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The Effectiveness of Cryotherapy and Dynamic Stretching on Muscle Recovery of Young Basketball Athletes After Intensive Training

Muhammad Ivan Miftahul Aziz[1*], Andi Sahrul Jahrir[2]

[1,2] Faculty of Sport and Health Science, Universitas Negeri Makassar, Indonesia
*Coressponding Author. E-mail: muhammad.ivan@unm.ac.id

Abstract: Optimal muscle recovery is essential for basketball athletes to maintain performance and prevent injury. Cryotherapy and dynamic stretching are two popular recovery methods, but the comparative effectiveness of the two still needs further research. The purpose of this study was to determine the effectiveness of cryotherapy and dynamic stretching on reducing muscle soreness in young basketball athletes after intensive training. This research method is a quasi-experiment with a pre-test post-test design in two groups. The sample of 22 basketball athletes BKMF FIKK UNM was divided into cryotherapy (n = 11) and dynamic stretching (n = 11) groups. Muscle pain levels were measured using Visual Analogue Scale (VAS) at 30 minutes, 24 hours, and 72 hours post-test. Analysis using independent t test, and ANOVA. Results showed that both groups experienced a significant decrease in VAS scores at all measurement times ($p<0.001$). At 72 hours post-test, cryotherapy showed lower VAS score (3.39 ± 0.42) than dynamic stretching (3.81 ± 0.50) with significant difference ($p=0.047$). There was a significant effect of intervention type ($p=0.000$), measurement time ($p=0.000$), and their interaction ($p=0.005$). This study shows that cryotherapy and dynamic stretching are effective in reducing muscle pain, but cryotherapy is superior in the final phase of recovery.

Keywords: Cryotherapy; Dynamic Stretching; Muscle Recovery; Basketball.

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INTRODUCTION

Basketball is one of the branches of team sports that requires complex physical, technical, and tactical abilities (Irawati & Aziz, 2025; Shi, 2024). The game involves high-intensity movements such as short sprints, vertical jumps, sudden changes of direction, and physical contact between players (Gottlieb et al., 2021; Koyama et al., 2022). This activity causes intense and repetitive muscle work that increases the risk of muscle fatigue, microscopic damage to muscle fibers, and the accumulation of metabolites such as lactic acid (Wilke & Behringer, 2021). This condition, if not balanced with an effective recovery strategy, can reduce the athlete's performance in the next training session or match and increase the risk of musculoskeletal injury.

Recovery strategies are one of the important components of modern sports training programs (Apriliyanto et al., 2025; Syahban et al., 2025). Proper recovery allows the athlete to restore the functional capacity of his muscles, prepare for the load

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of the next exercise, and reduce the effects of cumulative fatigue (Kellmann et al., 2018; Tuxtaevich, 2023). One popular method is cryotherapy or cold therapy. Cryotherapy works on the principle of lowering the temperature of body tissues to produce vasoconstriction, slow down cell metabolism, reduce inflammation, and reduce pain perception through analgesic mechanisms (Kwiecien & McHugh, 2021; Virnanda, 2025). Cryotherapy is effective in reducing the symptoms of delayed onset muscle soreness (DOMS) in athletes after intensive exercise (Nogueira et al., 2020). In addition, cryotherapy can accelerate the recovery of muscle strength after eccentric exercise (Kwiecien & McHugh, 2021).

In addition to cryotherapy, another method that is widely used in recovery is dynamic stretching. Dynamic stretching, which was originally better known as part of heating, is now also applied as part of active cooling. Dynamic stretching involves repetitive movements through a full range of motion that mimics exercise activities, thereby increasing blood flow to the muscles, optimizing the removal of metabolites from exercise, and improving the elasticity of soft tissues (Opplert & Babault, 2018; Toninelli & others, 2025; Zvetkova et al., 2023). In Indonesia, research on recovery methods after intensive training is still very limited, especially in the population of young basketball athletes. This shows that there is a gap in evidence-based practice. In fact, the selection of the right recovery method is crucial in the young athlete population, which is physiologically still in the stage of development of the musculoskeletal system so that it is more susceptible to fatigue and injury.

Based on the results of previous studies, there is a difference in the mechanism of action between cryotherapy and dynamic stretching in restoring muscle condition after intensive exercise. Cryotherapy works passively through temperature reduction and anti-inflammatory processes, while dynamic stretching is active by improving blood circulation and neuromuscular activity (Straburzyńska-Lupa et al., 2018; Vieira et al., 2021). However, until now, there is still limited research that directly compares the effectiveness of the two methods in young basketball athletes, especially in Indonesia. This knowledge gap is important to fill so that coaches and sports practitioners can determine a more effective recovery method that is in accordance with the characteristics of young athletes.

Therefore, this study aims to analyze the effectiveness of cryotherapy and dynamic stretching on muscle recovery in young basketball athletes of BKMF FIKK State University of Makassar (UNM) after intensive training. The results of this study are expected to contribute to the development of recovery strategies that are more measurable, based on scientific evidence, and relevant to the needs of young athletes at the university level.

METHOD

This study uses a quasi-experimental design with a design approach of two pretest-posttest groups. This design was chosen because it allows comparisons between two groups receiving different treatments (cryotherapy and dynamic stretching) as well as measurements before and after treatment is performed. Using this design, researchers can measure changes in the level of muscle soreness in athletes after performing each intervention. Pretests are done to measure the level of muscle pain before treatment, while posttests are done after treatment to determine the effect of both methods on muscle recovery. This design is considered appropriate to analyze the effectiveness of

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cryotherapy and dynamic stretching in improving muscle recovery in young basketball athletes after intensive training.

The population in this study is all young athletes registered at BKMF Basketball FIKK UNM who are involved in an intensive training program. The study sample consisted of 22 athletes, aged between 18 and 22, who were randomly divided into two groups of 11 athletes each. The first group (A) will receive cryotherapy treatment, while the second group (B) will receive dynamic stretching treatment. The selection of the sample aims to ensure that the selected athletes have a relatively similar level of fitness and engage in similar intensive training, so that the results of the study can be compared more accurately.

The instrument in this study uses the Visual Analogue Scale (VAS) instrument which is a subjective measurement tool used to assess the level of pain felt by individuals practically and quickly (Begum & Hossain, 2019; Freyd, 1923).

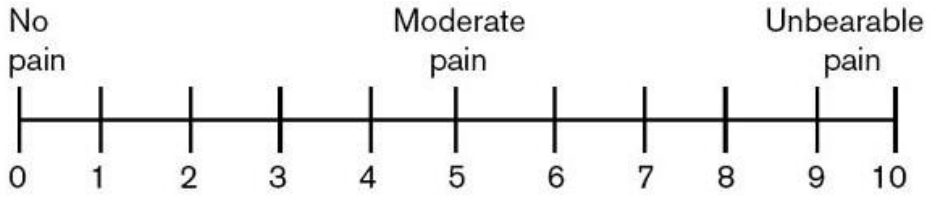

Figure 1. 0-10 VAS Pain Distress Scale
(Source: Freyd, M. The Graphic Rating Scale. Journal of Educational Psychology)

This scale is in the form of a horizontal straight line 10 cm long with two ends indicating extreme conditions, namely “no pain at all” on the left end (0) and “the most intense pain” on the right end (10). Respondents are asked to make a mark on the line according to the intensity of pain they feel at that time, and the pain value is measured in centimeters from the left end of the line to the mark made by the respondent.

The research procedure begins with a pretest stage, where all athletes will undergo a measurement of muscle soreness levels using the Visual Analog Scale (VAS) after undergoing 60 minutes of intensive training. After the pretest, athletes will be divided into two groups based on randomization. Group A will undergo cryotherapy intervention, in which athletes will be exposed to cold therapy for 15 minutes, while group B will undergo a 15-minute dynamic stretching consisting of a series of dynamic movements to stretch the main muscles. After the intervention, a posttest stage is performed to measure changes in the level of muscle pain using the same VAS. The entire research procedure was carried out under strict supervision to ensure each athlete followed the procedure correctly and that no interference could affect the results of the study.

RESULT

These findings provide a comprehensive overview of the effectiveness of each recovery method and its different impacts on different phases of muscle recovery.

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Table 1. Summary of Descriptive Data of Statistics

Group	Pre Test (Mean±SD)	Post 30 Min (Mean±SD)	Post 24 Hour (Mean±SD)	Post 72 Hour (Mean±SD)
Cryotherapy	5.98 ± 0.33	5.21 ± 0.38	4.20 ± 0.46	3.39 ± 0.42
Dynamic Stretching	5.92 ± 0.28	5.29 ± 0.28	4.41 ± 0.40	3.81 ± 0.50

In the Cryotherapy group, the pain value at the pre-test was 5.98 ± 0.33. After 30 minutes post-intervention, pain values were recorded at 5.21 ± 0.38. At the 24-hour post-intervention measurement, the pain value was 4.20 ± 0.46, and at 72 hours post-intervention the pain value was recorded at 3.39 ± 0.42. In the Dynamic Stretching group, the pain value in the pre-test was 5.92 ± 0.28. After 30 minutes post-intervention, the pain value was recorded at 5.29 ± 0.28. At the 24-hour post-intervention measurement, the pain value was 4.41 ± 0.40, and at 72 hours after the intervention the pain value was recorded at 3.81 ± 0.50.

Table 2. Summary of Testing Data Differences Between Groups by Measurement Time

Variable	t-value	p-value	Mean Difference
Pre-Test	0.393	0.698	0.05
Post 30 Min	-0.554	0.586	-0.08
Post 24 Hour	-1.161	0.259	-0.21
Post 72 Hour	-2.120	0.047	-0.42

The results of the independent t-test showed no significant difference between the two groups at the pre-test (p=0.698) or at the 30-minute and 24-hour post-test (p=0.586 and p=0.259). However, at the 72-hour post-test measurement, a significant difference (p=0.047) was found with the cryotherapy group having a lower VAS score. This indicates that cryotherapy is superior to dynamic stretching in accelerating muscle pain recovery at 72 hours after exercise.

Table 3. Analysis of data on the interaction between measurement time (30 minutes, 24 hours, and 72 hours) and type of intervention (cryotherapy and dynamic stretching)

	Sum of Squares	df	F	p-value
Type of Intervention	0.422	1	15.887	0.000
Time	30.220	2	568.616	0.000
Athlete (Subject)	9.365	21	16.783	0.000
Interaction (Group×Time)	0.324	2	6.102	0.005
Residuals	1.063	40	–	–

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Further analysis using ANOVA revealed a significant effect of intervention type (p=0.000) and measurement time (p=0.000) on VAS score. In addition, there was a significant interaction between intervention type and measurement time (p=0.005). This means that the effectiveness of each recovery method is different at each measurement time. The difference was most evident at 72 hours post-test, where cryotherapy produced a better recovery rate than dynamic stretching.

DISCUSSION

The results of this study indicate that both recovery methods, cryotherapy and dynamic stretching, are effective in reducing the level of muscle soreness (DOMS) in young basketball athletes after intensive training. This decrease occurred at all measurement times, both in the cryotherapy and dynamic stretching groups. This finding supports the previously developed framework, which states that intensive training causes microtrauma to muscle fibers, triggers an inflammatory response, and increases muscle pain perception. Recovery interventions are needed to modulate these inflammatory responses so that recovery runs faster and optimized.

Cryotherapy works through physiological mechanisms that rely on tissue cooling to reduce inflammation and slow local metabolism (Selfe et al., 2020; Syahputri et al., 2025). Exposure to cold temperatures leads to decreased blood flow to the area under exercise stress, thereby inhibiting the accumulation of inflammatory mediators such as prostaglandins and cytokines (Ikäheimo, 2018; Jurecka et al., 2023). The analgesic effect of cooling also reduces the transmission of pain signals to the central nervous system through decreased nerve conduction velocity (Silva et al., 2018). The findings of this study are in line with the research proposed by Noguera et al., which states that cryotherapy is effective in reducing DOMS and accelerating muscle strength recovery (Nogueira et al., 2020). The significant reduction in pain up to 72 hours in the cryotherapy group reinforces this theory, as well as demonstrating the important role of cold therapy in the secondary post-exercise inflammatory phase.

Dynamic stretching, as an active recovery method, exhibits a different mechanism of action. Dynamic stretching increases neuromuscular activity and improves blood circulation, thereby accelerating the transport of oxygen and nutrients to damaged muscle tissue and aiding the removal of residual exercise metabolites such as lactic acid (Opplert & Babault, 2018; Vieira et al., 2021). Other studies have shown that dynamic stretching is able to maintain muscle flexibility and reduce muscle tension that often occurs after exercise (Behm et al., 2023). In this study, although the pain reduction in the dynamic stretching group was not as fast as cryotherapy at 72 hours, the results were still significant, demonstrating the effectiveness of dynamic stretching in accelerating early recovery.

Analysis of the interaction between intervention type and measurement time showed that the effectiveness of each method was not constant over time, but changed according to the muscle recovery phase. In the early phase (30 minutes to 24 hours), both methods showed relatively comparable results, but in the late phase (72 hours), cryotherapy proved more effective. This finding supports the theory that muscle recovery is a dynamic process, where physiological needs in the early phase are more focused on improving circulation, whereas in the late phase there is more need to control secondary inflammation which is often the main cause of prolonged DOMS (Forcina et al., 2020).

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This research has also emphasized the role of cryotherapy in suppressing inflammation and the role of dynamic stretching in accelerating metabolite removal. The interrelationship between these variables can be described through the following logical relationship: intensive training → muscle microtrauma → inflammation & DOMS → recovery interventions → accelerated muscle recovery → optimal athlete performance. This linkage diagram shows the position of cryotherapy and dynamic stretching as independent variables that modulate the negative effects of intensive training on muscles.

The practical implications of these findings are significant for coaches, physiotherapists and sports practitioners. Recovery strategies that incorporate active and passive methods in an integrated manner can help maximize muscle recovery and prevent recurrent injuries. Dynamic stretching can be used in the early phase to facilitate increased blood flow, while cryotherapy can be optimized in the late phase to reduce inflammation and residual pain.

However, this study has some limitations. The use of VAS as the only measurement tool is subjective and influenced by individual perception. Future studies should include objective parameters such as creatine kinase levels or muscle strength measurements using a dynamometer to obtain more comprehensive results. In addition, the sample size limited to one university basketball club may limit the generalizability of the results to a wider population of athletes..

CONCLUSION

This study shows that both cryotherapy and dynamic stretching are effective in accelerating muscle soreness recovery in young basketball athletes after intensive training. Both methods were able to significantly reduce muscle soreness levels at each measurement time point, namely 30 minutes, 24 hours, and 72 hours post-exercise. However, cryotherapy proved superior in accelerating recovery in the late phase, as indicated by lower pain levels at 72 hours post-test compared to dynamic stretching. This indicates that the mechanism of action of cryotherapy, which suppresses the inflammatory response and provides an analgesic effect, is more effective in addressing delayed onset muscle soreness (DOMS) which usually peaks at 48 to 72 hours after physical activity. These findings provide important implications for coaches, physiotherapists and sports practitioners in developing optimal recovery strategies for athletes. The use of cryotherapy can be a primary option in the late recovery phase, while dynamic stretching can be utilized in the early phase to improve blood circulation and muscle flexibility. This integrated and phase-appropriate approach is expected to minimize the risk of injury and accelerate the return of athlete performance to optimal levels. Nevertheless, this study has limitations on the number of samples and the use of the subjective instrument Visual Analogue Scale (VAS) as the only measuring tool. Future research is recommended to use a larger sample size and add objective parameters such as inflammatory biomarkers or muscle performance measurements to strengthen the validity of the findings. Thus, the results of this study are expected to form the basis for the development of more comprehensive and evidence-based recovery protocols for athletes in various sports.

REFERENCE

Apriliyanto, R., Sulaiman, A., Sukardi Massa, R., Nasution, M. F. A., & Others. (2025). Kolaborasi Internasional Penelitian Cedera Olahraga Atlet Elit: Pemetaan Tren

Global Dan Sinergi Peneliti. Sport Discussion Reviews, 1(1), 26–50.
Begum, M. R., & Hossain, M. A. (2019). Validity And Reliability Of Visual Analogue Scale (Vas) For Pain Measurement. Journal Of Medical Case Reports And Reviews, 2(11).
Behm, D. G., Alizadeh, S., Daneshjoo, A., & Konrad, A. (2023). Potential Effects Of Dynamic Stretching On Injury Incidence Of Athletes: A Narrative Review Of Risk Factors. Sports Medicine, 53(7), 1359–1373.
Forcina, L., Cosentino, M., & Musarò, A. (2020). Mechanisms Regulating Muscle Regeneration: Insights Into The Interrelated And Time-Dependent Phases Of Tissue Healing. Cells, 9(5), 1297.
Freyd, M. (1923). The Graphic Rating Scale. Journal Of Educational Psychology, 14(2), 83.
Gottlieb, R., Shalom, A., & Calleja-Gonzalez, J. (2021). Physiology Of Basketball--Field Tests. Review Article. Journal Of Human Kinetics, 77, 159.
Ikäheimo, T. M. (2018). Cardiovascular Diseases, Cold Exposure And Exercise. Temperature, 5(2), 123–146.
Irawati, A. F., & Aziz, M. I. M. (2025). The Role Of Upper And Lower Body Strength Balance On Three-Point And Free-Throw Accuracy In Collegiate Basketball Players. Indonesian Journal Of Physical Education And Sport Science, 5(2), 277–285.
Jurecka, A., Woźniak, A., Mila-Kierzenkowska, C., Augustyńska, B., Oleksy, Ł., Stolarczyk, A., & G\Kadek, A. (2023). The Influence Of Single Whole-Body Cryostimulation On Cytokine Status And Oxidative Stress Biomarkers During Exhaustive Physical Effort: A Crossover Study. International Journal Of Molecular Sciences, 24(6), 5559.
Kellmann, M., Bertollo, M., Bosquet, L., Brink, M., Coutts, A. J., Duffield, R., Erlacher, D., Halson, S. L., Hecksteden, A., Heidari, J., & Others. (2018). Recovery And Performance In Sport: Consensus Statement. International Journal Of Sports Physiology And Performance, 13(2), 240–245.
Koyama, T., Rikukawa, A., Nagano, Y., Sasaki, S., Ichikawa, H., & Hirose, N. (2022). Acceleration Profile Of High-Intensity Movements In Basketball Games. The Journal Of Strength \& Conditioning Research, 36(6), 1715–1719.
Kwiecien, S. Y., & Mchugh, M. P. (2021). The Cold Truth: The Role Of Cryotherapy In The Treatment Of Injury And Recovery From Exercise. European Journal Of Applied Physiology, 121(8), 2125–2142.
Nogueira, N. M., Felappi, C. J., Lima, C. S., & Medeiros, D. M. (2020). Effects Of Local Cryotherapy For Recovery Of Delayed Onset Muscle Soreness And Strength Following Exercise-Induced Muscle Damage: Systematic Review And Meta-Analysis. Sport Sciences For Health, 16(1), 1–11.
Opplert, J., & Babault, N. (2018). Acute Effects Of Dynamic Stretching On Muscle Flexibility And Performance: An Analysis Of The Current Literature. Sports Medicine, 48(2), 299–325.
Selfe, J., Thorpe, C., May, K., & Alexander, J. (2020). Cryotherapy: Physiology And New Approaches. A Comprehensive Guide To Sports Physiology And Injury Management: An Interdisciplinary Approach, 21(6), 79.
Shi, D. (2024). The Role Of Basketball In Enhancing Students' Teamwork Skills.
Silva, D. A. Da, Peixoto, G. F. G., Rodrigues, K. M. S., & Farias, V. X. (2018). Analgesic Efficacy Of The Association Of Cryotherapy And Transcutaneous

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https://doi.org/10.21009/segar/1401.05 E-ISSN: 2580-9849

Electrical Nerve Stimulation. Brjp, 1, 274–278.

Straburzyńska-Lupa, A., Kasprzak, M. P., Romanowski, M. W., Kwaśniewska, A., Romanowski, W., Iskra, M., & Rutkowski, R. (2018). The Effect Of Whole-Body Cryotherapy At Different Temperatures On Proinflammatory Cytokines, Oxidative Stress Parameters, And Disease Activity In Patients With Ankylosing Spondylitis. Oxidative Medicine And Cellular Longevity, 2018(1), 2157496.

Syahban, A., Akhmad, N., Gumilang, E. S., Setyagraha, E., & Others. (2025). Analisis Bibliometrik Terapi Latihan: Evolusi Tren, Kolaborasi Internasional Dan Inovasi Dalam Rehabilitasi Atlet. Sport Discussion Reviews, 1(1), 51–73.

Syahputri, A. R., Hura, D. P., Simanihuruk, R. N., & Lubis, R. H. (2025). Prinsip Termodinamika Dalam Pengembangan Teknologi Cryotherapy Untuk Pengobatan Cedera: Studi Literatur. Jpft (Jurnal Pendidikan Fisika Tadulako Online), 13(2), 125–137.

Toninelli, N., & Others. (2025). Effects Of Passive Static Stretching On Mechanical, Neuromuscular, And Cardiovascular Function.

Tuxtaevich, A. T. (2023). Features Of Fatigue And Recovery Of Athletes. American Journal Of Biomedical Science \& Pharmaceutical Innovation, 3(12), 42–47.

Vieira, D. C. L., Opplert, J., & Babault, N. (2021). Acute Effects Of Dynamic Stretching On Neuromechanical Properties: An Interaction Between Stretching, Contraction, And Movement. European Journal Of Applied Physiology, 121(3), 957–967.

Virnanda, V. A. (2025). Pengaruh Pemberian Terapi Kompres Dingin (Cryotherapy) Terhadap Skala Nyeri Pada Pasien Pasca Operasi Abdomen. Itskes Insan Cendekia Medika Jombang.

Wilke, J., & Behringer, M. (2021). Is “Delayed Onset Muscle Soreness” A False Friend? The Potential Implication Of The Fascial Connective Tissue In Post-Exercise Discomfort. International Journal Of Molecular Sciences, 22(17), 9482.

Zvetkova, E., Koytchev, E., Ivanov, I., Ranchev, S., & Antonov, A. (2023). Biomechanical, Healing And Therapeutic Effects Of Stretching: A Comprehensive Review. Applied Sciences, 13(15), 8596.