Universiti Teknologi MARA
Cawangan Perlis
Jurnal Intelek

Volume 19 Issue 1 (February) 2024

The Effects of Foam Rolling vs Massage as Recovery Tools Among UiTM Perlis FC Footballers

Nurul Afiqah Bakar[1]*, Muhammad Nuh Sharid Roslan[2], Muhammad Hazim Zuraimy[3], Mohd Hazwan Zikri Abdul Halim[4] and Mohd Faridz Ahmad[5]

[1,2,3,5]Faculty of Sports Science and Recreation, Universiti Teknologi MARA, Cawangan Perlis, Kampus Arau, 02600 Arau, Perlis, Malaysia
[4]Football Association of Kedah, Aras 1, Astaka Utama, Stadium Darul Aman, Jalan Stadium, 05100 Alor Star, Kedah Darul Aman

*Authors' Email Address: *[1]nurulafiqah_bakar@uitm.edu.my, [2]sharidroslan@gmail.com, [3]mhazimz_18@yahoo.com, [4]wannrooney89@gmail.com, [3]faridzahmad@uitm.edu.my*

Received Date: 22 November 2023
Accepted Date: 5 December 2023
Revised Date:21 December 2023
Published Date: 31 January 2024

*Corresponding Author

ABSTRACT

A new idea of recovery has been discovered called self-myofascial release. Foam rolling is one of the self-myofascial approaches that can help to speed up the recovery process. It works by relaxing contracted muscles, improving blood and lymphatic circulation, and stimulating the stretch reflex in muscles. However, there is no previous research that studies the comparison of recovery modalities between foam rolling (FR), massage (M) and passive recovery (PAS) as tools of the recovery process on youth footballers. The aim of this study was to examine the effectiveness of FR (20 minutes of FR exercises on quadriceps, hamstrings, adductors, gluteus, and gastrocnemius), M (20 minutes of M on quadriceps, hamstrings, adductors, gluteus and gastrocnemius) and passive recovery (20 minutes sit on a bench) interventions performed immediately after a training session on Total Quality Recovery (TQR), perceived muscle soreness (VAS), jump performance, agility, sprint, and flexibility 24 hours after the training. During the two experimental sessions, 30 UiTM FC football players participated in a randomized controlled trial design. The first session was designed to collect the pretest values of each variable. After baseline measurements, the players performed a standardized football training. At the end of the training unit, all the players were randomly assigned to the FR, M and PAS recovery groups. A second experimental session was conducted to obtain the posttest values. As results, CMJ, agility (Arrowhead) and TQR showed positive effects in the FR group in comparison with the M and PAS groups at 24 hours after training. Thus, it is recommended that football coaches and physical trainers working with football players use a structured recovery session lasting approximately 20 minutes based on FR exercises that could be implemented at the end of a training session to enhance recovery between training loads.

Keywords: *foam rolling, manual therapy, massage, myofascial release, team sport*

ISSN: 1675-9885 / E-ISSN 2231-7716
DOI: http://10.24191/ji.v19i1.24775

INTRODUCTION

Football is a strenuous contact team sport that integrates technical, tactical, and physical skills (Stølen et al., 2005). Match analysis and physiological monitoring have revealed that football encompasses intermittent bouts of high-intensity actions of short duration, including sprinting, jumping, dribbling, tackling, and kicking (Rampinini et al., 2011). Time-motion analysis studies reported that during a 90-min game, an elite player is capable of traversing a distance of 10–12 km, reaching around 80–90% of their maximum heart rate and 70–80% of their maximum oxygen consumption (Stølen et al., 2005). Consequently, most of the body's physiological systems experience stress during games and intense training programs (Reilly & Rigby, 2001), which can make certain players more susceptible to acute fatigue and overload injuries. This is particularly true during congested fixture periods, when players are expected to compete and train frequently within a limited timeframe (Nédélec et al., 2012).

Prior research (Ispirlidis et al., 2008; Nédélec et al., 2014) has shown that it takes a minimum of 48-72 hours of rest for metabolic balance, muscle recovery, and reduction in anaerobic performance decline after a competitive match. This duration of rest may be lengthy when teams are faced with frequent matches in a short period of time. For instance, indicators of muscle injury at a biochemical level, such as creatine kinase (CK) and markers of inflammation (Ispirlidis et al., 2008; Nédélec et al., 2014), remain present for a duration beyond 72 hours; physical performance decrements (as evidenced by the large decreases in jump and sprint performance, and in isokinetic knee extension and flexion peak torques) are present for 24–96 hours after competition (Ispirlidis et al., 2008; Nédélec et al., 2014; Thomas et al., 2017). Hence, the ability to recover from rigorous training and competition is seen as a crucial factor in achieving success in football (Rey et al., 2019). In order to improve performance and minimize the occurrence of muscle damage, overtraining symptoms, and lower limb injuries, it is essential for technical and medical personnel to employ efficient recovery procedures (Rey et al., 2019).

In order to expedite the process of recovery, many postexercise approaches have been proposed and categorized as either active or passive recovery (Barnett, 2006). The football-specific scientific literature has examined and discussed on the effectiveness of various recovery procedures (Rey et al., 2019), such as stretching (Marin et al., 2012; Tessitore et al., 2007), low intensity aerobic activity (Rey et al., 2012), cold-water immersion (Rowsell et al., 2009), or neuromuscular electrical stimulation (Taylor et al., 2015). Nevertheless, there are often employed techniques in the field that lack empirical support specifically in the context of football players (e.g., massage, sauna, foam rolling [FR], and whole-body cryotherapy) (Rey et al., 2012). Foam rolling is an emerging technique for recovery, which involves self-myofascial release (Schroeder & Best, 2015). It shares various physiological effects with massage and has the potential to aid in fatigue recovery. These effects include enhancing arterial function, improving vascular endothelial function, reducing muscle soreness, and decreasing activity in the parasympathetic nervous system (Beardsley & Skarabot, 2015).

During self-myofascial release (FR), individuals apply pressure to the affected soft tissue using their own body mass, which stimulates the Golgi tendon unit and reduces muscular tension (Junker & Stoggl, 2015). As far as we know, there are only a few researches that have examined the impact of FR on the process of recovery. In general, published research has demonstrated the efficacy of FR (foam rolling) in promoting recovery by reducing muscle soreness (Casanova et al., 2017; MacDonald, 2013; Pearcey et al., 2015) and performance improvements in sprint (Pearcey et al., 2015), jump (MacDonald, 2013; Pearcey et al., 2015), agility (Pearcey et al., 2015), muscle activation (MacDonald, 2013), and passive and dynamic range of motion (MacDonald, 2013) in comparison with various control conditions.

Athletes and players frequently employ foam rolling as a prominent recovery technique following competition and training. However, as far as we know, only one study has evaluated the efficacy of FR for recovery following football-specific training. The aim of this study was to investigate the efficacy of a foam roller as a recovery tool for male football players. We in particular examined the

impact of FR on muscular soreness, perception of recovery, sprint performance, agility, vertical jump height, horizontal jump distance, and range of motion. Assuming the underlying principle of myofascial release has the potential to expedite the restoration of homeostasis in muscles that have been exercised, we put forth the hypothesis that engaging in self-massage using a foam roller would elicit more pronounced recovery-related outcomes when compared to both the massage therapy and control groups.

METHOD

Experimental Approach to the Problem

A randomized parallel study was conducted to assess the effects of three post-exercise recovery modalities on physical performance and perceived recovery 24 hours following a training session. Examining football players during their real training period was believed to enhance the relevance and application of the results. The three modes were as follows: (a) foam rolling (FR), (b) massage (M), and (c) passive recovery (PAS). During the testing sessions, it was necessary for the participants to wear identical athletic gear, and the measurements were taken at identical times of day in order to mitigate the impact of diurnal fluctuations on the chosen variables throughout both experimental sessions. Prior to the commencement of each testing session, players abided by the aforementioned guidelines that were formulated to be adhered to before the administration of the test.: (a) not consume any energy/performance-enhancing drinks or supplements 48 h prior to testing; (b) not consume beverages containing caffeine or alcohol at least three hours before testing; and (c) not consume food at least two hours prior to testing. Furthermore, the first experimental session was conducted following a period of 72 hours of rest. Prior to anaerobic testing, all participants engaged in a 10-minute standardized warm-up routine. This routine consisted of 5 minutes of submaximal running, both with and without changes in direction, followed by 2 minutes of gentle dynamic stretching (10 repetitions for hamstrings, quadriceps, and calf muscles) and by short distance accelerations (3 submaximal sprints, progressing to 90% of their maximal velocity for the shuttle distance [30 + 30 m]). This routine was supervised by the team's physical trainer before the tests.

Participants

Thirty Universiti Teknologi MARA (UiTM) collegiate football players volunteered for this study (Mean ± SD; age = 20 ± 1.1 years; height = 171 ± 4.5 cm; weight = 65 ± 7.4 kg). All participants were classified as intermediate football players with 9.5 ± 2.5 years of football training. Subjects were randomly assigned to experimental (a) foam rolling (FR) group (n=10), (b) massage (M) group (n=10), and control (c) passive recovery (PAS) group (n=10) (Table 1). The players consistently engaged in 4-5 football sessions per week with their team and, on average, spent 10 ± 1.7 hours per week in their regular training regimen. The team consistently competed in one official match per week. The probe occurred in the midst of the season. During the investigation, players were engaging in five weekly training sessions. Only players who completed the entire training session were taken into account for inclusion. The exclusion criteria were injuries that caused the individual to miss one or more football matches or training sessions in the month leading up to the commencement of data collection. None of the participants had previous experience of rigid FR exercise protocol. Before taking part, the investigator provided all participants with information regarding the advantages and potential risks associated with participating in the experiment. All participants then read and signed a written informed consent statement, expressing their voluntary intention to participate. Human ethics clearance was granted by the Institutional Ethics Committee prior to the completion of any testing procedures.

Procedures

Two consecutive experimental sessions were conducted during the in-season period. The participants were instructed to arrive well-rested at the same time each evening for both experimental sessions, which were separated 24 hours apart. The first session was intended to obtain the player's subjective evaluations and anthropometric measurements (pretest). Immediately after, all players engaged in a regular football training session which lasted for 60 minutes. The session comprised of various activities, including a 7-minute session of continuous dribbling and passing combination play, a 6-minute small-sided game, two sets of 12 intervals of 15-second sprints with 15-second intervals of passive rest between each repetition, and 5 minutes of passive recovery between sets and two sets of 15-minute-high intensity positional games. In order to maintain consistent training intensity between the FR and control groups, players were instructed to rate their perceived effort (RPE) on Borg's 0-10 scale at the end of the session. The session duration was used to calculate an RPE-load value by multiplying each individual RPE value. Following the completion of the training unit, all players were assigned to either the FR group, M group or the passive recovery (PAS) group by a random selection process. A second experimental session was conducted to get the post-test values. Players performed the same test, administered in the same order as in the first trial.

Jumping, sprint velocity, agility and flexibility are considered as determining factors of professional football players (Stølen et al., 2005). These indicators were used in this study as simple and reliable measures of performance. Before the tests the players performed a 15 min structured warm-up adapted from Olsen et al. (2005) to prevent lower limb injuries, during which they carried out transit mobility, technique, balance, and power exercises. After the warm-up, the players performed 5 tests, administrated in the same order throughout the study: (a) countermovement jump (CMJ); (b) standing long jump (SLJ); (c) 20 m sprint; (d) Arrowhead agility test; and (e) sit and reach. Participants were habituated to these tests, routinely administrated during the football season. For each test, players were allowed 2 trials, with a 3 min recovery period between. The best trial was used for subsequent analysis.

Vertical Jump Performance

CMJ was performed on a force plate (SWIFT EZJump Mat, Australia), which calculates the height of the jump. For the CMJ, from a standing position with the hands fixed on the hips, the football players were required to bend their knees to a freely chosen angle and perform a maximal vertical thrust (Rodacki et al., 2002). Participants were instructed to keep their body vertical throughout the jump and to land with knees fully extended. Any jump that was perceived to deviate from the required instructions was repeated.

Horizontal Jump Performance

SLJ test required participants to stand at the back of a line marked on the ground together with feet slightly apart. A pair foot take-off and landing was used, together with arms yet bending regarding the knees in imitation of provide foregoing drive. The participants attempted in conformity with jump as far as possible, landing with both feet without falling backwards.

20-m Sprint Test

The 20 m sprint was performed on the field. This test involves running over 20 meters of a single maximal sprint, with recorded time. Participants were given to practice before the test started. Start with one foot in front of the other from a stationary position. The front foot has to be either on or behind the start line. This starting position should be held for 2 seconds before starting and there should be no rocking movements are required. This test used the stopwatch to record the timing. The timing started after the participants from the first movement and the timing stopped after the chest of the participants passed the finishing line. Each player was granted two attempts, with a two-minute interval

of rest in between. Throughout the two experimental sessions, the participants were instructed to wear the same footwear in order to minimize the impact of varying sporting equipment on performances.

Arrowhead Agility Test

The arrowhead agility test was measured by using a stopwatch. The participants are allowed to position their front foot 20 cm away from the starting point. When they are ready, the player needs to sprint as fast as they can around the marker, from the starting point to the middle marker (A), turn to the side (B), then sprinted around marker (C) and lastly sprint back to the starting point. Time will be started and taken once the running begins. The participants will run either on the left side or right side depending on the trial. Two trials are needed for each side. The order will be alternated to avoid any effect of fatigue on the other side.

Flexibility (Sit-and-Reach) Test

The sit-and-reach test was applied to evaluate the progress in lumbar and hamstring flexibility. The sit-and-reach test was conducted using the protocol proposed by Wells and Dillon (1952). Two trials were conducted, with a 30-second interval between each trial.

Perceptual Measures

Two different perceptual measures were administered before the training session and 24 hours after. The Total Quality Recovery (TQR) scale proposed by Kenttä and Hassmén (1998) was used to evaluate the player's general perception of recovery. Additionally, players rated their muscle soreness level on a visual analog scale (VAS) from 1 to 7 (1 = very, very good; 2 = very good; 3 = good; 4 = tender but not sore; 5 = sore; 6 = very sore; and 7 = very, very sore) (Morgan et al., 1988) using palpation of the belly and the distal region of relaxed knee extensors and flexors in order to assess delayed onset muscle soreness. The players had been familiarized with the instruments for one week prior to the beginning of the study.

Recovery Modalities

The recovery protocols were performed immediately at the end of the first experimental training session (approximately 5 min after the training session). The participants in the FR group, using a high-density foam roller, performed five different exercises, targeting muscle groups most used in soccer (quadriceps, hamstrings, adductors, gluteus, and gastrocnemius). Players were instructed to begin with the foam roller at the most distal portion of the muscle and to place as much of their body mass as tolerable on the foam roller at all times. Players were advised to roll their body mass back and forth across the foam roller as smoothly as possible at a cadence of 50 beats per minute (Pearcy et al., 2015). The participants performed each of the five exercises on both the right and left legs for two 45-s bouts each with a 15-s rest. Total FR time was 20 minutes. The FR protocol was supervised by two of the investigators.

The massage protocol adapted and modified from Arabaci (2008) was for recovery modalities of massage. The massage protocol was performed chronologically on each participant to ensure consistency and reliability. The massage procedure focused on the anterior and posterior sides of both legs. The massage was applied on the same muscle group (quadriceps, hamstrings, adductors, gluteus and gastrocnemius) as foam rolling. The lubrication assists the sports massage therapist to easily maneuver the hands on the skin surface and to reduce friction which may agitate the participant's skin. According to Arabaci (2008), a sufficient amount of oil would be enough to give comfort during the application of massage without irritating the skin or hair on the lower limb. Total M time was 20 minutes. The M protocol was conducted by two experienced masseurs from a professional football club.

During the passive recovery, the players were instructed to sit on a bench for 20 minutes, according to the duration of the FR and M protocols. The players were instructed to not engage in any other form of recovery procedure (i.e., PNF, cold water immersion, etc.) during the two experimental sessions.

Statistical Analyses

Data were presented as means ± SD. A 0.05 level of confidence was selected throughout the study. Statistical analyses were conducted using the statistical package IBM SPSS Statistic version 25. A paired samples t-test was performed to evaluate whether there was a difference between the performance and perceptual variables of UiTM Perlis FC footballers before and after the recovery intervention. In addition to this testing, for each variable percentage difference in the change scores between FR, M and passive recovery (PAS) from pretest to posttest was calculated.

RESULTS

Performance Measures

The results in Table 1 indicated that there was significant improvement after post-test when compared to pretest in AAT (right) performance while showed a significant decrement after post-test when compared to pretest in CMJ performance for passive recovery. No significant different had been found in other variables. For foam rolling, there was significant improvement after post-test when compared to pretest in CMJ, AAT (right) and AAT (left) performance while no different had been found in other variables. Lastly for massage, there was significant improvement only for AAT (right) and AAT (left) performance while no different had been found in other variables.

Perceptual Measures

There was significant improvement after post-test when compared to pretest in VAS for passive recovery and TQR for foam rolling while the other variables were found to be no significant improvement as being showed in Table 1.

Table 1: Pre-Post Results in Physical Performance Tests and Subjective Ratings After FR, M and PAS in UiTM FC Football Players

	Passive Recovery (*N*=10)				Foam Rolling (*N*=10)				Massage (*N*=10)			
	Pre	Post	*p* values	Δ (%)	Pre	Post	*p* values	Δ (%)	Pre	Post	*p* values	Δ (%)
Performance Measure												
CMJ (cm)	38.4±5.8	37.2±6.1	*0.02*	-3.01	37.4±3.8	39.8±3.2	*0.003*	6.63	39.2±6.6	40.2±6.3	*>0.05*	2.3
SLJ (m)	2.15±0.21	2.18±0.21	*>0.05*	1.4	2.19±0.13	2.30±0.14	*>0.05*	4.84	2.15±0.21	2.18±0.21	*>0.05*	5.13
20 m sprint (s)	3.3±0.2	3.3±0.2	*>0.05*	0.85	2.2±0.1	2.3±0.1	*>0.05*	-1.01	2.2±0.2	2.2±0.2	*>0.05*	3.9
AAT – Left (s)	8.2±0.5	8.3±0.5	*>0.05*	0.46	8.3±0.3	7.8±0.5	*0.01*	-5.75	8.1±0.3	7.7±0.2	*0.001*	-4.8
AAT – Right (s)	8.3±0.5	8.3±0.5	*0.008*	0.70	8.4±0.3	7.8±0.6	*0.01*	-7.04	8.3±0.3	7.8±0.3	*0.001*	-5.81
Sit and Reach (cm)	35.6±9.9	35.6±9.7	*>0.05*	0.15	36.2±8.0	37.1±7.5	*>0.05*	2.59	35.7±8.5	36.6±6.5	*>0.05*	2.59
Perceptual Measure												
TQR	15±2	12±1	*>0.05*	-17.01	13±2	15±0	*0.005*	13.64	15±2	15±1	*>0.05*	3.36
VAS	1.4±1.3	3.3±1.4	*0.01*	135.71	2.7±2.0	3.3±1.9	*>0.05*	22.22	2.0±2.2	2.3±2.3	*>0.05*	15

DISCUSSION

Several post-training recovery interventions have been suggested to enhance performance, and to avoid the incidence of muscle damage, the symptoms of overreaching, and the lower limb injuries that result from the high frequency and intensity of training, despite the lack of scientific agreement regarding their efficacy (Rey et al., 2012). Thus, the present study was mainly designed to investigate the effects of immediate post-training foam rolling (FR), massage (M) interventions and passive recovery (PAS) in UiTM Perlis FC football players on performance and perceptual variables.

Performance Measures

The primary findings of this investigation were found to have significant improvement after post-test when compared to pre-test for AAT (right) in passive recovery. The possible explanation might be due to the nature of AAT movement as it need more resting time since it can be considered as high-intensity exercise. This had been agreed by Van Gelder and Bartz (2011) that agility is as a rapid whole-body movement with change of running direction in response to a stimulus. Therefore, during passive recovery, players were required to rest which directly led them having more time for recovery. Apart from that, there was a significant decrement had been showed in CMJ performance after post-test when compared to pre-test. Since jumping performance can be defined as can be defined as the explosive nature of force production (Abdessemed et al., 1999) which requires a minimum of at least 3 minutes for its full replenishment (Pincivero and Campy, 2004). Due to that, the possible explanation of performance decrement might be due to recovery time was too long which led muscle to become less ready to perform the post-test as being recommended by Spencer et al. (2006) as to ensure athlete have optimal preparation for the following exercise. In contrast, there were no significant improvement had been found in SLJ, 20 m sprint, AAT (left) and sit & reach. The possible explanation of reducing the performance might be due to the inability to reduce the blood lactate during recovery session. Previous study had agreed that, decreasing blood lactate levels following the exercise is a primary marker of recovery session (Lu et al., 2019). Therefore, since the recovery methods of this study was only sitting for 20 minutes, the level of blood lactate remaining unchanged or might be slightly reduce since movement such as walking are more effective in reducing blood lactate levels due to muscle pumping mechanism (Brown and Glaister, 2014; Gmada et al., 2005).

This current study incorporated many anaerobic tests and identified inconsistencies about the effect of foam roller exercises on each variable. Foam rolling methods shown to have a significant improvement after post-test when compared to pre-test for CMJ, AAT (right) and AAT (left). The finding of this study found to be similar with previous studies by Pearcey et al. (2015) when they found that the FR group showed significant improvements in vertical jump performance 24 hours following exercise-induced muscle damage and Rey et al., (2019) as FR had a large benefit in minimizing decrements in agility performance 24 hours after training (Rey et al., 2019). The possible explanation might be, since both components can be considered as high intensity movement, the improvement may have been related to a reduction in reduced pain, increased voluntary activation, and a reduction in neural inhibition (MacDonald, 2013; Pearcey et al., 2015). In contrast, there were no significant improvement had been found in SLJ, 20 m sprint and sit & reach. There were several previous studies that found similar findings with this study where foam roll does not improve power performance (Jones et al.,2015), a review by Wiewelhove et al. (2019) found that post-rolling recovery exercise-induced decreases in sprint and no significant different for flexibility after foam rolling session (Couture et al., 2015). The possible explanation of no improvement for all variables might be due to the consistency of the pressure given towards the selected area which might become as one of the limitations of this study. This had been agreed by Couture et al. (2015) that a major factor influencing the results was the pressure per unit area exerted by the roller onto the tissue, which is influenced by the roller density and diameter.

In addition, this study found to have a significant improvement for massage recovery protocols after post-test when compared to pre-test for AAT (right) and AAT (left). The possible explanation

might be due to nature of agility exercise which can be considered as high intensity movement that can caused muscle damaged. Therefore, previous study by Mancinelli et al. (2006) have the similar findings where the application of massage can alleviate soreness on agility performance. In contrast, there were no significant different had been found in CMJ, SLJ, 20 m sprint and sit & reach. This study found to be similar from previous study by Zainuddin et al. (2005) where it is beneficial in reducing DOMS and swelling associated with high-intensity eccentric exercise, but for recreational athletes and sports professionals who use massage should be cognizant of the fact that no positive effects of massage on recovery of muscle function can be expected. In addition, no different had been found on those variables might be due to the consistency of massage related to pressure and area which can be considered as one of the limitations of this study.

Perceptual Measures

The potential for psychological factors influencing the individual's performance is crucial for coaches (Tessitore et al., 2007). The TQR scale is a commonly employed approach to evaluate the recovery and under-recovery status of athletes. It aims to demonstrate the connection between training and recovery in a practical and non-invasive way (Kenttä and Hassmén, 1998). Earlier research has shown significant inverse correlations between TQR (Total Quality Recovery) and indicators of muscle injury, such as CK (creatine kinase). This suggests that TQR could serve as a reliable indicator of the recovery status of athletes participating in team sports (Osiecki et al., 2015). The results of the present study showed a significant improvement ($p=0.005$) in TQR values 24 hours post-training for the FR group, indicating self-massage with foam rolling can enhance a player's perception of recovery significantly more than massage and passive recovery. This data is consistent with earlier literature that has utilized the TQR scale to evaluate the recovery state following the implementation of various recovery techniques in football players. In their study, Rey et al. (2019) investigated the impact of foam rolling as a post-match recovery method on the physical performance and subjective perceptions of recovery in young football players. The researchers used the TQR method to assess these factors. The aforementioned study's findings demonstrate that utilizing foam rolling as a recovery strategy has a significant effect on TQR values. Considering the weight of players' perceptions in football, the findings of this study have noteworthy practical implications. Therefore, coaches should contemplate incorporating foam rolling exercises into the cool-down phase to enhance the players' psychological well-being and their readiness for subsequent training sessions the following day. VAS results in addition, showed that active recovery modalities; FR and M are able to reduce soreness.

CONCLUSION

In summary, the findings of the present investigation suggest that incorporating post-training FR exercises may be beneficial for alleviating muscle soreness, improving players' perception of recovery, enhancing vertical jump performance, and increasing agility in professional football players on the subsequent day. Football, being a physically demanding and high-intensity team sport, imposes substantial physical and psychological demands on players during both training and competition. Therefore, coaches and strength and conditioning professionals must employ appropriate recovery strategies to optimize players' readiness for upcoming performances. This study shows that incorporating FR exercises into the cool-down phase for football players is beneficial in reducing muscle pain, improving the players' perception of recovery, and enhancing anaerobic performance 24 hours after an intense football training session. Considering the importance of players' emotional state, it might be considered that any measures made to improve the perception of recovery following exercise could assist football players to train effectively, meet the intended workload, and achieve the desired level of performance. Therefore, in order to reduce the detrimental effects of football training, coaches and strength and conditioning experts who work with elite players might construct recovery sessions lasting around 20 minutes, utilizing FR exercises, to improve recovery between training sessions. Furthermore, coaches could be advised to employ perception questionnaires to monitor players' levels

of fatigue and recovery, as well as individual responses to specific recovery methods, to customize recovery sessions, especially during congested fixture periods or demanding training micro cycles.

ACKNOWLEDGEMENTS

The authors would like to express appreciation to Universiti Teknologi MARA Perlis Branch, Arau Campus for its equipment and amenities that were useful to ensure the completion of this study, to Football Association of Kedah for its certified masseurs and thank to all UiTM Perlis FC players who took part in this study.

FUNDING

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

AUTHORS' CONTRIBUTION

Bakar, N.A., Roslan, M.N.S. and Zuraimy, M.H. conceived, planned the experiments and data preparation. Roslan, M.N.S., Zuraimy, M.H. and Abdul Halim, M.H., carried out the experiments. Ahmad, M.F. contributed to the method and writing. Bakar, N.A. took the lead in writing the manuscript. All authors provided critical feedback and helped shape the research, analysis and manuscript.

CONFLICT OF INTEREST DECLARATION

We certify that the article is the Authors' and Co-Authors' original work. The article has not received prior publication and is not under consideration for publication elsewhere. This research/manuscript has not been submitted for publication nor has it been published in whole or in part elsewhere. We testify to the fact that all Authors have contributed significantly to the work, validity and legitimacy of the data and its interpretation for submission to Jurnal Intelek.

REFERENCES

Abdessemed, D., Duche, P., Hautier, C., Poumarat, G. & Bedu, M. (1999). Effect of recovery duration on muscular power and blood lactate during the bench press exercise. *Int J Sports Med 20*, 368–373. https://doi.org/10.1055/s-2007-971146.

Arabaci, R. (2008). Acute effects of pre-event lower limb massage on explosive and high speed motor capacities and flexibility. *Journal of Sports Science and Medicine*, *7*, 549-555.

Barnett, A. (2006). Using recovery modalities between training sessions in elite athletes: does it help? *Sports Medicine*, *36*(9), 781-797.

Beardsley, C., & Škarabot, J. (2015). Effects of self-myofascial release: A systematic review. *Journal of Bodywork and Movement Therapies*, *19*(4), 747-758. https://doi.org/10.1016/j.jbmt.2015.08.007

Bradley, P. S., & Portas, M. D. (2007). The relationship between preseason range of motion and muscle strain injury in elite soccer players. *The Journal of Strength & Conditioning Research*, *21*(4), 1155-1159. http://doi.org/10.1519/R-20416.1

Brown, J. & Glaister, M. (2014). The interactive effects of recovery mode and duration on subsequent repeated sprint performance. *J Strength Cond Res., 28*(3), 651–660. 10.1519/JSC.0b013e3182a1fe28.

Casanova, N., Reis, J. F., Vaz, J. R., Machado, R., Mendes, B., Button, D. C., Pezarat-Correia, P. & Freitas, S. R. (2018). Effects of roller massager on muscle recovery after exercise-induced muscle damage. *Journal of Sports Sciences*, *36*(1), 56-63. http://doi.org/10.1080/02640414.2017.1280609

Couture, G., Karlik, D., Glass, S. C., & Hatzel, B. M. (2015). The effect of foam rolling duration on hamstring range of motion. *The Open Orthopaedics Journal, 9*, 450-455. https://doi.org/10.2174%2F1874325001509010450.

Gmada, N., Bouhlel, E., Mrizak, I., Debabi, H., Ben Jabrallah, M., Tabka, Z., Feki, Y. & Amri, M. (2005). Effect of combined active recovery from supramaximal exercise on blood lactate disappearance in trained and untrained man. *Int J Sports Med., 26*(10), 874–879. 10.1055/s-2005-837464.

Ispirlidis, I., Fatouros, I. G., Jamurtas, A. Z., Nikolaidis, M. G., Michailidis, I., Douroudos, I., Margonis, K., Chatzinikolaou, A., Kalistratos, E., Katrabasas, I., Alexiou, V. & Taxildaris, K. (2008). Time-course of changes in inflammatory and performance responses following a soccer game. *Clinical Journal of Sport Medicine*, *18*(5), 423-431. http://doi.org/10.1097/JSM.0b013e3181818e0b

Jones, A., Brown, L. E., Coburn, J. W., & Noffal, G. J. (2015). Effects of foam rolling on vertical jump performance. *International Journal of Kinesiology and Sports Science, 3*(3), 38-42. 10.7575/aiac.ijkss.v.3n.3p.38.

Junker, D. H., & Stöggl, T. L. (2015). The foam roll as a tool to improve hamstring flexibility. *The Journal of Strength & Conditioning Research*, *29*(12), 3480-3485. http://doi.org/10.1519/JSC.0000000000001007

Kenttä, G., & Hassmén, P. (1998). Overtraining and recovery: a conceptual model. *Sports Medicine*, *26*, 1-16.

Kinugasa, T., & Kilding, A. E. (2009). A comparison of post-match recovery strategies in youth soccer players. *The Journal of Strength & Conditioning Research*, *23*(5), 1402-1407. http://doi.org/10.1519/JSC.0b013e3181a0226a

Little, T., & Williams, A. G. (2005). Specificity of acceleration, maximum speed, and agility in professional soccer players. *The Journal of Strength & Conditioning Research*, *19*(1), 76-78. http://doi.org/10.1519/14253.1

Lu, X., Wang, Y., Lu, J., You, Y., Zhang, L., Zhu, D. & Yao, F. (2019). Does vibration benefit delayed-onset muscle soreness?: A meta-analysis and systematic review. *J Int Med Res. 47*(1), 3–18. 10.1177/0300060518814999

MacDonald, G. Z., Button, D. C., Drinkwater, E. J., & Behm, D. G. (2014). Foam Rolling as a Recovery Tool after an Intense Bout of Physical Activity. *Medicine and Science in Sports and Exercise*, *46*(1), 131-142. http://doi.org/10.1249/MSS.0b013e3182a123db

Mancinelli, C., A., Davis, D., S., Aboulhosn, L., Brady, M., Eisenhofer, J., & Foutty, S. (2006). The effects of massage on delayed onset muscle soreness and physical performance in female collegiate athletes. *Physical Therapy in Sport, 7*(1), 5-13. https://doi.org/10.1016/j.ptsp.2005.10.004.

Marin, P. J., Zarzuela, R., Zarzosa, F., Herrero, A. J., Garatachea, N., Rhea, M. R., & García-López, D. (2012). Whole-body vibration as a method of recovery for soccer players. *European Journal of Sport Science*, *12*(1), 2-8. https://doi.org/10.1080/17461391.2010.536579

Morgan, W. P., Costill, D. L., Flynn, M. G., Raglin, J. S., & O'connor, P. J. (1988). Mood disturbance following increased training in swimmers. *Medicine and Science in Sports and Exercise*, *20*(4), 408-414. https://doi.org/10.1249/00005768-198808000-00014

Nedelec, M., McCall, A., Carling, C., Legall, F., Berthoin, S., & Dupont, G. (2014). The influence of soccer playing actions on the recovery kinetics after a soccer match. *The Journal of Strength & Conditioning Research*, *28*(6), 1517-1523. http://10.1519/JSC.0000000000000293

Nédélec, M., McCall, A., Carling, C., Legall, F., Berthoin, S., & Dupont, G. (2012). Recovery in soccer: part I – post-match fatigue and time course of recovery. *Sports Medicine*, *42*, 997-1015. http://doi.org/10.2165/11635270-000000000-00000

Osiecki, R., Rubio, T. B. G., Coelho, R. L., Novack, L. F., Conde, J. H. S., Alves, C. G., & Malfatti, C. R. M. (2015). The total quality recovery scale (TQR) as a proxy for determining athletes' recovery state after a professional soccer match. *Journal of Exercise Physiology*, *18*(3), 27-32.

Pearcey, G. E., Bradbury-Squires, D. J., Kawamoto, J. E., Drinkwater, E. J., Behm, D. G., & Button, D. C. (2015). Foam rolling for delayed-onset muscle soreness and recovery of dynamic performance measures. *Journal of Athletic Training*, *50*(1), 5-13. https://doi.org/10.4085/1062-6050-50.1.01

Pincivero, D., M. & Campy, R., M. (2004). The effects of rest interval length and training on quadriceps femoris muscle. Part I: Knee extensor torque and muscle fatigue. *J Sports Med Phys Fitness, 44*,111–118.

Rampinini, E., Bosio, A., Ferraresi, I., Petruolo, A., Morelli, A., & Sassi, A. (2011). Match-related fatigue in soccer players. *Medicine & Science in Sports & Exercise*, *43*(11), 2161-2170. http://doi.org/10.1249/MSS.0b013e31821e9c5c

Reilly, T. & Rigby, M. (2002). Effect on active warm-down following competitive soccer. In Murphy, A., Reilly, T., & Spinks, W. (Eds.), *Science and Football IV* (pp. 226–229). Routledge.

Rey, E., Lago-Peñas, C., Lago-Ballesteros, J., & Casáis, L. (2012). The Effect of Recovery Strategies on Contractile Properties Using Tensiomyography and Perceived Muscle Soreness in Professional Soccer Players. *Journal of Strength and Conditioning Research*, *26*(11), 3081–3088. https://doi.org/10.1519/jsc.0b013e3182470d33

Rey, E., Padrón-Cabo, A., Costa, P. B., & Barcala-Furelos, R. (2019). Effects of foam rolling as a recovery tool in professional soccer players. *The Journal of Strength & Conditioning Research*, *33*(8), 2194-2201. https://doi.org/10.1519/jsc.0000000000002277

Rodacki, A. L. F., Fowler, N. E., & Bennett, S. J. (2002). Vertical jump coordination: fatigue effects. *Medicine & Science in Sports & Exercise*, *34*(1), 105-116. https://doi.org/10.1097/00005768-200201000-00017

Schroeder, A. N., & Best, T. M. (2015). Is self myofascial release an effective preexercise and recovery strategy? A literature review. *Current Sports Medicine Reports, 14*(5), 352. https://doi.org/10.1249/jsr.0000000000000182

Spencer, M., Bishop, D., Dawson, B., Goodman, C., & Duffield, R. (2006). Metabolism and performance in repeated cycle sprints: active versus passive recovery. *Medicine And Science In Sports and Exercise, 38*(8), 1492-1499. https://doi.org/10.1249/01.mss.0000228944.62776.a7.

Stølen, T., Chamari, K., Castagna, C., & Wisløff, U. (2005). Physiology of soccer: an update. *Sports Medicine*, *35*, 501-536.

Taylor, T., West, D. J., Howatson, G., Jones, C., Bracken, R. M., Love, T. D., Cook, C. J., Swift, E., Baker, J. S., & Kilduff, L. P. (2015). The impact of neuromuscular electrical stimulation on recovery after intensive, muscle damaging, maximal speed training in professional team sports players. *Journal of Science and Medicine in Sport*, *18*(3), 328–332. https://doi.org/10.1016/j.jsams.2014.04.004

Tessitore, A., Meeusen, R., Cortis, C., & Capranica, L. (2007). Effects of different recovery interventions on anaerobic performances following preseason soccer training. *The Journal of Strength & Conditioning Research*, *21*(3), 745-750.

Thomas, K., Dent, J., Howatson, G., & Goodall, S. (2017). Etiology and Recovery of Neuromuscular Fatigue after Simulated Soccer Match Play. *Medicine and Science in Sports and Exercise*, *49*(5), 955-964. http://dx.doi.org/10.1249/MSS.0000000000001196

Van Gelder, L., H., & Bartz, S., D. (2011) The effect of acute stretching on agility performance. The *Journal of Strength & Conditioning Research 25*(11), 3014-3021. https://doi.org/10.1519/jsc.0b013e318212e42b

Vescovi, J. D., & McGuigan, M. R. (2008). Relationships between sprinting, agility, and jump ability in female athletes. *Journal of Sports Sciences*, *26*(1), 97-107. https://doi.org/10.1080/02640410701348644

Wiewelhove, T., Döweling, A., Schneider, C., Hottenrott, L., Meyer, T., Kellmann, M., Pfeiffer, M. & Ferrauti, A. (2019). A meta-analysis of the effects of foam rolling on performance and recovery. *Frontiers In Physiology, 10* (376), 1-15. https://doi.org/10.3389/fphys.2019.00376.

Zainuddin, Z., Newton, M., Sacco, P., & Nosaka, K. (2005). Effects of massage on delayed-onset muscle soreness, swelling, and recovery of muscle function. *Journal of Athletic Training, 40*(3), 174.