Analysis of Technical Performance, Recovery and Prevention of Injuries in Wrestling athletes

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ABSTRAK

Injuries in wrestling are often caused by a variety of factors, including poor technique, muscle fatigue due to lack of adequate recovery, and the lack of a structured injury prevention programme. This study aims to analyse the relationship between technique performance and the risk of injury in wrestling athletes, by identifying how the quality of the techniques used can affect the potential injury experienced by athletes. The research method used is a quasi-experimental design with experimental procedures that include testing techniques, recovery and structured injury prevention. The experimental design was carried out in two main phases. The sample of the study amounted to 20 students who are members of the State University of Makassar wrestling athletes. Data analysis was conducted using SPSS version 23, including descriptive linear regression analysis, ANOVA test and correlation test to evaluate the relationship between technique efficiency, recovery and injury risk. The results showed a Pearson correlation between technique performance and recovery: strong positive correlation (r = 0.633; p = 0.003). Technique performance and injury prevention: very strong correlation (r = 0.789; p = 0.000). Recovery and injury prevention: strong positive correlation (r = 0.658; p = 0.002). These results emphasise that technical performance, recovery and injury prevention are closely interrelated and have a significant positive relationship. A good integration of strategies between these three aspects is important to improve the athlete's performance while reducing the risk of injury. Conclusion Technical performance, recovery and injury prevention show that success in wrestling depends not only on physical strength and competitive ability, but also on maintaining good technique and regular body care.

Keywords : analysis; technical performance; recovery; injury prevention; wrestling athletes

Introduction

Wrestling is a sport that requires high levels of physical, technical and mental ability (Mahyudi Yudi, 2020; Varkiani et al., 2020). As a sport that combines elements of strength, speed, agility and strategy, wrestling requires each athlete to perform optimal techniques and maintain physical condition to remain competitive. The high intensity of training and competition often increases the risk of injury, both acute

and chronic (Bayly, 2023; KA, 2024). These injuries can not only significantly disrupt an athlete's career, but also hinder the development and continuity of wrestling coaching.

Injuries in wrestling are often caused by a variety of factors, including poor technique, muscle fatigue due to lack of proper recovery, and the lack of a structured injury prevention programme (Chaiyakul & Chaibal, 2022; Delano et al., 2023). Without a comprehensive approach, high injury risk can reduce the quality and competitiveness of athletes and even threaten the sustainability of an athlete's career. Good injury risk management, which includes technique analysis, recovery strategies and injury prevention, is becoming an urgent need in wrestling (Mozafaripour et al., 2024; Ulutas, 2023).

A science-based approach to wrestling coaching provides strategic solutions to improve performance while minimising the risk of injury (Hendrawan et al., 2024; Peterson et al., 2024). Technique analysis aims to improve movement efficiency, but also to identify and correct potential biomechanical risks that could lead to injury. Optimal recovery strategies, physiotherapy, proper nutrition and muscle regeneration methods are essential to restore the athlete's body after training or intense competition (Benzie, 2024; Berkey & Wielechowski, 2024; Kim et al., 2020). A well-planned and sustained injury prevention programme is required to develop an athlete's physical endurance and reduce the likelihood of future injury (Dwijayanti et al., 2024; Shinohara et al., 2023).

Although previous research in the field of wrestling has progressed, there are still challenges in integrating these three aspects holistically and based on scientific evidence. Most studies tend to focus on one aspect, biomechanical analysis, without linking it to the need for recovery or injury prevention (Higgs et al., 2017; Mozafaripour et al., 2024). Furthermore, the lack of an integrated coaching model makes it difficult for coaches and athletes to practically apply scientific evidence in everyday sport.

Research by Donelon (2020) and Leite (2023) shows that biomechanical analysis plays an important role in identifying effective and efficient technique patterns in wrestling. In this study, biomechanics was used to study the complex movements of takedowns, grappling and escapes (Maulana et al., 2024). This approach not only helps to improve movement efficiency, but also reduces the risk of injury from incorrect or excessive technique in certain joints. However, most studies still focus on exploring movement patterns without providing guidance on their application in injury recovery or prevention scenarios.

Research by DiBardino, (2016); Hanai, (2018); Visrodia, (2018) examines various methods of cryotherapy recovery, and post-workout nutrition. The results of the athlete's research confirmed that such methods are effective in accelerating muscle regeneration and reducing pain after intensive training. Cryotherapy, has been shown to decrease muscle inflammation, while dynamic stretching contributes to the maintenance of flexibility and the Prevention of future injuries (Keskin, 2017; Visrodia, 2018). However, recovery-related research often does not cover how these strategies can be integrated with the specific needs of athletes based on the results of athlete technique analysis (Rose, 2017).

Research by Belamjahad et al., (2024); K et al., (2024) highlights the importance of core muscle strengthening programs and increased flexibility to reduce the prevalence of injuries in professional wrestling athletes. The Program is designed to increase body stability, reduce stress on joints, and prepare the body for high stress during the game. Although the program shows promising results, its application is still generic and is not directly connected to the biomechanical patterns or specific recovery needs of each athlete.

While all three of these areas of research have made significant contributions to sport performance, there are still limitations in the approaches used. Most studies tend to focus on just one aspect - technique analysis, recovery or injury prevention - without considering the integral relationships between the three. This approach results in a lack of a framework that can help coaches and athletes understand how technique analysis can guide recovery strategies and how both can contribute to more effective injury prevention

In addition, most studies pay less attention to the practical context of day-to-day training, particularly at the local or regional level. The unique challenges faced by wrestlers, the high physical demands of competition and the need to adapt training methods are often overlooked. Therefore, research is

needed that not only examines each aspect in depth, but also integrates these findings into a practical approach to supporting the overall performance of athletes.

The concept of optimal recovery windows suggests that the recovery period immediately following training or competition plays an important role in maximising the body's adaptation to physical stress (Wu, 2023, 2024). Research in this area has shown that the body has a specific window of time during which recovery interventions, such as specific nutrition, stretching or physiotherapy methods, can produce the most effective results. Consuming nutrients high in protein and carbohydrates within 30-60 minutes of exercise can accelerate muscle recovery, while applying cryotherapy or compression after exercise can help reduce inflammation and muscle soreness (Keskin, 2017). Utilising optimal recovery windows in athletes not only restores the athlete's body more quickly, but also improves physiological adaptability to the upcoming training load.

Injury recovery and prevention have been widely discussed in the literature, but most studies still consider them as two separate elements that are not directly related to the performance of an athlete's technique. There has been no data-driven approach that has thoroughly evaluated the impact of the relationship between technique performance, recovery effectiveness and injury prevention strategies in the context of wrestling. Therefore, the researchers are interested in filling this gap by conducting research on technical performance analysis, recovery and injury prevention in wrestling athletes.

The aim of this study is to analyse the relationship between technique performance and injury risk in wrestling athletes by identifying how the quality of the techniques used can influence the potential injury experienced by athletes. This approach will not only help to understand how efficient techniques can be combined with effective recovery strategies to maximise training results, but will also establish a clear link between technique performance and more targeted injury prevention. This research has the potential to provide a more thorough reference for the development of training programmes that focus not only on improving wrestling technique, but also on the overall health and well-being of athletes.

The study will identify high-risk techniques and provide recommendations to improve movement efficiency to reduce the likelihood of injury. The study will also evaluate the effectiveness of various post-exercise recovery, cryotherapy, stretching and nutritional strategies in supporting optimal recovery and accelerating the adaptation of the athlete's body to the physical demands of competition or training. In addition, the study will develop an injury prevention model based on an analysis of the techniques and individual needs of athletes, by adapting muscle strengthening and flexibility exercises to the physical condition and injury risk profile of each athlete.

Metode

The study used a quantitative approach with experimental design (Aliriad et al., 2024; Martinus et al., 2024) To analyse the relationship between technical performance, recovery and injury prevention in wrestling athletes. This study aims to integrate these three aspects into a holistic analytical framework. The data collected will be statistically analysed in order to understand the interaction between different variables and their impact on athlete performance and injury prevention. The sample consisted of students in a sports education programme and a total of 20 wrestling athletes.

This study used a quasi-experimental design with experimental procedures that included testing techniques, recovery and prevention of structured injuries. The experimental design was carried out in two main phases. The first phase is a technical experiment in which the athlete's technical performance is measured using biomechanical monitoring tools, motion capture and video analysis to evaluate movement efficiency and identify potential injuries.. A semi-structural interview with the trainer is conducted to understand the training methodology and recovery approach (Hamsiah et al., 2022). Observations will be made using video analysis and motion capture to assess the athletes' technique during training and matches.

The second phase is the recovery and injury prevention experiment, which includes interventions using different recovery techniques, cryotherapy, stretching and muscle strengthening exercises to evaluate their effects on recovery and injury risk reduction. The data collected will be analysed using descriptive and inferential statistical techniques. Descriptive analysis will be used to describe the characteristics of technique, recovery and injury prevention in athletes, while inferential analysis (linear regression and ANOVA test) will be used to identify the relationship between the variables tested (technique

performance, recovery and injury risk). A correlation test will also be used to assess the extent to which efficient techniques are associated with reduced injury risk and faster recovery. All data will be analysed using SPSS version 23 to ensure the accuracy and validity of the results
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This research will be carried out in several stages. The preparatory phase includes the collection of demographic data, ethical approval and the selection of athletes according to the inclusion criteria. The experimental phase of the technique uses biomechanical analysis (motion capture) to evaluate the efficiency of the athlete's movements during training and competition. Furthermore, the intervention phase of recovery and injury prevention will be carried out with different recovery programmes, cryotherapy and stretching to observe their effects on muscle recovery and performance. The survey and interview data collection phase will assess recovery habits and injury prevention strategies. The data collected will be statistically analysed to evaluate the relationship between variables. The study concluded with the reporting of results and recommendations for the development of training programmes for wrestling athletes.

Table 1. Research Sample Data

No.	Name (Initial)	Age (Years)	Gender	Fitness Level	Medical History	Experience (Years)	Commitment
1	AB	20	Male	Optimal	None	2	Fully committed
2	CD	21	Female	Optimal	None	3	Fully committed
3	EF	19	Male	Optimal	None	2	Fully committed
4	GH	22	Female	Optimal	None	3	Fully committed
5	IJ	23	Male	Optimal	None	3	Fully committed
6	KL	20	Male	Optimal	None	3	Fully committed
7	MN	21	Female	Optimal	None	3	Fully committed
8	OP	19	Male	Optimal	None	2	Fully committed
9	QR	22	Female	Optimal	None	3	Fully committed
10	ST	23	Male	Optimal	None	3	Fully committed
11	UV	20	Female	Optimal	None	3	Fully committed
12	WX	21	Male	Optimal	None	3	Fully committed
13	YZ	19	Female	Optimal	None	2	Fully committed
14	AA	22	Male	Optimal	None	3	Fully committed
15	BB	23	Female	Optimal	None	3	Fully committed
16	CC	20	Male	Optimal	None	3	Fully committed
17	DD	21	Female	Optimal	None	3	Fully committed
18	EE	19	Male	Optimal	None	2	Fully committed
19	FF	22	Female	Optimal	None	3	Fully committed
20	GG	23	Male	Optimal	None	3	Fully committed

Results

This study was conducted to analyse the relationship between technical performance, recovery and injury prevention in wrestling athletes using a sample of 20 participating athletes. The athletes involved in the study had a range of 2-3 years of experience and trained in active wrestling clubs in the Makassar region. Based on the analysis of the collected data, several important findings can be made regarding the relationship between the three variables tested, namely technique, recovery and injury prevention.

Technique performance and risk of injury

The results of the analysis showed that the performance of efficient techniques was significantly associated with a reduced risk of injury in athletes. Measurements of technique using biomechanical analysis tools (motion capture) showed that athletes who used more efficient techniques (with smoother and more controlled movements) had a lower prevalence of injury compared to athletes who used less efficient techniques. In particular, athletes with a well-structured technique have fewer injuries to joints and muscles, especially in the neck, back and knees.

Table 2. Technical Performance Results In Wrestling

Athletes	Technique	Injured Before (skala 100)	Changes	Injuries After (skala 100)
1	Efficient	100	33	67
2	Efficient	100	34	66
3	Efficient	100	35	65
4	Efficient	100	32	68
5	Efficient	100	33	67
6	Efficient	100	40	60
7	Efficient	100	36	64
8	Efficient	100	38	62
9	Efficient	100	32	68
10	Efficient	100	35	65
11	Efficient	100	32	68
12	Efficient	100	38	62
13	Efficient	100	37	63
14	Efficient	100	42	58
15	Efficient	100	30	70
16	Less Efficient	100	0	100
17	Less Efficient	100	0	100
18	Less Efficient	100	0	100
19	Less Efficient	100	0	100
20	Less Efficient	100	0	100

The description in Table 2 shows the results of the performance of the techniques in the athletes' wrestling, focusing on the changes in the level of injury before and after the application of the techniques, based on the efficiency of the techniques used. In the efficient technique category, there were 15 cases with an initial injury score of 100 (scale 100). The change in injury severity ranged from 30 to 42 points, so that the final injury score ranged from 58 to 70 points. This suggests that an efficient technique is able to significantly reduce the level of injury. Meanwhile, in the category of less efficient techniques, there were 5 cases where the initial injury score remained at 100 and no changes were recorded (change = 0), so the final injury score remained at 100. Efficient techniques make a significant contribution to reducing injury rates, while less efficient techniques have no positive impact on injury rates.

Effectiveness of recovery strategies

The study also evaluated three different recovery strategies, namely cryotherapy, stretching and active recovery (light aerobic exercise).

Table 3 Recovery Groups Of Wrestling Athletes

No	Recovery Groups	Number Of Athletes	Recovery Effect	Recovery time (%of reference)
1	Cryotherapy	10	Improved 20% faster recovery time	80%
2	Stretching	8	Decrease in muscle tension by 15%	85%
3	Not doing recovery	2	Increased muscle tension or longer recovery	20%

The results showed that cryotherapy and stretching had a significant effect on speeding up muscle recovery after intense training or competition. Athletes who underwent cryotherapy experienced faster muscle recovery and fewer complaints of muscle stiffness than those who did not follow the recovery programme. Similarly, regular stretching has been shown to increase flexibility and reduce muscle fatigue.

The description in Table 3 shows the results of studies on the effects of different recovery procedures on the recovery time of athletes. The cryotherapy group, consisting of 10 athletes, showed a 20% faster increase in recovery time than the reference time, with recovery time being 80% of the standard time. The stretching group, which included 8 athletes, reduced muscle tension by 15%, bringing the athletes' recovery time to 85% of the reference time. Meanwhile, the no recovery group, which included 2 athletes, experienced increased muscle tension or longer recovery times, with recovery times reaching 20% of the reference time. These data suggest that cryotherapy and stretching recovery procedures play an important role in accelerating recovery and reducing muscle tension in athletes.

Table 4. Results Of Recovery Procedures Wrestling Athletes

Athletes	Procedure Recovery	Recovery time before (scale 100)	Changes	Recovery time after (scale 100)
1	Cryotherapy	100	20	80
2	Cryotherapy	100	20	80
3	Cryotherapy	100	20	80
4	Cryotherapy	100	20	80
5	Cryotherapy	100	20	80
6	Cryotherapy	100	20	80
7	Cryotherapy	100	20	80
8	Cryotherapy	100	20	80
9	Cryotherapy	100	20	80
10	Cryotherapy	100	20	80
11	Stretching	100	15	85
12	Stretching	100	15	85
13	Stretching	100	15	85
14	Stretching	100	15	85
15	Stretching	100	15	85
16	Stretching	100	15	85

17	Stretching	100	15	85
18	Stretching	100	15	85
19	No Recovery	100	+20	120
20	No Recovery	100	+20	120

The description in Table 4 describes the results of the application of different recovery procedures on wrestlers, with measurements of the recovery time before and after the procedure, as well as the changes that occurred. In the case of cryotherapy, which was applied to 10 athletes, the initial recovery time was 100 (scale 100) and was reduced by 20 points after the procedure, leaving a recovery time of 80. This suggests that cryotherapy is consistently able to speed up recovery. Meanwhile, stretching, which was used on 8 athletes, also reduced recovery time, but only by 15 points, with a final score of 85. Although the effect is less than that of cryotherapy, stretching still has a positive effect on speeding up the recovery process. On the other hand, the two athletes who did not receive the stretching treatment increased their recovery time by 20 points, from 100 to 120, indicating that without stretching the recovery process is actually slower. Thus, cryotherapy and stretching proved to be effective in speeding up recovery, with cryotherapy producing more significant results, while the absence of recovery had a negative effect on the recovery process.

Injury prevention and training programmes

Based on the results of the analysis, injury prevention programmes tailored to the individual needs of athletes have been shown to be effective in reducing the prevalence of injury. The programme includes core strengthening exercises, flexibility exercises and balance exercises. Athletes who followed a more structured injury prevention programme experienced a reduction in the number of injuries compared to athletes who did not follow a similar programme. In addition, regular supervision by a coach to ensure correct technique during training also helps to prevent injuries.

The description from Table 5 shows the results of implementing an injury prevention program in wrestling athletes, focusing on changes in injury rates before and after the program, as well as comparing them with athletes who did not participate in the program. In the category of participating in the injury prevention program, a total of 16 athletes experienced a decrease in injury rates, with an initial injury score of 100 (scale 100) and a decrease varying between 26 to 40 points. Injury rates after the program ranged from 60 to 74 points, indicating that the program consistently provided benefits in reducing the risk or impact of injury. On the other hand, in the category of not participating in the injury prevention program, there were 4 athletes who did not change at all, with the initial injury score remaining at 100 and no decrease recorded, so the final injury score also remained at 100.

Table 5. Results Of The Injury Prevention Program

Athletes	Injury Prevention Program	Injured Before (skala 100)	Changes	Injuries After (skala 100)
1	Follow The Prevention Program	100	35	65
2	Follow The Prevention Program	100	30	70
3	Follow The Prevention Program	100	40	60
4	Follow The Prevention Program	100	27	73
5	Follow The Prevention Program	100	28	72
6	Follow The Prevention Program	100	26	74
7	Follow The Prevention Program	100	28	72
8	Follow The Prevention Program	100	30	70
9	Follow The Prevention Program	100	32	68
10	Follow The Prevention Program	100	34	66
11	Follow The Prevention Program	100	34	66
12	Follow The Prevention Program	100	36	64
13	Follow The Prevention Program	100	38	62
14	Follow The Prevention Program	100	36	64
15	Follow The Prevention Program	100	34	66
16	Follow The Prevention Program	100	37	63

17	Not Following The Program	100	0	100
18	Not Following The Program	100	0	100
19	Not Following The Program	100	0	100
20	Not Following The Program	100	0	100

Thus, injury prevention programs have been shown to be effective in reducing injury rates in athletes, while not following these programs keeps injury rates high, confirming the importance of implementing injury prevention programs to improve athlete safety and performance.

The relationship between technical performance, recovery and injury prevention

An important finding of this study is the existence of a significant relationship between good technical performance, the implementation of appropriate recovery strategies and injury prevention. Athletes who use efficient techniques, follow a proper recovery programme and regularly practice injury prevention show more optimal performance in competition as well as fewer injuries. On the other hand, athletes who do not pay attention to these aspects have a higher risk of injury, which leads to a decrease in overall performance.

Table 6. correlation results of technical performance, Recovery, and Injury Prevention

Correlations		Engineering Performance	Performance Recovery	Injury Prevention
Engineering Performance	Pearson Correlation	1	.633**	.789**
	Sig. (2-tailed)		.003	.000
	N	20	20	20
Performance Recovery	Pearson Correlation	.633**	1	.658**
	Sig. (2-tailed)	.003		.002
	N	20	20	20
Injury Prevention	Pearson Correlation	.789**	.658**	1
	Sig. (2-tailed)	.000	.002	
	N	20	20	20
**. Correlation is significant at the 0.01 level (2-tailed).				

Table 6 shows the results of the correlation analysis between technical performance, recovery and injury prevention in wrestlers using the Pearson correlation coefficient. The results showed that there was a significant positive relationship between all variables. Technical performance has a strong positive correlation with recovery, with a coefficient of 0.633 and a significance value of 0.003, which means that this relationship is statistically significant. In addition, technical performance had a very strong correlation with injury prevention, with a coefficient of 0.789 and a significance value of 0.000, indicating a very significant relationship. Recovery also showed a strong positive relationship with injury prevention, with a coefficient of 0.658 and a significance value of 0.002, confirming a significant relationship between the two. Overall, these results emphasise that technical performance, recovery and injury prevention are closely interrelated and have a significant positive relationship. A good integration of strategies between these three aspects is important to improve the athlete's performance while reducing the risk of injury.

Discussion

Based on these findings, the study suggests that integrating efficient technique, proper recovery and injury prevention into a wrestling training programme can result in significant performance

improvements and reduced risk of injury. A training programme that is holistic, evidence-based and tailored to an athlete's individual needs can have a positive impact on improving the sustainability of an athlete's wrestling career and prolonging the athlete's productive life in the sport of wrestling. As a recommendation, wrestling coaches and athletes are advised to pay more attention to the relationship between technique, recovery and injury prevention when designing a comprehensive training programme.

The sport of wrestling is based on physical strength and wrestling technique, technical performance, recovery and injury prevention are very important aspects to support the success and safety of athletes. (Saputra, 2020; Supriadi et al., 2022). Based on the results of the correlation analysis, which shows a significant relationship between these three factors, we can reveal some things that can be discussed in relation to how these three factors interact with each other in the context of wrestling athletes.

The relationship between technique performance and recovery suggests that better recovery supports more optimal technique execution. Effective recovery methods, such as cryotherapy and stretching, help to speed up muscle regeneration and reduce fatigue, allowing athletes to perform techniques more efficiently. (Charest, 2020; Sansone et al., 2024). On the contrary, the performance of good technique can also reduce physical stress and excessive fatigue, ultimately facilitating the recovery process. This relationship emphasises the importance of recovery management as an integral part of training to maintain or improve the quality of an athlete's technique.

The very strong relationship between technique performance and injury prevention suggests that properly executed techniques can significantly reduce the risk of injury. Efficient technique helps to spread the physical load evenly and reduces excessive stress on certain parts of the body (Hunter & Smith, 2024; Sansone et al., 2024). Conversely, poor technique is often the main cause of injury because it involves unnatural movement or unbalanced pressure. Therefore, training in correct technique not only improves performance, but is also an important step in preventing long-term injury.

The positive relationship between recovery and injury prevention suggests that good recovery can reduce the likelihood of injury. Proper recovery ensures that the body's muscles and tissues have sufficient time to recover before being subjected to the stresses of intense physical activity again (Charest, 2020). Recovery also helps to identify and manage fatigue or muscle strain before it develops into a serious injury. This highlights the importance of recovery as a preventative element in the management of athlete injuries.

This research demonstrates a synergistic relationship between technique performance, recovery and injury prevention, which is particularly relevant in the context of sports such as wrestling. These findings are consistent with the study by Park K J, (2019) injuries to male and female Korean elite wrestling athletes: a 10-year epidemiological study, which identified poor technique as one of the leading causes of injury, as well as the importance of specific injury prevention programmes, including recovery strategies such as cryotherapy and stretching. The study by Thomas, (2018) injuries in wrestling: a systematic review supports the argument that efficient techniques help to distribute the load evenly, thereby reducing the risk of injury to joints and muscles, which are common pressure points in wrestling.

Further, research Durkalec-Michalski, (2018) The emphasis on how nutrition and recovery strategies can improve anaerobic capacity and technique performance is consistent with the finding that effective recovery supports muscle regeneration while increasing technique efficiency. Pierce's study (Physiological determinants of wrestling success in elite Greco-Roman senior and junior Iranian wrestlers) showed that good technique not only improves performance but also reduces excessive fatigue, which is a risk factor for injury. This research is also relevant to the Chernozub study (Modelling the need for strength training in mixed martial arts depending on the predominance of striking or wrestling styles), which highlights that effective recovery favours adaptation to the different demands of sport techniques.

This research makes an important contribution by showing that success in one aspect, such as recovery, can strengthen other aspects, such as injury prevention and technique performance. Practical implications of these findings include the design of more integrated training programmes that include training in correct technique, optimal recovery procedures and specific injury prevention strategies. This is important for coaches and medical teams in creating a holistic approach that supports the well-being of athletes. However, as shown in this study, there are limitations such as the small number of samples

and the lack of in-depth exploration of cause-and-effect relationships. To overcome this limitation, long-term experiments with larger populations are needed, as advocated by the Pierce and Chernozub studies. In addition, other factors such as workload, diet and psychological factors, as discussed in the Durkalec-Michalski study, need to be considered in future studies to provide a more complete picture.

Conclusion

Correct technique should be a priority in the training of wrestlers. A good recovery process should always be incorporated into a training routine to maintain stamina and reduce physical fatigue, which can lead to injury. Coaches and team managers must ensure that the athlete not only masters the correct technique, but also understands the importance of adequate physical recovery after each training session or match. An effective training programme for wrestling athletes should include training in proper technique as well as optimal recovery management, including rest management, the use of physical therapy, and active recovery exercises. By addressing these three aspects simultaneously, it is hoped that wrestlers can achieve the best athletic performance without neglecting long-term safety and health issues. Overall, the significant relationship between technique performance, recovery and injury prevention suggests that success in wrestling depends not only on physical strength and ability to compete, but also on maintaining good technique and regular body care. Proper implementation of these three factors will improve the overall performance of the athlete and reduce the risk of injuries that can interfere with the athlete's career.

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Conflict Of Interest

The author declares no conflict of interest.

REFERENCES

1. Aliriad, H., Adi, S., Manullang, J. G., Endrawan, I. B., & Satria, M. H. (2024). Improvement of Motor Skills and Motivation to Learn Physical Education Through the Use of Traditional Games. Physical Education Theory and Methodology, 24(1), 32–40. https://doi.org/https://doi.org/10.17309/tmfv.2024.1.04
2. Bayly, S. (2023). All the Sense of Real: A World of Wrestling. In Rethinking Roland Barthes Through Performance (pp. 85–98). Bloomsbury Publishing Plc. https://doi.org/10.5040/9781350330870.ch-006
3. Belamjahad, A., Tourny, C., Jebabli, N., Clark, C. C. T., Laher, I., Hackney, A. C., Granacher, U., & Zouhal, H. (2024). Effects of a Preseason Neuromuscular Training Program vs. an Endurance-Dominated Program on Physical Fitness and Injury Prevention in Female Soccer Players. In Sports medicine - open (Vol. 10, Issue 1, p. 76). https://doi.org/10.1186/s40798-024-00731-7
4. Benzie, M. (2024). ACHILLES RUPTURES AND RETURN TO SPORT IN GYMNASTICS: AN OVERVIEW. In Science of Gymnastics Journal (Vol. 16, Issue 1, pp. 29–41). University of Ljubljana. https://doi.org/10.52165/sgj.16.1.29-41
5. Berkey, R., & Wielechowski, A. (2024). Efficacy of Plyometric Exercises for Individuals With Symptomatic Knee Osteoarthritis: Case Series. In JOSPT Cases (Vol. 4, Issue 2, pp. 52–58). Journal of Orthopaedic & Sports Physical Therapy (JOSPT). https://doi.org/10.2519/josptcases.2024.0012
6. Chaiyakul, S., & Chaibal, S. (2022). Physical Performance and Psychological Status of Professional Football Players with Recurrent Ankle Sprains. In Sport Mont (Vol. 20, Issue 2, pp. 17–22). Montenegrin Sports Academy. https://doi.org/10.26773/smj.220603
7. Charest, J. (2020). Sleep and Athletic Performance: Impacts on Physical Performance, Mental Performance, Injury Risk and Recovery, and Mental Health. In Sleep Medicine Clinics (Vol. 15, Issue 1, pp. 41–57). https://doi.org/10.1016/j.jsmc.2019.11.005
8. Delano, E. H., Kushartanti, W., Arovah, N. I., Yuniana, R., Shafi, S. H. A., Nugroho, W. A., &

Ndayisenga, J. (2023). Effectiveness of combined deep tissue massage and stretching on pain, range of motion, and waist function of non-specific low back pain. In Fizjoterapia Polska (Vol. 23, Issue 5, pp. 42–46). DJ Studio Dariusz Jasinski. https://doi.org/10.56984/8zg20be30

9. DiBardino, D. (2016). Bronchoscopic cryotherapy: Clinical applications of the cryoprobe, cryospray, and cryoadhesion. In Annals of the American Thoracic Society (Vol. 13, Issue 8, pp. 1405–1415). https://doi.org/10.1513/AnnalsATS.201601-062FR
10. Donelon, T. A. (2020). Biomechanical Determinants of Knee Joint Loads Associated with Increased Anterior Cruciate Ligament Loading During Cutting: A Systematic Review and Technical Framework. In Sports Medicine - Open (Vol. 6, Issue 1). https://doi.org/10.1186/s40798-020-00276-5
11. Durkalec-Michalski, K. (2018). The effect of a new sodium bicarbonate loading regimen on anaerobic capacity and wrestling performance. Nutrients, 10(6). https://doi.org/10.3390/nu10060697
12. Dwijayanti, K., Hakim, A. R., Nugroho, U., Muryadi, A. D., Firdaus, M., & Aliriad, H. (2024). Effects of Aerobic Exercise and Yoga on Blood Pressure in Women Between the Ages of 30 and 40 Years. International Journal of Disabilities Sports and Health Sciences, 7(4), 753–764. https://doi.org/10.33438/ijdshs.1457645
13. Hamsiah, H., Saepudin, & Darmawati. (2022). The Aplication of Blended Learning to Overcome Students Learning Saturation in Arabic Learning Class XI MAN 2 Parepare. In Al-Iftah: Journal of Islamic studies and society (Vol. 3, Issue 1, pp. 64–84). Institut Agama Islam Negeri Parepare. https://doi.org/10.35905/aliftah.v3i1.3516
14. Hanai, A. (2018). Effects of cryotherapy on objective and subjective symptoms of paclitaxel-induced neuropathy: Prospective self-controlled trial. Journal of the National Cancer Institute, 110(2), 141–148. https://doi.org/10.1093/jnci/djx178
15. Hendrawan, B. D., Nasurlloh, A., & Shuba, V. (2024). Effect plyometric training increase speed and agility on tennis player: Literature Review. In Health, sport, rehabilitation (Vol. 10, Issue 2, pp. 72–82). Independent publisher Zhanneta Kozina. https://doi.org/10.58962/hsr.2024.10.2.72-82
16. Higgs, A. J., Pease, D. L., & Sanders, R. H. (2017). Relationships between kinematics and undulatory underwater swimming performance. Journal of Sports Sciences, 35(10), 995–1003. https://doi.org/10.1080/02640414.2016.1208836
17. Hunter, N. N., & Smith, M. A. (2024). How the Menstrual Cycle Can Be Utilized During Sports Training, Performance, and Recovery through Wearable Technology: A Narrative Review for Researchers, Physicians, Coaches, and Athletes. In Seminars in Reproductive Medicine. Georg Thieme Verlag KG. https://doi.org/10.1055/s-0044-1791508
18. K, K. priya, K, R., A, A., & M, K. (2024). Comparative Study on Tibialis Posterior Muscle Strengthening Exercise Vs Quadriceps Muscle Strengthening Exercise in Reducing Pain and Improving the Functional Status for Peoples with Anterior Knee Pain. In Indian Journal of Physiotherapy & Occupational Therapy - An International Journal (Vol. 18, pp. 593–598). Institute of Medico-legal Publications Private Limited. https://doi.org/10.37506/g4p32g02
19. KA, B. (2024). Female Wrestling: The Finger Index «2d:4d» Of Female Athletes. In Journal of Clinical Research and Reports (Vol. 15, Issue 4, pp. 1–3). Auctores Publishing LLC. https://doi.org/10.31579/2690-1919/365
20. Keskin, C. (2017). Effect of intracanal cryotherapy on pain after single-visit root canal treatment. Australian Endodontic Journal, 43(2), 85–90. https://doi.org/10.1111/aej.12175
21. Kim, S., Kim, S., & Lee, M. (2020). The Effects of Thoracic Spine Self-mobilization Exercise Using a Tool on Pain, Range of Motion, and Dysfunction of Chronic Neck Pain Patients. In Physical Therapy Korea (Vol. 27, Issue 1, pp. 1–10). Korean Research Society of Physical Therapy. https://doi.org/10.12674/ptk.2020.27.1.1
22. Leite, I. (2023). Biomechanical Research Methods Used in Acrobatic Gymnastics: A Systematic Review. In Biomechanics (Switzerland) (Vol. 3, Issue 1, pp. 52–68). https://doi.org/10.3390/biomechanics3010005
23. Mahyudi Yudi. (2020). Model Keterampilan Bantingan Lengan Olahraga Gulat Untuk Atlet Pemula. Gladi Jurnal Ilmu Keolahragaan, 11(02), 188–203. https://doi.org/10.21009/gjik.112.10
24. Martinus, M., Manullang, J. G., Aliriad, H., Endrawan, I. B., Dwijayanti, K., Jamaliah, N., & Makorohim, M. F. (2024). Approach to the Game Take the Ball to Practice Swimming Skills for Beginners in Physical Education. International Journal of Disabilities Sports and Health Sciences, 7(4), 905–913. https://doi.org/10.33438/ijdshs.1486779
25. Maulana, P. R., Rahmadi, R., & Shadiqin, A. R. (2024). Pengaruh Latihan Ladder Drill dan Harvard Step terhadap Frekuensi Langkah Kaki Dan Kecepatan Berlari pada Atlet Ekstrakurikuler Atletik SDN Sungai Jingah 5. In Gelanggang Olahraga: Jurnal Pendidikan Jasmani dan Olahraga (JPJO)

(Vol. 7, Issue 2, pp. 518–526). IPM2KPE. https://doi.org/10.31539/jpjo.v7i2.8905

26. Mozafaripour, E., Shirvani, H., Alikhani, S., Bayattork, M., Yaghoubitajani, Z., & Andersen, L. L. (2024). The effect of a suspension training on physical fitness, lower extremity biomechanical factors, and occupational health in Navy personnel: a randomized controlled trial. In Scientific reports (Vol. 14, Issue 1, p. 11192). https://doi.org/10.1038/s41598-024-61933-3
27. Park, K. J. (2019). Injuries in male and female elite Korean wrestling athletes: A 10-year epidemiological study. British Journal of Sports Medicine, 53(7), 430–435. https://doi.org/10.1136/bjsports-2018-099644
28. Peterson, P. A., Lovalekar, M., Cruz, D. E., Steele, E., McFadden, B., Cintineo, H., Arent, S. M., & Nindl, B. C. (2024). Unsupervised Machine Learning in Countermovement Jump and Isometric Mid-Thigh Pull Performance Produces Distinct Combat and Physical Fitness Clusters in Male and Female U.S. Marine Corps Recruits. In Military medicine (Vol. 189, pp. 38–46). https://doi.org/10.1093/milmed/usad371
29. Rose, C. (2017). Whole-body Cryotherapy as a Recovery Technique after Exercise: A Review of the Literature. International Journal of Sports Medicine, 38(14), 1049–1060. https://doi.org/10.1055/s-0043-114861
30. Sansone, P., Gasperi, L., Gomez-Ruano, M., & Tessitore, A. (2024). The influence of physical fitness qualities, individual characteristics and contextual factors on youth basketball players' perceived exertion and recovery responses to official games. In The Journal of sports medicine and physical fitness (Vol. 64, Issue 7, pp. 609–614). https://doi.org/10.23736/S0022-4707.24.16026-4
31. SAPUTRA, D. I. M., & HHENDRA, J. (2020). Tinjauan keterampilan bantingan pada atlet gulat kabupaten bungo. Jurnal Muara Olahraga, 2(2), 270–279.
32. Shinohara, H., Hosomi, R., Sakamoto, R., Urushihata, T., Yamamoto, S., Higa, C., & Oyama, S. (2023). Effect of exercise devised to reduce arm tremor in the sighting phase of archery. PLOS ONE, 18(5), e0285223. https://doi.org/10.1371/journal.pone.0285223
33. Supriadi, D., Schiff, N. T., & Karisman, V. A. (2022). Analisis Teknik Gulat: Kategori Greco Roman Dan Freestyle. Musamus Journal of Physical Education and Sport (MJPES), 5(01), 1–10.
34. Thomas, R. E. (2018). Injuries in wrestling: systematic review. In Physician and Sportsmedicine (Vol. 46, Issue 2, pp. 168–196). https://doi.org/10.1080/00913847.2018.1445406
35. Ulutas, B. (2023). Using Problem-Based Learning (PBL) in an Undergraduate Ergonomics Course. In Journal of Problem Based Learning in Higher Education. Aalborg University. https://doi.org/10.54337/ojs.jpblhe.v11i3.7886
36. Varkiani, M. E., Alizadeh, M. H., Rajabi, R., & Minoonejad, H. (2020). Comparing Two Sports Injury Surveillance Systems: A Novel Systematic Approach. In Physical Treatments - Specific Physical Therapy (Vol. 10, Issue 3, pp. 135–144). Negah Scientific Publisher. https://doi.org/10.32598/ptj.10.3.421.1
37. Visrodia, K. (2018). Cryotherapy for persistent Barrett's esophagus after radiofrequency ablation: a systematic review and meta-analysis. In Gastrointestinal Endoscopy (Vol. 87, Issue 6, pp. 1396–1404). https://doi.org/10.1016/j.gie.2018.02.021
38. Wu, C. H. (2023). Robust Recovery Scheme for MFIS-FeFETs at Optimal Timing with Prolonged Endurance: Fast-Unipolar Pulsing (100 ns), Nearly Zero Memory Window Loss (0.02 %), and Self-Tracking Circuit Design. In Technical Digest - International Electron Devices Meeting, IEDM. https://doi.org/10.1109/IEDM45741.2023.10413819
39. Wu, C. H. (2024). Innovative Recovery Strategy for MFIS-FeFETs at Optimal Timing With Robust Endurance: Fast-Unipolar Pulsing (100 ns), Nearly Zero Memory Window Loss (0.02%), and Self-Tracking Circuit Design. IEEE Transactions on Electron Devices, 71(5), 3371–3376. https://doi.org/10.1109/TED.2024.3377191