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The influence of recovery management on arm muscle strength in the basketball team of SMA negeri 8 Malang

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Abstract

This study aims to determine the influence of recovery management on the arm muscle strength of the basketball team of SMA Negeri 8 Malang. Using an experimental "one-group pretest-posttest design," the study involved 24 athletes, consisting of 12 male and 12 female participants. The measurements of muscle strength were conducted using an expanding dynamometer before and after the implementation of recovery management techniques, including Cold Water Immersion (CWI), foam rolling, elevation, and Proprioceptive Neuromuscular Facilitation (PNF). The results showed a significant improvement in the pull muscle strength of female athletes, with an average pretest score of 18.66 and a posttest score of 20.58, yielding p = 0.029. However, no significant improvement was found in their push muscle strength, as the pretest score was 16.66 and the posttest score was 19.33, yielding p = 0.056. For male athletes, no significant difference was found in muscle strength for either pull (p = 0.183) or push (p = 0.232). These findings indicate that recovery management was more effective for improving the pull muscle strength of female athletes, potentially due to physiological, hormonal, and muscle adaptation differences. The study concludes that recovery management effectively enhances arm muscle strength, particularly in the pull muscles of female athletes, but is less effective for other conditions, as shown by the pretest and posttest analysis of male athletes, where no significant improvement in arm muscle strength was observed.

Keywords: *Basketball; Cold Water Immersion; Arm muscle strength; Recovery Management*

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INTRODUCTION

Sports, particularly basketball, is one of the most popular sports among students in Indonesia. The Development Basketball League (DBL) serves as the premier competition and a stepping stone for young athletes toward their professional careers. Despite being in their teenage years, athletes are required to maintain optimal performance. The high intensity of training combined with the demands of fulfilling school obligations poses a unique challenge for athletes and coaches in managing the recovery. Shooting, passing, and dribbling are among the crucial skills in basketball (Veldema et al., 2022). Consequently, arm muscle fatigue can become a serious issue, as it may reduce muscle power, thereby decreasing the athletes' ability to perform optimally (Jildeh et al., 2019).

Given the high intensity of their activities, athletes must employ optimal recovery strategies to prevent muscle fatigue resulting from training and competition. Recovery management, which includes techniques such as Cold Water Immersion (CWI), foam rolling, elevation, Proprioceptive Neuromuscular Facilitation (PNF), and adequate rest, can optimize muscle recovery and reduce the risk of injury (Versey et al., 2013). With the appropriate and effective use of recovery management, arm muscle power can be maintained or even maximized, allowing athletes to sustain optimal performance during training and competitions (Oakley, 2019).

However, recovery management has not been adequately addressed among student-athletes at SMA Negeri 8 Malang, despite their busy training schedules and academic commitments. At SMA Negeri 8 Malang, it is crucial to pay attention to effective recovery strategies to address muscle fatigue, especially in the arm muscles, which are vital in basketball games (Montgomery et al., 2008a). Research on recovery management for muscle recovery, particularly arm muscles, remains limited at SMA Negeri 8 Malang, highlighting the need for efforts to address this issue.

The purpose of this study is to investigate the impact of recovery management on arm muscle strength in the DBL basketball team of SMA Negeri 8 Malang. Previous studies have demonstrated the effectiveness of recovery management in physical recovery, with most of these studies focusing on professional athletes, such as those conducted by Mihajlovic et al. (2023), Montgomery et al. (2008), and Dobreanu (2020). Few studies have considered male and female student-athletes. This research aims to explore the implementation of recovery management on arm muscle strength in student-athletes, particularly at SMA Negeri 8 Malang.

From the explanation above, this study focuses on analyzing the influence of recovery management on the arm muscle strength of male and female basketball student-athletes at SMA Negeri 8 Malang. It is hoped that this study will provide new solutions for developing optimal recovery management strategies to support young athletes' performance, especially at SMA Negeri 8 Malang, in competitions such as the DBL and other events.

From the provided explanations, the use of recovery management, including CWI, foam rolling, elevation, and PNF, facilitates faster muscle recovery after training. Therefore, it is essential to pay attention to recovery practices after training for basketball teams, as it is a critical factor in maintaining physical readiness for subsequent training or competitions. This study is expected to contribute to the development of effective muscle recovery methods for basketball teams. Despite the numerous studies conducted, there has been no research on the

implementation of recovery management to examine its impact on arm muscle strength, particularly in the basketball team of SMA Negeri 8 Malang. Based on this foundation, the research titled “The Influence of Recovery Management on Arm Muscle Strength in the Basketball Team of SMA Negeri 8 Malang” is proposed.

METHOD

This study is experimental research. The design used in this research is the "One-group pretest-posttest design", which involves a single group with a pretest conducted before the treatment and a posttest afterward. The design can be illustrated as follows:

Table 1. One Group Pretest-Posttest Design (Winarno, 2018).

Subject	Pretest	Treatment	Posttest
R	O_1	X	O_2

Description:

R : The basketball team of SMA Negeri 8 Kota Malang

O_1 : Pretest

X : Treatment using recovery management

O_2 : Posttest

In this "One-group pretest-posttest design," the researcher will first conduct a pretest on the experimental group using an expanding dynamometer test to measure arm muscle strength before treatment. After the pretest, the researcher will apply recovery management as the treatment for the experimental group. This research was conducted at SMA Negeri 8 Malang, located in Malang City, East Java Province, from July to August, with a total of 18 sessions, including the pretest and posttest. The sampling technique used in this research is total sampling, involving all members of the population, which are 24 basketball athletes (12 male and 12 female) from SMA Negeri 8 Kota Malang.

The test used is the expanding dynamometer test to measure arm muscle strength through pull and push tests. The test norms are as follows

Tabel 1. Norms of Pull Test Arm Muscle Strength (Expanding Dynamometer Test) in Men and Women

No.	Norm	Men (kg)	Women (kg)
1.	Very good	> 44	> 44
2.	Good	35 – 43.5	35 – 43.5
3.	Medium	26 – 34.5	26 – 34.5
4.	Less	18 – 25.5	18 – 25.5
5.	Very less	< 17.5	< 17.5

Tabel 2. Norms of Push Test Arm Muscle Strength (Expanding Dynamometer Test) in Men and Women

No.	Norm	Laki-laki (kg)	Perempuan (kg)
1.	Very good	> 44	> 44
2.	Good	35 – 43.5	35 – 43.5
3.	Medium	26 – 34.5	26 – 34.5
4.	Less	18 – 25.5	18 – 25.5
5.	Very less	< 17.5	< 17.5

The data analysis technique employed is univariate analysis to determine data distribution or normality using the Shapiro-Wilk Test, with a criterion of p-value > alpha (0.05). For bivariate analysis, the Paired Sample T-test is used to compare the means of two data sets (before and after treatment). The result is considered significant if $p < 0.05$ and not significant if $p > 0.05$.

RESULTS

Demographic Test

Table 4 Characteristics of Respondents by Age

Characteristic	Mean	Minimum	Maximum	Std. Deviation
Age	15.91	15.00	17.00	0.88055

From the data above, the average age of respondents is 16.41 years old, with the youngest being 15 years old and the oldest 17 years old.

Table 5 Characteristics of Respondents by Gender

Characteristics	n	%
Gender		
Female	12	50.0
Male	12	50.0

The table above shows that the respondents are evenly divided by gender.

Table 6 Characteristics of Female Respondents by Pull and Push Test Results

Characteristics	n	Mean	Min-Max	Std. Deviation
Pre-Test				
Pull Test	12	18.66	13-26	4.185
Push Test	12	16.66	8-27	5.466
Post-Test				
Pull Test	12	20.58	11-32	5.401
Push Test	12	19.33	10-30	5.898

Table 3 shows that the pretest average pull test score is 18.66, with a minimum score of 13 and a maximum of 26, while the push test averages 16.66, with a minimum of 8 and a maximum of 27. In the posttest, the pull test average increases to 20.58, with a minimum score of 11 and the highest being 32, and the push test to 19.33, with a minimum score of 10 and the maximum score is 30.

Table 7 Characteristics of Male Respondents by Pull and Push Test Results

Characteristics	n	Mean	Min-Max	Std. Deviation
Pre-Test				
Pull Test	12	29.33	11-41	8.669
Push Test	12	38	12-70	19.376
Post-Test				
Pull Test	12	32.83	16-55	10.886
Push Test	12	41.75	15-73	19.376

Table 4 shows that the pretest average pull test score is 29.33, with a minimum score of 11 and the maximum score being 41, and the push test averages 38.00, with a minimum score of 12 and the maximum score being 70. In the posttest, the pull test average increases to 32.83, with a maximum score of 16 and a minimum score being 55, and the push test to 41.75, with a minimum score of 15 and a maximum score being 73.

Prerequisite Tests

Normality Test

Table 8 Results of the Normality Test

Variables	Normality Test Results	Descriptions
Pull Test		
Female		
Pre-Test	0.524	Normal data distribution
Post-Test	0.525	Normal data distribution
Male		
Pre-Test	0.811	Normal data distribution
Post-Test	0873	Normal data distribution
Push Test		
Female		
Pre-Test	0.906	Normal data distribution
Post-Test	0.997	Normal data distribution
Male		
Pre-Test		

Post-Test	0.563	Normal data distribution
	0.992	Normal data distribution

The results of the normality test for the pull test and push test variables for females indicate a normal data distribution in both pretest and posttest, allowing comparative analysis using a dependent t-test. Similarly, the results of the normality test for the pull test and push test variables for males also show a normal data distribution in both pretest and posttest, allowing comparative analysis using a dependent t-test.

Dependent T-Test

a) Female

Table 9 Comparison of Pull Test Results Before and After the Treatment

Variable		Mean	95% CI	Mean Difference	P value
Pull Test	Before	18.66	- 3.59 - -0.23	-1.91	0.029*
	After	20.58			

Based on Table 6, the average pull test result increased from 18.66 before the treatment to 20.58 after the treatment. Additionally, the statistical test results indicate a significant difference between the pull test results before and after the treatment (p-value = 0.029).

Table 10 Comparison of Push Test Results Before and After the Treatment

Variable		Mean	95% CI	Mean Difference	P value
Push Test	Before	16.66	- 5.42 - 0.08	-2.66	0.056*
	After	19.33			

Based on Table 7, the average push test result increased from 16.66 before the treatment to 19.33 after the treatment. However, the statistical test results show no significant difference between the push test results before and after the treatment (p-value = 0.056).

b) Male

Table 11 Comparison of Pull Test Results Before and After the Treatment

Variable		Mean	95% CI	Mean Difference	P value
Pull Test	Before	29.33	- 8.92 - 1.92	-3.5	0.183*
	After	32.33			

Based on Table 8, the average pull test result increased from 29.33 before the treatment to 32.33 after the treatment. However, the statistical test results show no significant difference between the pull test results before and after the treatment (p-value = 0.183).

Table 12 Comparison of Push Test Results Before and After the Treatment

Variable		Mean	95% CI	Mean Difference	P value
Push Test	Before	38	-10.28 - 2.78	-3.75	0.232*
	After	41.75			

Based on Table 9, it was found that the average push test result increased from 38 before the treatment to 41.75 after the treatment. Furthermore, the statistical test results showed no significant difference between the push test before and after the treatment (p-value = 0.232).

The study aimed to determine the effect of recovery management on the arm muscle strength of basketball team athletes at SMA Negeri 8 Kota Malang. This research was conducted to investigate the impact of recovery management on arm muscle strength. The study results showed that the average arm muscle strength test results for the female basketball team during the pretest were 18.66 for the pull test and 16.66 for the push test, while the posttest results were 20.58 for the pull test and 19.33 for the push test. With a significance value of 0.029 for the pull test and 0.056 for the push test, it indicates a significant effect on the pull movement and no significant effect on the push movement regarding arm muscle strength in the female basketball team at SMA Negeri 8 Kota Malang. Meanwhile, the results for the male basketball team showed that the average arm muscle strength test during the pretest was 29.33 for the pull test and 38 for the push test, while the posttest results were 32.33 for the pull test and 41.75 for the push test. With significance values of 0.183 for the pull test and 0.232 for the push test, it indicates no significant effect of recovery management on the arm muscle strength of the male basketball team at SMA Negeri 8 Kota Malang.

This study found that recovery management cannot significantly accelerate the increase in muscle strength. Recovery management is only effective in helping athletes shorten muscle recovery after training or competition fatigue (Enns & Tiidus, 2012). The result is that athletes can train at their best performance consistently and reduce the risk of injury that may disrupt their activities. Although recovery management showed no significant effect, it was proven to have a greater influence on the pull strength of the female basketball team due to physiological differences, muscle distribution, and sensitivity to training adaptation. Conversely, for push muscles, both male and female athletes have a better baseline strength due to the habitual use

of these muscles in dominant basketball movements. As a result, recovery management does not provide a significant difference in push strength in either group.

The interpretation of the effect of recovery management on females shows a significant impact on the pull test because, in general, females have smaller upper body muscle mass, particularly in muscles used for pulling, compared to males (Abe et al., 2021). The results indicate that recovery management is more effective in improving pull strength compared to push strength in females. This may be due to the higher sensitivity of pull muscles in females to training adaptation because of their smaller muscle mass. Thus, recovery management plays a significant role in aiding adaptation and increasing arm muscle strength. Unlike the pull test, the push muscles are more frequently used in daily activities, particularly in basketball games, where passing and shooting are the most frequently performed and trained movements (Matthew & Gretchen, 2018). Thus, there is no significant effect of recovery management on arm muscle strength in the push test.

Estrogen hormone in females also contributes, as it helps rebuild tissue and repair muscle damage faster, but muscle growth is much slower compared to males (Enns & Tiidus, 2012). Therefore, recovery management makes the pull muscles in females more sensitive to adaptation (Seko et al., 2020). Conversely, push muscles, which tend to be larger and more stable, are less influenced by recovery management (Mulroy et al., 2004).

For males, the interpretation of the results indicates that recovery management does not have a significant effect. Several aspects contribute to the limited influence of recovery management, such as high initial muscle capacity. According to Handelsman et al. (2018), males have significantly higher testosterone levels than females, resulting in a higher muscle baseline. When the initial muscle capacity is already high, the resulting effect is also smaller (Ishida et al., 2020).

The lack of weight training intensity is another factor that diminishes the significance of recovery management treatment. The proximity to the competition phase leads coaches to focus more on technique and tactics training, with less emphasis on physical factors, particularly strength. If weight training is insufficient, the stimulus for muscle damage and recovery is less optimal, making the effect of recovery management less apparent (Schoenfeld et al., 2015).

This research introduces something new about the influence of recovery management on arm muscle strength in high school basketball athletes, particularly focusing on male and female athletes. The novelty of this research lies in the detailed investigation of recovery

methods such as Cold Water Immersion (CWI), foam rolling, elevation, and Proprioceptive Neuromuscular Facilitation (PNF), which are generally studied in professional athletes but rarely applied in the context of student-athletes with high academic and training demands.

CONCLUSION

This study demonstrates that recovery management has a significant effect on the pull muscle strength of female basketball athletes but does not significantly affect push muscle strength. This phenomenon is attributed to physiological differences, muscle mass distribution, and training adaptation sensitivity between pull and push muscles. In pull muscles, the smaller muscle mass in females makes them more responsive to training adaptations facilitated by recovery management. On the contrary, push muscles, which are more frequently used in daily basketball activities such as passing and shooting, have a more stable baseline strength and thus do not exhibit significant changes. On the other hand, for male athletes, recovery management does not significantly influence the increase in muscle strength for either pull or push movements. This may be due to an initially high muscle capacity supported by testosterone levels that promote muscle development. Additionally, the lack of focus on weight training during the competition phase, which reduces the effectiveness of recovery management in stimulating muscle adaptation, also contributes to the non-significant impact of recovery management.

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