysed using one-way analysis of variance (ANOVA) for repeated measures. Post hoc analyses were conducted using Bonferroni pairwise comparisons. All

statistical analyses were conducted using SPSS (version 26) and significance level was set at $P \leq 0.05$.

Table 3: Descriptive statistics (mean $\pm$ SD) and Repeated Measure ANOVA of all the variables

Variables	FR	SS	DS	CG	F	P
Static Balance (No. of errors)	5.87 $\pm$ 4.29	7.25 $\pm$ 4.33	6.56 $\pm$ 3.76	9.75 $\pm$ 5.27	5.591	0.002
Dynamic Balance (%)	474.39 $\pm$ 74.10	285.15 $\pm$ 55.36	389.70 $\pm$ 51.09	233.41 $\pm$ 28.87	9.284	0.000
Agility (Secs)	19.66 $\pm$ 1.66	20.06 $\pm$ 1.92	19.88 $\pm$ 1.74	20.05 $\pm$ 1.86	1.967	0.132
Maximum Anaerobic Performance (watts)	344.59 $\pm$ 100.62	354.95 $\pm$ 119.49	330.56 $\pm$ 98.65	332.77 $\pm$ 96.78	.572	0.636
Minimum Anaerobic Performance (watts)	243.68 $\pm$ 62.44	237.69 $\pm$ 74.28	229.15 $\pm$ 71.83	223.20 $\pm$ 68.75	1.357	0.268
Average Anaerobic Performance (watts)	292.19 $\pm$ 76.73	289.81 $\pm$ 82.59	277.10 $\pm$ 80.76	274.82 $\pm$ 81.10	.977	0.412
Fatigue Index (watts/sec)	2.67 $\pm$ 1.43	3.07 $\pm$ 2.36	2.61 $\pm$ 1.34	2.85 $\pm$ 1.49	.353	0.787

Table 4: Bonferroni Post hoc test

Variable	(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	P
Static Balance (No. of errors)	CG	DS	3.188	.941	.024
		FR	3.875	.957	.006
Dynamic Balance (%)	CG	SS	59.574	18.872	.039
		FR	93.205	22.323	.005
	DS	FR	36.486	9.486	.010

CG: Control Group, DS: Dynamic Stretching, FR: Foam Rolling, SS: Static Stretching, SE: Standard Error

DISCUSSION

The primary goal of the study was to evaluate the acute effects of foam roller, static and dynamic stretching on balance, agility and anaerobic performance of taekwondo athletes. We hypothesized that there will be a significant difference between the acute effects of foam roller, static and dynamic stretching on balance, agility and anaerobic performance of university level taekwondo athletes.

Static Balance

In the present study we found that static balance is improved by performing DS ($P \leq 0.024$) and FR ($P \leq 0.006$) as compared to the CG. These results were supported by different researches for DS and FR.^[4,10] While Halperin et al., (2014) found no significant improvement in static balance while comparing FR with SS.^[15]

The positive acute effects of DS may result from some level of post-activation potentiation (PAP), which is the temporary increase in muscle contractile performance after a previous 'conditioning' contractile activity. It seems that PAP may raise the rate constant of cross-bridge attachments, which may enable a greater number of cross-bridges to form and increase force production and was hypothesised that the increases in force output after dynamic stretching were caused by an intensification of neuromuscular function, and suggest that DS has a PAP effect on performance.^[4] The positive acute effects of foam rolling are may be because of the change in the thixotropic property of the fascia encasing the muscle.^[16]

Dynamic Balance

In the current study, we found statistically significant difference in the composite values of dynamic balance in CG who had performed aerobic running only, showed a better improvement in dynamic balance compared to the same athlete who had performed SS ($P \leq 0.039$) and FR ($P \leq 0.005$) protocol. The study also shows a statistically significant improvement with the DS protocol ($P \leq 0.010$) compared to the FR protocol.

The finding of the current study was supported by the Chatzopoulos et al (2014) who found that DS and CG performed significantly better than SS protocol.^[10] Amiri-Khorasani & Gulick (2015) were also consistent with our result showing that DS improves dynamic balance performance to a larger extent than SS among female football players.^[4] Herda et al (2008) reported that DS increases electromyographic amplitude, which may reflect a positive effect of DS on muscle activation.^[17] DS elevates muscle temperature and stimulates the nervous system.^[18,19]

On the other hand, the results of present study are inconsistent with Costa et al (2009) where they reported, that a stretching protocol of 45-second hold did not impair balance, whereas a 15-second hold improved balance in young women.^[20] Belkhiria-Turki et al (2014) also illustrated that there is no substantial effect of 1 (4 sets), 2 (8 sets) or 3 (12 sets) min of static or dynamic stretching of individual muscle groups (10, 20 or 30 min of total stretching duration) on the SEBT performance.^[8]

As regards to the effect of FR on dynamic balance, our results are supported by Junker and Stöggli (2019) who found no chronic/acute effect of self myofascial release on Y balance test performance.^[21]

In contrast there is evidence that dynamic balance ability following postural muscle chain self myofascial release is significantly improved. Such an improvement could be attributed to numerous factors like muscle contractions, proprioception or central nervous system activation. In addition, myofascial includes a multitude of sensory nerves related to proprioceptive and mechanical receptors like Golgi receptors or Pacini receptors.^[22]

Agility

In the present study, we found that there was not any significant difference in agility while performing any of the protocol, thus our hypothesis was rejected here and null hypothesis was accepted which shows that there will be no significant difference between the acute effects of foam roller, static and dynamic stretching on agility.

The result of our study is in accordance with Faigenbaum et al (2006) and Chaouachi et al (2010), who reported no significant differences between DS, SS and CG for agility.^[23,24] Chen et al (2021) also noted that there is no statistical difference among protocols in terms of 505 agility test outcomes.^[13] Bishop & Middleton (2013) also stated that performing SS following a dynamic warm-up prior to performance does not significantly affect speed, agility and vertical jump performance.^[25] Where as Kurt & Firtin (2016) showed that SS has a better effect than DS.^[2] On the other hand, both

DS and DS combined with FR improved flexibility and agility,^[26] as well as DS significantly improved the performance compared to SS and CG.^[10,27]

Anaerobic Performance

The maximum power, average power, minimum power and fatigue index all the four parameters of RAST showed no significant difference between the any of the protocol performed by the athletes. In the support of our results, kendall (2017) found no significant difference between the static and dynamic stretching protocol performed with active warm-ups.^[28] In contrast, there are literatures that have stated that DS is better than SS, as well as by adding DS with SS instead of doing SS alone can improve anaerobic performance to a greater degree.^[2,23]

CONCLUSION

The present study may provide athletes and coaches with information that dynamic stretching is beneficial for improving static and dynamic balance as well as foam rolling can be used for improving static balance. Taking our findings into account the coaches, physical education teachers, strength and conditioning experts and physiotherapist may reconsider the use of static stretching, dynamic stretching and foam rolling.

LIMITATIONS AND FUTURE RECOMMENDATIONS

Despite our best efforts there are some limitations in our study. The study included only male university level taekwondo athletes with the age group of 18-26 years. The large sample size can be considered in future work as this study has included 16 athletes only. As the study was done only in the male university level taekwondo athletes, the future research can be done in both male and female genders as well as in team sports athletes as results may vary according to the type of sport the player plays as well as due to gender specific responses the results may vary. The study can be done with some changes in duration of stretch or foam rolling as well as for specific parameters with respect to a particular sport.

REFERENCES

1. Su H, Chang N-J, Wu W-L, Guo L-Y, Chu I-H. Acute Effects of Foam Rolling, Static Stretching, and Dynamic Stretching During Warm-Ups on Muscular Flexibility and Strength in Young Adults. *Journal of Sport Rehabilitation* 2016;26:1–24.
2. Kurt C, Firtin I. Comparison of the acute effects of static and dynamic stretching exercises on flexibility, agility and anaerobic performance in professional football players. *FTR - Türkiye Fiziksel Tıp ve Rehabilitasyon Dergisi* 2016;62:206–13.
3. Perrier E, Hoffman M. Effects Of Static And Dynamic Stretching On Reaction Time And Performance In A Countermovement Jump: 801. *Medicine and Science in Sports and Exercise - MED SCI SPORT EXERCISE* 2009;41.
4. Amiri-Khorasani M, Gulick DT. Acute effects of different stretching methods on static and dynamic balance in female football players. *International Journal of Therapy and Rehabilitation Mark Allen Group*; 2015;22:68–73.
5. Healey KC, Hatfield DL, Blanpied P, Dorfman LR, Riebe D. The effects of myofascial release with foam rolling on performance. *J Strength Cond Res* 2014;28:61–8.
6. Yıldız M, Bozdemir M, Akyıldız Z. ACUTE EFFECTS OF PRE-EXERCISE FOAM ROLLING IN ADDITION TO DYNAMIC STRETCHING ON ANAEROBIC POWER. 2018;
7. Behara B, Jacobson BH. Acute Effects of Deep Tissue Foam Rolling and Dynamic Stretching on Muscular Strength, Power, and Flexibility in Division I Linemen. *Journal of Strength and Conditioning Research* 2017;31:888–92.
8. Belkhiria-Turki L, Chaouachi A, Turki O, Hammami R, Chtara M, Amri M, Drinkwater EJ, Behm DG. Greater volumes of static and dynamic stretching within a warm-up do not impair star excursion balance performance. *J Sports Med Phys Fitness* 2014;54:279–88.

9. Handrakis JP, Southard VN, Abreu JM, Aloisa M, Doyen MR, Echevarria LM, Hwang H, Samuels C, Venegas SA, Douris PC. Static stretching does not impair performance in active middle-aged adults. *J Strength Cond Res* 2010;24:825–30.
10. Chatzopoulos D, Galazoulas C, Patikas D, Kotzamanidis C. Acute Effects of Static and Dynamic Stretching on Balance, Agility, Reaction Time and Movement Time. *Journal of sports science & medicine* 2014;13:403–9.
11. Wiewelhove T, Döweling A, Schneider C, Hottenrott L, Meyer T, Kellmann M, Pfeiffer M, Ferrauti A. A Meta-Analysis of the Effects of Foam Rolling on Performance and Recovery. *Front Physiol* 2019;10:376.
12. Hsu F-Y, Tsai K-L, Lee C-L, Chang W-D, Chang N-J. Effects of Dynamic Stretching Combined With Static Stretching, Foam Rolling, or Vibration Rolling as a Warm-Up Exercise on Athletic Performance in Elite Table Tennis Players. *Journal of Sport Rehabilitation Human Kinetics*; 2020;30:198–205.
13. Chen A-H, Chiu C-H, Hsu C-H, Wang I-L, Chou K-M, Tsai Y-S, Lin Y-F, Chen C-H. Acute Effects of Vibration Foam Rolling Warm-Up on Jump and Flexibility Asymmetry, Agility and Frequency Speed of Kick Test Performance in Taekwondo Athletes. *Symmetry Multidisciplinary Digital Publishing Institute*; 2021;13:1664.
14. Total Foam Rolling Techniques: Trade Secrets of a Personal Trainer by Steve Barrett - PDF Drive [Internet]. [cited 2023 Feb 25]. Available from: <http://www.pdfdrive.com/total-foam-rolling-techniques-trade-secrets-of-a-personal-trainer-e175921600.html>
15. Halperin I, Aboodarda SJ, Button DC, Andersen LL, Behm DG. ROLLER MASSAGER IMPROVES RANGE OF MOTION OF PLANTAR FLEXOR MUSCLES WITHOUT SUBSEQUENT DECREASES IN FORCE PARAMETERS. *Int J Sports Phys Ther* 2014;9:92–102.
16. Schleip R. Fascial plasticity – a new neurobiological explanation Part 2. *Journal of Bodywork and Movement Therapies* 2003;7:104–16.
17. Herda TJ, Cramer JT, Ryan ED, McHugh MP, Stout JR. Acute Effects of Static versus Dynamic Stretching on Isometric Peak Torque, Electromyography, and Mechanomyography of the Biceps Femoris Muscle. *Journal of Strength and Conditioning Research* 2008;22:809–17.
18. Fletcher IM, Jones B. The effect of different warm-up stretch protocols on 20 meter sprint performance in trained rugby union players. *J Strength Cond Res* 2004;18:885–8.
19. Jaggars JR, Swank AM, Frost KL, Lee CD. The Acute Effects of Dynamic and Ballistic Stretching on Vertical Jump Height, Force, and Power. *Journal of Strength and Conditioning Research* 2008;22:1844–9.
20. Costa PB, Graves BS, Whitehurst M, Jacobs PL. The acute effects of different durations of static stretching on dynamic balance performance. *J Strength Cond Res* 2009;23:141–7.
21. Junker D, Stögl T. The Training Effects of Foam Rolling on Core Strength Endurance, Balance, Muscle Performance and Range of Motion: A Randomized Controlled Trial. *J Sports Sci Med* 2019;18:229–38.
22. Zhang Q, Trama R, Fouré A, Hautier CA. The Immediate Effects of Self-Myofascial Release on Flexibility, Jump Performance and Dynamic Balance Ability. *Journal of Human Kinetics* 2020;75:139–48.
23. Faigenbaum A, Kang J, McFarland J, Bloom J, Magnatta J, Ratamess N, Hoffman J. Acute Effects of Different Warm-Up Protocols on Anaerobic Performance in Teenage Athletes. *Pediatric exercise science* 2006;17:64–75.
24. Chaouachi A, Castagna C, Chtara M, Brughelli M, Turki O, Galy O, Chamari K, Behm DG. Effect of Warm-Ups Involving Static or Dynamic Stretching on Agility, Sprinting, and Jumping Performance in Trained Individuals. *The Journal of Strength & Conditioning Research* 2010;24:2001.
25. Bishop DC, Middleton G. Effects of static stretching following a dynamic warm-up on speed, agility and power. *Journal of Human Sport and Exercise* 2013;8:391–400.

26. Seer E, Kaya DÖ. Comparison of Immediate Effects of Foam Rolling and Dynamic Stretching to Only Dynamic Stretching on Flexibility, Balance, and Agility in Male Soccer Players. *Journal of Sport Rehabilitation Human Kinetics*; 2021;31:10–6.
27. Van Gelder LH, Bartz SD. The Effect of Acute Stretching on Agility Performance. *The Journal of Strength & Conditioning Research* 2011;25:3014.
28. KENDALL BJ. The Acute Effects of Static Stretching Compared to Dynamic Stretching with and without an Active Warm up on Anaerobic Performance. *Int J Exerc Sci* 2017;10:53–61.