Sriwijaya Journal of Sport
Volume 4, Issue 1, October 2024: 1-12
http://sjs.ejournal.unsri.ac.id/index.php/sjs
e-ISSN: 2808-5299 p-ISSN: 2808-5701

The acute effect of dynamic warm-up at different intensities for jumping performance

Muhammad Al-Basit Fahmi Jasli[1], Nor Fadila Kasim*[1], Fairus Fariza Zainudin[1]

[1]Department of Coaching, Faculty of Sport Science and Coaching, Sultan Idris Education University, Tanjong Malim, Malaysia
*Corresponding Author

Abstract

Background Problems: Warm-up is carried out before exercise to prevent injuries and optimize the subsequent exercise performance. The warm-up intensity for jumping performance should focus on preparing the body for explosive movements while minimizing the risk of injury. A well-designed warm-up routine can improve jump performance, increase flexibility, and enhance muscle activation. **Research Objectives:** This study aims to identify the effect of warm-up at 60%, 80% heart rate on jumping performance, 0 minutes rest, 10 minutes rest, and 20 minutes rest. **Methods:** 10 male athletes (age = 22.40 ± 1.42 years and BMI = 24.28 ± 2.15) involved in this study. Each participant was required to perform 3 types of warm-ups: 60% heart rate, 80% heart rate, and control. Jumping performance was measured immediately after warm-up and post warm-up at 10 and 20 minutes. All measurements were carried out on a different day to avoid bias. **Finding/Results:** The results show that there is no significant difference in intensity at 0 minutes, 10 minutes, and 20 minutes post warm-up and no significant difference in jumping performance across all intensities at 60% heart rate, 80% heart rate, and control group. **Conclusion:** These findings suggest that DWU may not have a significant effect on acute jumping performance. It is suggested that future researchers investigate different warm-up protocol options and use a bigger sample size to better understand how warm-up intensity affects jumping performance.
Keywords: Dynamic Warm-Up; Intensity; Jumping Performance

Received: 17 September 2024; Revised: 19 October 2024; Accepted: 30 October 2024

http://dx.doi.org/10.55379/sjs.v4i1.6

Corresponding author: Nor Fadila Kasim, 35900, Tanjung Malim, Perak, Malaysia
Email: norfadila@fsskj.upsi.edu.my

INTRODUCTION

Warm-up is carried out before exercise to prevent injuries and optimism the subsequent exercise performance, while also ensuring that the body is prepared and the activities that follow will be more effective (Silva et al., 2018). Warm-up before exercise or competition is commonly used to prepare for athletic demands and to prevent injury (Ding et al., 2022). A recent meta-analysis reported that warm-up effectively enhances performance (Sople & Wilcox, 2024). Structural warm-up routines were reported to reduce lower limb injuries Therefore, warm-up is essential in performance enhancement and injury prevention (Chiba et al., 2022).

Usually, a warm-up consists of activities at a slower pace with reduced intensity (McGowan et al., 2015). Warming up the body increases oxygen in the body and activates the production of hormones that will help in the process of channelling energy to the muscles (McGowan et al., 2015). Warm-up is a crucial component of any exercise session as it prepares the body for more intense activity, helps to prevent injury, and increases blood flow to the muscles, raises body temperature, and improves joint flexibility. Several studies have observed that warm-up improves sports performance for events such as running (García-Pinillos et al., 2019), swimming (Czelusniak et al., 2021) and cycling (Fujii et al., 2018). Given that warm-up had no effect on the length of endurance running, it is possible that warm-up had a greater impact on explosive exercise than endurance exercise Hence, five minutes of running warm-up at 70% of their predicted maximum heart rate improved jump performance.

In many sports, the capacity to produce explosive power with the lower body might be seen as crucial. For the execution of various sports acts, particularly those involving direction changes, acceleration, jumping, and running, speed also referred to as power is essential (Yang, 2023). Vertical jump performance is considered an efficient field evaluation of lower body power because the leap height corresponds considerably with power relative to body mass. Since this type of warm-up can increase blood flow to active muscles, raise body temperature, and improve the range of motion within the joints, it is widely believed that children and adolescents who engage in it will enhance physical performance and reduce the risk of muscular injury.

However, this study focused on the warm-up before the training to reach peak power and mean power among athletes. According to the research done, a person who does warm-up activities is more active and has a higher performance in sports than those who do not warm up. This is because warm-up exercises increase blood flow to the muscles, resulting in faster distribution of nutrients to the muscles required to produce energy (Park et al., 2018). This increases the blood supply to the muscles, as well as the delivery of oxygen and glucose required for energy production (Faigenbaum et al., 2022).

The best physical performance can only be produced by a person if adequate preparation has been passed (Faigenbaum et al., 2022). Preparation for good performance can be discussed from two time periods, namely acute and chronic (Boullosa et al., 2020). Acute effects of performance are immediate, whereas chronic effects are experienced over an extended period. The preparation required before a training session, or a game is known as acute preparation. More research is needed to determine the optimal warm-up intensity for different activities, even though the advantages of warm-ups are well recognized. While there are general warm-up guidelines, performance may be improved by following warm-up routines that are specific to the requirements of each sport or activity. Variables including exercise duration, intensity, and movement patterns may influence the optimal warm-up regimen (Boullosa et al., 2020). Dynamic warm-up (DWU) has been shown to improve jumping performance by priming muscles for explosive movement. (Shah & Shende, 2024), dynamic movement can increase the force and power required for vertical leaping performance by boosting muscular flexibility and coordination.

Intensity can also contribute to enhancing the jumping performance, regardless of the type of warm-up. To date, low-intensity warm-up has been reported as not effective in enhancing jumping performance due to insufficient rise in muscle temperature (Sotiropoulos et al., 2010) . However, the optimal intensity level for maximizing jumping performance is still debatable. It is critical to find the ideal intensity because too little can prevent muscle force from being increased, while too much can result in lower performance (Patti et al., 2022). Therefore, athletes must perform warm-up exercises at an optimal intensity and duration to optimism their jump performance. More research is needed to discover the optimal warm-up intensity, duration, and resting period for the best jump performance results.

Thus, investigating the impact of different warm-up intensities on specific activities, such as jumping in badminton, could provide valuable insights for developing more effective warm-up procedures. In badminton, jumping skills are crucial for improving athletes' capacity to smash, access high shots, and conduct rapid movements during competition (Shah & Shende, 2024b). Consequently, superior jumping performance can enhance the likelihood of victory in badminton competitions. In conclusion, warm-up is a crucial component of physical activity, and previous studies have consistently demonstrated its enhancement of sports performance. Warm-up induces physiological alterations that improve muscular functionality, flexibility, and overall performance (Tsurubami et al., 2020). Further research is necessary to determine the optimal warm-up intensity for certain activities, considering the unique needs and demands of each sport. The intensity, duration, and recovery period after warm-up substantially influence jump performance. Inadequate elevation of muscle temperature from low-intensity warm-ups may not improve performance, but high-intensity warm-ups may induce muscular weariness (Lee et al., 2024). Determining the ideal warm-up intensity, length, and rest interval is crucial for athletes to attain peak high jump performance.

METHOD

Research Design

The first session focuses on a 60% heart rate warm-up. For the first test, the athlete will do a treadmill consisting of five minutes of aerobic jogging of low intensity using the H10 Heart Rate Sensor in the body, followed by 6 dynamic warm-ups with moderate intensity. After that, the athletes will do the DWU to get a lower extremity since they are mainly involved in the vertical jump. Each athlete will make nine attempts to do vertical. In addition, there will be 3 rest periods, which will be 0 minutes rest, 10 minutes rest, and 20 minutes rest. Among the DWU performed by athletes are light skip, high knee pulls, light high knee, walking lunges, A-skip, and Carioca. WU exercise twice for 10 m. The repetition that athletes do is 3 repetitions for each exercise in 10 m.

The second session will focus on an 80% HR warm-up. Athletes will do a treadmill consisting of 5 minutes of aerobic jogging of low intensity using the H10 heart rate sensor in the body, followed by 6 dynamic warm-ups with high intensity. The DWU were chosen to target muscles of the lower extremity, then the athlete will perform a vertical jump of nine attempts. After that, there will be 3 rest periods, which will be 0 minutes rest, 10 minutes rest, and 20 minutes rest. The DWU performed by athletes are light skip, high knee pulls, light high knee, walking lunges, a-skip, and carioca. WU exercises twice for 10 m. The repetition that athletes do is six repetitions for each exercise in 10 m. The third session is comprised of five minutes of aerobic jogging of low intensity using the H10 Heart Rate Sensor in the body, without involving dynamic exercises of any kind.

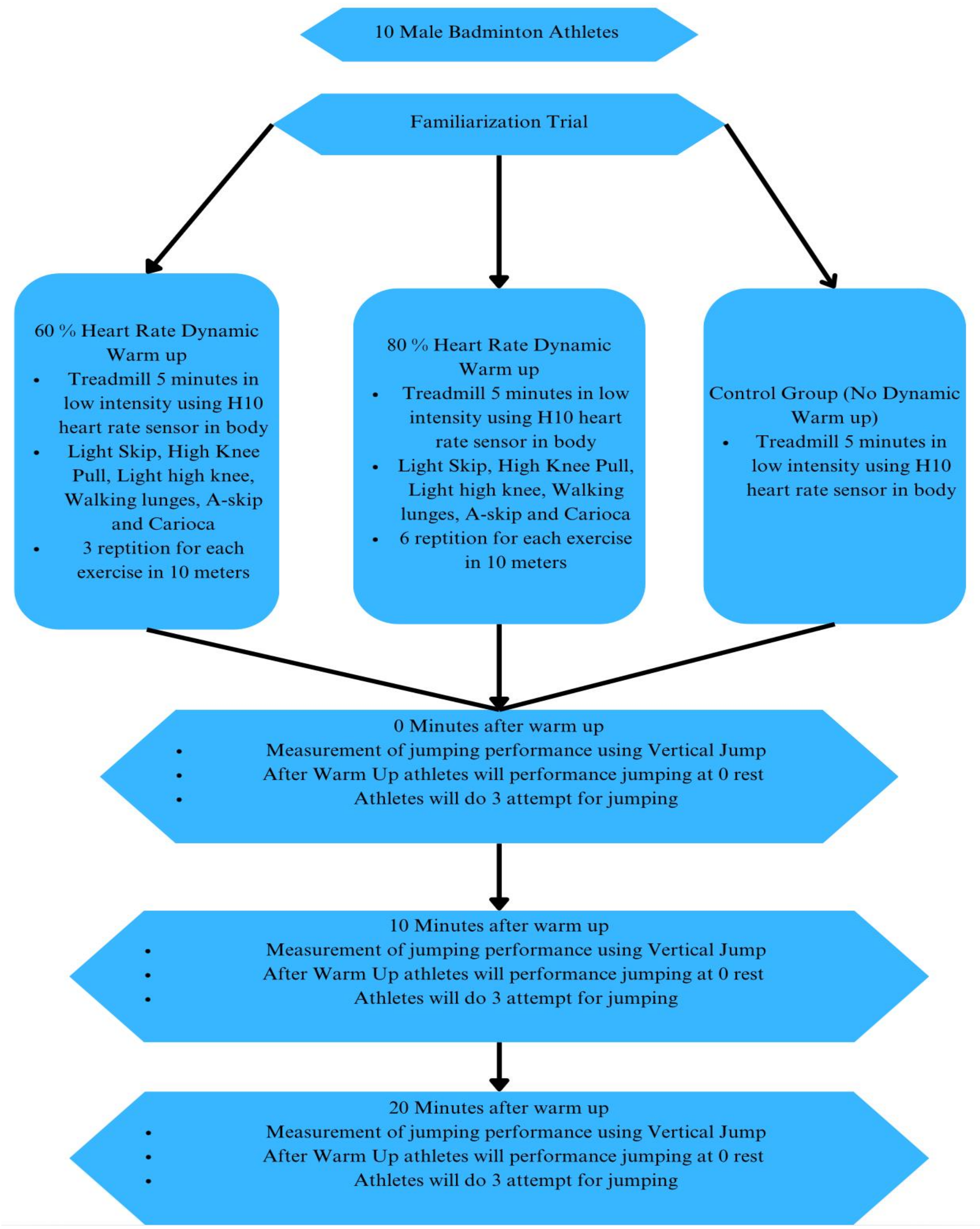

Figure 1. Research Design

Participants

The participants for this study were badminton athletes, aged 20 to 25 years old. Training sessions were conducted three times during data collection. Inclusion criteria required athletes to have a minimum of 3 to 7 months of experience in playing badminton, to be in excellent health, and to have no history of upper limb injuries in the past six months or any condition affecting movement that could impact study outcomes.

Research Instruments

The athletes were ready to go through a VJ test. They are a method for vertical jump athletes who will perform 9 attempts and 3 rest periods, which will be 0 minutes of rest, 10 minutes of rest, and 20 minutes of rest.

Data Analysis

In this study, data will be analysed using the Statistical Package for the Social Sciences (SPSS, version 26.0) and Microsoft Excel 2020. Descriptive statistics, including mean and standard deviation (mean ± SE), will be presented in tables. A One-Way ANOVA will be conducted to assess differences between variables, with statistical significance set at $p < 0.05$. To determine the sample size needed for this repeated measure study, the G*Power software (version 3.1.9.6) was used. A minimum sample size of 7 was required for this study to achieve a statistical power (1-β) of 0.80 at a significant level of $\alpha = 0.05$ and a predicted effect size of 0.25.

RESULTS

Table 1. Comparison of jumping performance of intensity at 0, 10 and 20 minutes post-warm-up

Time	Intensity	Mean ± Std. Error	Sig
0 Minutes	60 %	4085.3 ± 146.9	0.364
	80%	4289 ± 145.8	
	Control	4391.6 ± 163.1	
10 Minutes	60%	4028.2 ± 145.7	0.426
	80%	4279.7 ± 173.5	
	Control	4313.4 ± 177.2	
20 Minutes	60%	4064.5 ± 159.3	0.647
	80%	4242.1 ± 181.4	
	Control	4256.5 ± 165.6	

Table 1 above shows the jumping performance of different intensities immediately after warm-up (0 minute) and at 10- and 20-minutes post-warm-up. One-Way ANOVA analysis indicates that intensity at 0-minute shows that there is no significant difference F (2,29) = 1.049, P=.364, and similarly, no significant differences were seen during the remaining 10 (p=0.426) and rest 20 (p=0.674). Based on the warm-up session, the intensity did not influence the jumping performance immediately after warm-up, nor at 10 and 20 minutes post-warm-up.

Table 2. Comparison of jumping performance of different intensity

Time	Intensity	Mean ± Std. Error	Sig
60 %	0 Minutes	4085.3 ± 146.9	
	10 Minutes	4028.2 ± 145.7	0.468
	20 Minutes	4064.5 ± 159.3	
80%	0 Minutes	4289 ± 145.8	
	10 Minutes	4279.7 ± 173.5	0.543
	20 Minutes	4242.1 ± 181.4	
Control	0 Minutes	4391.6 ± 163.1	
	10 Minutes	4313.4 ± 177.2	0.323
	20 Minutes	4256.5 ± 165.6	

Table 2 below shows intensity at 60% heart rate, 80% heart rate, and Control Group resulted in no significant difference at all frames with F (2,32) =.1.153, P=.468, p=.543 and therefore, 60% and 80% intensity did not affect jumping performance immediately after the warm-up session.

DISCUSSION

The data from Tables 1 and 2 demonstrate that the intensity levels employed during the warm-up sessions—60% and 80% of heart rate, along with a control group with no warm-up—did not significantly influence jumping performance in athletes immediately following the warm-up, nor at 10- and 20-minutes post-rest. At 0 minutes post-warm-up, the One-Way ANOVA analysis of jumping performance indicated no significant differences among the intensity levels (p = 0.364). Likewise, at both 10 minutes (p = 0.426) and 20 minutes (p = 0.647) following the warm-up, no statistically significant variation in jumping performance was observed across the various intensity groups. The results indicate that neither light nor moderate-intensity warm-ups had an immediate or delayed effect on jumping performance (Tsurubami et al., 2020). In this study, they discovered that both moderate and high-intensity warm-ups increase muscle temperature. However, jumping performance was significantly improved with a high-intensity warm-up, implying that moderate-intensity may not reach the required physiological threshold for activating the neuromuscular system. In addition to that, the timing protocol of the post-warm-up assessment may also play a role in this study. Andrade et al. (2014), the time specific for optimum jumping performance varies based on individual factors such as fitness level and recovery capacity. Thus, suggesting that neither 60% nor 80% of heart rate intensity provides sufficient stimulus for jumping performance.

The absence of notable differences in intensities at each time interval corresponds with prior research, indicating that moderate-intensity warm-ups may not confer a distinct benefit in enhancing short-term power performance in sports such as badminton, where explosive actions like jumping are essential (Zois et al., 2015). Jumping physiologically depends significantly on the activation of fast-twitch muscle fibres and neuromuscular preparedness (Davies et al., 2015), which may not be adequately improved by the intensity levels examined here or may necessitate alternative warm-up techniques to optimism performance. Furthermore, as all athletes were trained individuals, their foundational physical conditioning may have alleviated any influence that these warm-up intensities could have exerted on performance (Ding et al., 2022).

The results indicate that to improve immediate jumping performance, warm-ups at 60% and 80% heart rate might not be necessary. Warm-ups are crucial for preventing injuries and preparing muscles, but the study's intensity levels did not improve performance. Other warm-up techniques, such as dynamic stretches or plyometric exercises, may be studied in future studies as they may better stimulate the neuromuscular system and improve short-term explosive performance (Hough et al., 2009). Fast-twitch muscles are activated, and force production is induced by plyometric training, which is necessary for short-term explosive action such as jumping (Wang et al., 2023). Additional research on alternate warm-up techniques may yield more insights into effective strategies for enhancing athletes' explosive jumping abilities (Yu et al., 2024).

CONCLUSION

Overall, this study indicates that athletes' immediate and delayed leaping performance was not significantly impacted by warm-up intensities of 60% and 80% of heart rate, as well as the control condition. The findings show that either right away or after 10 to 20 minutes of rest, these specific warm-up intensities do not affect short-term leaping performance or explosive power. Trained athletes may necessitate unique warm-up tactics to enhance explosive performance. Therefore, it is suggested that upcoming research should investigate the effectiveness of other warm-up protocols such as plyometric warm-up as they may produce suitable influence on jumping performance. For coaches and athletes, it is recommended that to design and tailor warm-up protocols that include certain intensities and are specific to the nature of the sport to optimize performance in the future.

AUTHOR'S CONTRIBUTION

Muhammad Al-Basit Fahmi Jasli: Writing - Original Draft. **Nor Fadila Kasim**: Methodology - Validating. **Fairus Fariza Zainudin**: Software and Writing - Original Draft.

REFERENCES

Andrade, D., Henriquez-Olguin, C., Beltran, A., Ramirez, M., Labarca, C., Cornejo, M., Alvarez, C., & Ramirez-Campillo, R. (2014). Effects of general, specific and combined warm-up on explosive muscular performance. *Biology of Sport*, *32*(2), 123–128. https://doi.org/10.5604/20831862.1140426

Boullosa, D., Esteve-Lanao, J., Casado, A., Peyré-Tartaruga, L. A., Gomes da Rosa, R., & Del Coso, J. (2020). Factors Affecting Training and Physical Performance in Recreational Endurance Runners. *Sports*, *8*(3), 35. https://doi.org/10.3390/sports8030035

Chiba, I., Samukawa, M., Takizawa, K., Nishikawa, Y., Ishida, T., Kasahara, S., Yamanaka, M., & Tohyama, H. (2022). Warm-Up Intensity and Time-Course Effects on Jump Height under Cold Conditions. *International Journal of Environmental Research and Public Health*, *19*(9). https://doi.org/10.3390/ijerph19095781

Czelusniak, O., Favreau, E., & Ives, S. J. (2021). Effects of Warm-Up on Sprint Swimming Performance, Rating of Perceived Exertion, and Blood Lactate

Concentration: A Systematic Review. *Journal of Functional Morphology and Kinesiology*, *6*(4), 85. https://doi.org/10.3390/jfmk6040085

Davies, G., Riemann, B. L., & Manske, R. (2015). Current Concepts of Plyometric Exercise. *International Journal of Sports Physical Therapy*, *10*(6), 760–786. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4637913/

Ding, L., Luo, J., Smith, D. M., Mackey, M., Fu, H., Davis, M., & Hu, Y. (2022). Effectiveness of Warm-Up Intervention Programs to Prevent Sports Injuries among Children and Adolescents: A Systematic Review and Meta-Analysis. *International Journal of Environmental Research and Public Health*, *19*(10). https://doi.org/10.3390/ijerph19106336

Faigenbaum, A. D., Kang, J., DiFiore, M., Finnerty, C., Garcia, A., Cipriano, L. A., Bush, J. A., & Ratamess, N. A. (2022b). A Comparison of Warm-Up Effects on Maximal Aerobic Exercise Performance in Children. *International Journal of Environmental Research and Public Health*, *19*(21). https://doi.org/10.3390/ijerph192114122

Fujii, N., Nishida, Y., Ogawa, T., Tanigawa, S., & Nishiyasu, T. (2018). Effects of work-matched moderate- and high-intensity warm-up on power output during 2-min supramaximal cycling. *Biology of Sport*, *35*(3), 223–228. https://doi.org/10.5114/biolsport.2018.74633

García-Pinillos, F., Ramírez-Campillo, R., Roche-Seruendo, L. E., Soto-Hermoso, V. M., & Latorre-Román, P. Á. (2019). How do recreational endurance runners warm-up and cool-down? A descriptive study on the use of continuous runs. *International Journal of Performance Analysis in Sport*, *19*(1), 102–109. https://doi.org/10.1080/24748668.2019.1566846

Hough, P. A., Ross, E. Z., & Howatson, G. (2009). Effects of Dynamic and Static Stretching on Vertical Jump Performance and Electromyographic Activity. *Journal of Strength and Conditioning Research*, *23*(2), 507–512. https://doi.org/10.1519/JSC.0b013e31818cc65d

Lee, S., Lim, J., & Park, J. (2024). A warm-up strategy with or without voluntary contraction on athletic performance, lower-leg temperature, and blood lactate concentration. *PLoS ONE*, *19*(1 January), 1–15. https://doi.org/10.1371/journal.pone.0295537

McGowan, C. J., Pyne, D. B., Thompson, K. G., & Rattray, B. (2015b). Warm-Up Strategies for Sport and Exercise: Mechanisms and Applications. *Sports Medicine*, *45*(11), 1523–1546. https://doi.org/10.1007/s40279-015-0376-x

Park, H.-K., Jung, M.-K., Park, E., Lee, C.-Y., Jee, Y.-S., Eun, D., Cha, J.-Y., & Yoo, J. (2018). The effect of warm-ups with stretching on the isokinetic moments of collegiate men. *Journal of Exercise Rehabilitation*, *14*(1), 78–82. https://doi.org/10.12965/jer.1835210.605

Patti, A., Giustino, V., Hirose, N., Messina, G., Cataldi, S., Grigoli, G., Marchese, A., Mulè, G., Drid, P., Palma, A., & Bianco, A. (2022). Effects of an experimental short-time high-intensity warm-up on explosive muscle strength performance in soccer players: A pilot study. *Frontiers in Physiology*, *13*(August), 1–8. https://doi.org/10.3389/fphys.2022.984305

Shah, H., & Shende, M. (2024a). The Relation Between Agility, Jumping Ability and Sports Performance in Professional Badminton Players. *International Journal For Multidisciplinary Research*, *6*(2), 1–7. https://doi.org/10.36948/ijfmr.2024.v06i02.16223

Silva, L. M., Neiva, H. P., Marques, M. C., Izquierdo, M., & Marinho, D. A. (2018). Effects of Warm-Up, Post-Warm-Up, and Re-Warm-Up Strategies on Explosive Efforts in Team Sports: A Systematic Review. *Sports Medicine*, *48*(10), 2285–2299. https://doi.org/10.1007/s40279-018-0958-5

Sople, D., & Wilcox, R. B. (2024). Dynamic Warm-ups Play Pivotal Role in Athletic Performance and Injury Prevention. *Arthroscopy, Sports Medicine, and Rehabilitation*, 101023. https://doi.org/10.1016/j.asmr.2024.101023

Sotiropoulos, K., Smilios, I., Christou, M., Barzouka, K., Spaias, A., Douda, H., & Tokmakidis, S. P. (2010). Effects of warm-up on vertical jump performance and muscle electrical activity using half-squats at low and moderate intensity. *Journal of Sports Science and Medicine*, *9*(2), 326–331. https://pmc.ncbi.nlm.nih.gov/articles/PMC3761727/

Tsurubami, R., Oba, K., Samukawa, M., Takizawa, K., Chiba, I., Yamanaka, M., & Tohyama, H. (2020). Warm-Up Intensity and Time Course Effects on Jump Performance. *Journal of Sports Science & Medicine*, *19*(4), 714–720. https://pmc.ncbi.nlm.nih.gov/articles/PMC7675624/

Wang, X., Lv, C., Qin, X., Ji, S., & Dong, D. (2023). Effectiveness of plyometric training vs. complex training on the explosive power of lower limbs: A Systematic review. *Frontiers in Physiology*, *13*(January), 1–15. https://doi.org/10.3389/fphys.2022.1061110

Yang, K. (2023). Strength Training Effects on Lower Limb Explosive Power in Athletes. *Revista Brasileira de Medicina Do Esporte*, *29*, 2022–2024. https://doi.org/10.1590/1517-8692202329012022_0592

Yu, W., Feng, D., Zhong, Y., Luo, X., Xu, Q., & Yu, J. (2024). Examining the Influence of Warm-Up Static and Dynamic Stretching, as well as Post-Activation Potentiation Effects, on the Acute Enhancement of Gymnastic Performance: A Systematic Review with Meta-Analysis. *Journal of Sports Science and Medicine*, *23*(1), 156–176. https://doi.org/10.52082/jssm.2024.156

Zois, J., Bishop, D., & Aughey, R. (2015). High-intensity warm-ups: Effects during subsequent intermittent exercise. *International Journal of Sports Physiology and Performance*, *10*(4), 498–503. https://doi.org/10.1123/ijspp.2014-0338