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Contents

Massage Has the Potential to Accelerate Recovery and Decrease Muscle Soreness after Physical Exercise (Literature Review)

Fatkur Rohman Kafrawi1, Nurhasan2, Endang Sri Wahjuni2, Novadri Ayubi1, Heryanto Nur Muhammad2, Nining Widyah Kusnanik2, Anton Komaini3,*

1Doctoral Program of Sport Science, Postgraduate, Universitas Negeri Surabaya, Surabaya, Indonesia

2Faculty of Sport Science, Universitas Negeri Surabaya, Surabaya, Indonesia

3Faculty of Sport Science, Universitas Negera Padang, Padang, Indonesia

A B S T R A C T

Physical exercise can cause fatigue, resulting in a decrease in muscle work efficiency. This study aimed to analyze the potential of massage to accelerate recovery through a literature review. This type of research is a literature review. Article searches were carried out using a comprehensive strategy in research journal databases such as Web of Science (WOS), Scopus, and Pubmed. The keywords used are massage, physical exercise, muscle pain, inflammatory response, and recovery. The inclusion criteria are journals that discuss sports massage, physical exercise, muscle pain, inflammatory response, and recovery after exercise. Furthermore, the exclusion criteria are journals published in the last 6 years from 2022. 30 articles were obtained, and 12 articles were analyzed based on the suitability of the topic, objectives, research protocol, and research results. Exercises performed at high intensity, especially with repetitive eccentric movements, will cause muscle damage, inflammation, and muscle pain. This review reports that physical intensity exercise that triggers muscle soreness has many advantages when massaged. This benefit is so beneficial in sports that the potential for the use of regular NSAIDs is reduced. In addition, massage has the potential to accelerate recovery, reduce pain intensity, and increase ROM and muscle strength after physical exercise. Therefore, we recommend that massage be used as an alternative to speed up recovery and reduce pain intensity after exercise.

Keywords Massage, Physical Exercise, Fatique, Muscle Soreness, Inflammation, Recovery

1. Introduction

Physical exercise can cause fatigue resulting in decreased efficiency of muscle work [1]. The magnitude of the body's functional changes caused by exercise is influenced by the intensity and duration of the exercise [2]. The mechanism of muscle fatigue is considered to be a complex interaction phenomenon between central and peripheral factors [3]. A study reported that central nervous system (CNS) processes that reduce nerve impulses to muscles cause a decrease in muscle strength known as central fatigue [2]. On the other hand, peripheral fatigue is mainly triggered by increased levels of lactic acid in the blood [4,5]. One study reported that lactic acid contributes to ischemic pain in sensory neurons that innervate muscles [6]. In addition, post-exercise increase in pro-inflammatory cytokines is believed to be the cause of delayed onset muscle soreness (DOMS) and tissue disruption [7,8].In the current case, non-steroidal anti-inflammatory drug (NSAIDs) modalities are the most popular in the management of post-exercise pain [9-12]. On the other hand, the use of NSAIDs is a wrong action because it interferes with the response of muscle growth it will have an impact on hypertrophy and muscle strength [13]. In addition, the use of NSAIDs will cause dependence [14]. In this regard, fatigue and pain caused by

training sessions and competitions will interfere with athlete performance [15].
Alternative solutions need to be found to overcome these problems. One of them with the massage. Massage has been widely used when an athlete is injured in a match [16,17]. In addition, several studies have reported that massage can increase muscle strength and reduce pain during the break [1,7,18]. On the other hand, the lack of reports on this matter gives us the opportunity to discuss in depth and evaluate the available information regarding the potential of the massage through a literature review.This study aims to analyze the potential of massage to accelerate recovery and decrease muscle soreness after physical exercise.

2. Materials and Methods

This type of research is a literature review. Article searches were carried out using a comprehensive strategy in research journal databases such as Web of Science (WOS), Scopus, and Pubmed. The keywords used are massage, physical exercise, muscle pain, inflammatory response, and recovery. The inclusion criteria are journals that discuss sports massage, physical exercise, muscle pain, inflammatory response, and recovery after exercise.
Furthermore, the exclusion criteria are journals published in the last 6 years from 2022. 30 articles were obtained, and 12 articles were analyzed based on the suitability of the topic, objectives, research protocol, and research results.

3. Results

The results of the research in this literature review are presented in Table 1.

Table 1. Review of research results on the effect of massage on recovery and pain intensity

Author	Sample Characteristics	Study Design	Intervention	Results
(Chen et al., 2019) [19]	Twenty-six 14-year-old soccer players participated in this study. Subjects were divided into 2 groups, namely the group with massage intervention on the feet and the control group without massage	A Random Controlled Trial	The massage intervention was given for 15 minutes in the supine position after performing repeated running ability tests	Massage can increase parasympathetic activity so that it has the potential to speed up recovery after repeated sprint exercises
(Shalfawi, Enoksen and Myklebust, 2019) [20]	Four men and four women with an average age of 18 years participated in the study	A random crossover	The intervention was given with a multi-bar roller massager on the quadriceps muscle for 10 minutes before and 15 minutes after cycling until fatigue	Blood lactate levels were higher during fatigue and decreased after multi-bar massage. In addition, there is a tendency to have a positive effect on muscle strength but there is no significant difference in VO2Max

(Chwała et al., 2021) [1]	Eighty-four healthy men aged 20-25 years were involved in this study and then randomly divided the group into four groups. Two groups performed isometric exercises (1 control group with passive rest and 1 group received massage intervention) and 2 groups performed auxotonic exercises (1 control group with passive rest and 1 group received massage intervention)	Eksperimental	The intervention was given in the form of a vibration massage 20 minutes after the subject did isometric and auksotonic exercises using a leg press with submaximal intensity	A significant difference in maximal strength was seen in the isometric exercise group that was given vibration massage. The effects of a massage done right have the potential to speed up recovery after a workout
(Piotrowska et al., 2021) [21]	Twelve 21-year-old untrained men participated in the study. Furthermore, the subjects were randomly divided into 2 groups, namely the control group and the treatment group	Eksperimental	Vibration massage intervention was given for 60 minutes after the subject performed a cycle ergometer exercise for 180 minutes	The administration of vibration massage intervention was significantly able to reduce creatine kinase levels as a marker of muscle damage compared to the control group
(White et al., 2020) [22]	A total of 9 healthy men aged 23 years participated in the study	Eksperimental	Subjects completed massage therapy and control conditions (on 2 different trial days, separated by 1 week). The intervention was given after the subject did moderate to high-intensity exercise in the form of intermittent sprint training	Massage therapy seems to be able to reduce the inflammatory response after high-intensity exercise so it has the potential to speed up recovery
(Bender et al., 2019) [23]	A total of seventy eight runners aged 18 to 60 years were included in this study. Subjects were divided into 2 groups, namely treatment which was given massage, and the control group was given false joint mobilization	Eksperimental	Massage intervention was carried out for 10 minutes after the subject did a 10 km running activity	Massage done after physical exercise can reduce pain intensity
(Cheatham, Stull and Kolber, 2018) [24]	A total of 45 adults participated in the study. Subjects were divided into 3 groups, namely the group with roller massage, the group with non-roller pidgin, and the control group	A Randomized Controlled Trial	The massage intervention was carried out for 2 minutes and the control group did not massage	Roller massage was able to reduce pain intensity and increase the Range of Motion compared to the non-roller group and the control group
(Nunes et al., 2016) [25]	Seventy-four triathlon athletes between the ages of 37 and 39 who completed an event and experienced pain in the anterior thigh participated in the study	A Randomized Trial	After the competition, the subjects in the experimental group were given a quadriceps massage intervention for 7 minutes and the control group rested in a sitting position	Massage therapy is effective for reducing pain and accelerating recovery after long-distance triathlon training activities

(Hoffman et al., 2016) [26]	Seventy-three ultramarathon athletes participated in the study. Subjects were divided into 3 groups, namely the massage group (n=25), the pneumatic compress group (n=24), and the control group (n=24)	A Randomized Trial	After the competition, subjects were randomly assigned to an intervention of massage for 20 minutes, pneumatic compresses, and supine rest	There was a significant decrease in muscle pain intensity in the massage and pneumatic compress group compared to the control group
(Xing et al., 2021) [27]	Thirty-two male rats aged 608 weeks weighing 180-200 grams were used as research subjects. Subjects were divided into 4 groups, namely the normal group, model, fake massage, and massage	Eksperimental	Massage and fake massage were performed 1 week after model formation. The intervention was carried out for 10 minutes and was carried out once a day for a week. The sham massage group received no massage, but the right gastrocnemius muscle was lightly clamped for 10 minutes. The normal and model groups did not receive any intervention	The results of this study reported that massage facilitates adaptive changes in the somatosensory cortex that lead to repair of peripheral nerve injury recovery
(Hunt et al., 2019) [28]	Thirty male rats were selected and then divided into 2 groups, namely the treatment group with massage and the control group without massage	Eksperimental	The rats were anesthetized then the right gastrocnemius muscle received a cyclic compressive load for 30 minutes as a mimetic massage. After being treated, the mice were placed in their cages and allowed to recover. After 24 hours post-treatment, the mice were euthanized and then the muscles were surgically removed and frozen	Massage can increase muscle stem cells so that it has the potential to repair injured muscles

4. Discussion

The main purpose of this literature review is to analyze the potential of massage to accelerate recovery and reduce pain intensity after physical exercise. Exercises performed at high intensity, especially with repetitive eccentric movements, will cause muscle damage, inflammation, and muscle pain [29–32]. These symptoms will be felt for 4 to 7 days and usually, the pain reaches its peak 24 hours after exercise [33,34].

The results of this literature review show that there is evidence that massage has been used as an alternative to speed up recovery and reduce pain intensity. We investigated the mechanism of massage effects starting from muscle cells in experimental animals who reported that massage was able to increase muscle stem cells and potentially repair injured muscles. [28]. In addition, massage is able to facilitate adaptive changes in the somatosensory cortex that lead to injury recovery and peripheral nerve repair [27]. In this regard, massage basically facilitates the integration of information byreversing the activity of the somatosensory cortex to restore sensory function. Furthermore, we observed that massage

has been shown to lower blood lactic acid levels [20]. We believe in a theory reporting that lactate contributes to ischemic pain in sensory neurons that innervate muscles [6]. In addition, we found evidence that massage has the potential to decrease the inflammatory response and muscle damage [21,22]. In this regard, other studies have also reported the effectiveness of massage to reduce pain intensity [23–26]. Reducing pain intensity will potentially restore muscle work efficiency, increase ROM and muscle strength [20,24]. Some of the results of this literature report that massage is effective for 10, 20, 30 and 60 minutes [21,26–28].

The findings of this literature review imply that high-intensity physical exercisethat triggers muscle soreness has many advantages when given massage. This benefit is so beneficial in sports that the potential for the use of regular NSAIDs is reduced. In addition, a short exercise massage has the potential to accelerate recovery, reduce pain intensity, increase ROM and muscle strength after physical exercise. We recognize that this literature review leaves unanswered questions. This includes the effect of repeated massages that are carried out regularly and the most effective duration for doing massages because the results of the literature vary in duration.

5. Conclusions

Exercises performed at high intensity, especially with repetitive eccentric movements, will cause muscle damage, inflammation, and muscle pain. This review reports that physical intensity exercise that triggers muscle soreness has many advantages when massaged. This benefit is so beneficial in sports that the potential for use of regular NSAIDs is reduced. In addition, massage has the potential to accelerate recovery, reduce pain intensity, increase ROM and muscle strength after physical exercise.

Therefore, we recommend that massage be used as an alternative to speed up recovery and decrease post-exercise pain intensity.

Declarations

Conflict of Interest

The authors declare that they have no conflict of interest.

Authors' Contributions

All authors contributed equally in the research and preparation of the paper.

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General Preparatory Exercise Program Based on Android Tennis Sports

Nurkadri1,*, Asep Suharta1, Indra Darma Sitepu1, Argubi Silwan1, Febry Hakim Nur1, Taufik Akbar1, Rizky Nursasongko Gunri1, Muslimin2
ulty of Sport Science, Universitas Negeri Medan, North Sumatera, Indonesia
2Sports Education Study Program, Faculty of Teaching Training and Language, Universitas Bina Darma, Palembang, Indonesia

A B S T R A C T

This research explores the general preparatory physical exercise program using Android forVolta Club tennis players and students of sport sciencefaculty, Universitas Negeri Medan. This research adopts the method of the research and development model Borg and Gall. The development procedure used includes several stages: 1) recognizing the content of the product being developed, 2) developing the initial product, 3) expert validation. The data analysis technique used in this study was done in two ways, namely quantitative and qualitative. In this article, the data used is only at the validation stage of material experts and media experts. Based on the results of the material expert validation regarding the product, it can be obtained as follows: assessment of the material aspect obtained 86.70 % (Very Feasible), the aspect of human resources for sportspersonnel obtained 96% (Very Feasible), the mechanism for implementing the physical exercise program was 90% (Very Feasible), and the overall percentage was obtained 95.4% (Very Worthy). Next is the assessment of media experts from various aspects: Display 72.2% (Decent), Coloring 77.7% (Very Decent), Images (Photos/videos) 80% (Decent), Fonts 80% (Very Decent), Menu 80% (Decent),Ease 73.3% (Eligible), and the usefulness of the 96%aspect of the media expert's assessment stated that theandroid-based general preparation physical exercise program application media was very feasible. The overall percentage obtained is 79% with a decent category.

Keywords General Preparation, Exercise Program, Tennis Sports, Android

1. Introduction

Higher education is directed at the development of science and technology, as well as improving the welfare of the community and the competitiveness of the nation. In this research, program targets and program performance indicators that are directly related to research outcomes and community service points 3 and 4 explain increasing the relevance, quality, and quantity of science and technology and Higher Education resources, as well as increasing the relevance and productivity of research and development. So in this case, universities are required to research with more emphasis on increasing the relevance, quality of research, and quantity of the development of science and technology and development of science and technology resources.

Development is a research method that produces a product in an area of expertise particularly, followed by certain by-products and has the effectiveness of the product. Development Research is research that produces a product that has been analyzed first for its effectiveness and has been designed, evaluated with the results of the development model [1,2]. Research and development methods are research methods used to produce certain products and test product effectiveness [3,4]. This is further confirmed by the research of Paul Ford et al., explaining that by using the development of appropriate exercise stimulation (product development) its relationship to the natural growth and maturation process by

using the concept of a "return window" to accelerate and improvephysical development [5]. In this case, development research is research that produces renewal products that were previously designed, tested, analyzed for effectiveness, and disseminated to the public. In this digital era, a breakthrough is needed for development in the field of sports to be able to easily achieve the goals of the sport. The fact that technology plays a much larger role in the digital era than it did for previous generations has made today's generation have a high level of technological literacy [6]. With this change, it is hoped that the successfull sportspeople who are more advanced and modern, so that sports infrastructure is needed globally [7]. The increasing number of human needs makes humans creative and innovate by developing technology and creating new pathways for sports organizations through developed infrastructure [8]. Researchers see from what is the reality on the ground, especially in North Sumatra, there has never been facilities and infrastructure of a technology that makes it easier for coaches and athletes to carry out training programs, in this case, the sport of tennis.

This was emphasized by Firmansyah, a State-Owned

Enterprise employee who is a former international athlete at his time and currently serves as Head Coach and Person in Charge of the Volta Tennis Club (VTC), who said "Tennis is a sport for the upper middle class. So far in Indonesia, getting tennis court athletes is quite difficult because there are athletes who meet the criteria, but parents who are financially incapable, or financially very supportive, but these athletes are less talented". This systematic review proves that technology provides a method that is well-accepted for parents with an interesting form of exercise; its implementation is also very high, both through supervision and no supervision, whose implementation is for 12 evaluated weeks [9]. And the results make it clear that 13 studies (59%) used commercially available systems for exercise programs: 4 (31%) used consoles Nintendo Wii with Fit/Sports games [9-13].

Then, confirmed by Gudo Siswoyo Gunri, who is the General Secretary of the Medan City (Persatuan Lawn Tenis Indonesia) PELTI that "In this present era where the Covid-19 pandemic is spreading, it is hoped that a breakthrough or development of a form of exercise that makes it easier for players, coaches or athletes to be able to practice independently with an exercise program using technology whether it's a cellphone, android or others. So that anyone can be biased and can master the sport of tennis." Researchers assume that at this time, apart from the Covid-19 pandemic problem, especially in the current technological era, it is digital, so it is very useful for infrastructure to inform digital an increase in self-ability in exercising without supervision or with supervision.

Previous research has systematically shown that these forms or models of technology-based exercise are good for older people in exercising, and more research is needed to investigate the feasibility, acceptability, and effectiveness of technology-based training programs [9]. Based on the background of the problem from several sources, this research wants to explore the truth and effectiveness of a digital development that is used as an infrastructure for the implementation of an exercise program, where the aim is to simplify and increase skills in the sport of tennis.

2. Material Methods

The development method used in this research is the adoption of the Borg and Gall development model with 6 steps. This was done due to time and cost constraints. This is supported by the statement that research and development can be stopped until a final draft is produced, without testing the results [14]. The results or impacts of implementing the development of movement activities already exist in group trials and limited trials. The stages in this research can be presented as follows: a) Needs analysis: literature study, observation and needs analysis. In the needs analysis, the researcher conducted interviews with coaches and several sources of former North Sumatran athletes, and based on several journals that were relevant to current problems.

b) Planning: general preparatory exercise program based on android for tennis. Product design planning

is carried out to finalize the research to be carried out. The steps taken for product design planning are: planning for making Android-based applications (a. Collecting data to create program data menus, datacollection needs to be done to determine the menus that will be created in the application so that the program menus created can accommodate allelements of fulfillment standard process b) Design database using XMEYE software, program code generation using PHP 5 and HTML 5).

c) Application development in the draft is initially validated by supervising experts and experts in information technology (consisting of 2 experts) so that this design is effective and efficient in its use. Then after making the draft initial, it continues to improve the design after receiving input from the experts who have been determined. Initial product design: program general preparatory physical exercise creation, exercise video creation, and application development. The making of this training program is based on the training periodization theory from Bompa, where the training program is for the physical form of athletes in preparation general. Next is the making of videos or pictures of the forms of physical exercise in the general preparation phase. Then these forms of physical exercise are entered intothe android application which will later be used for independent training.
d) Revise the product; After getting some input and suggestions on the implementation of the Focus Group Disscussion (FGD), the product of this research was perfected by following the input and suggestions that had been given. Furthermore, after the draft of the exercise program application has been designed, validation of the program application design was carried out, involving 2 (two) material experts and experts media for the exercise program application. The application development carried out by the researcher is an idea created based on the needs of the trainer and customer, which then the researcher submits and conducts discussions to several experts and validators to get input or revisions related to an exercise program android-based general preparatory physical that will be developed to improve the results of the research conducted. The data analysis technique used in this development research is to use a descriptive technique in the form of a percentage. In data processing, the percentage is obtained by the formula of [15]:

$$NP = \frac{n}{N} x\ 100$$

NP = Value in %.
N = Value obtained.
N = Total value/sum of all data.
The percentage results obtained then classified to obtain data conclusions. The following table, 1 will present the classification in percentage [15].

Table 1. Percentage Classification

Percentage	Criteria	Classification
0 - 20%	Not Good	Not Eligible
20,1-40%	Less Good	Less Eligible
40,1-70%	Fairly Good	Fairly Decent
70,1-90%	Good	Decent
90,1-100%	Very Good	Very Decent

3. Result and Discussion

Result

Researchers carry out development activities starting from a design that is not clear but continues to be developed while continuing to make improvements and involving several parties including users of the product developed. Activities start from systematic, neat, and clear planning, including the purpose of android-based applications. The relevance of the problem in the background of the problem, theories that support the research process and suggestions from experts provide good direction in the research process and making applications. Product development is a subjective understanding of a producer of "something" that can be offered as an effort to achieve organizational goals through meeting the needs of the training program. Objectives and user desires, following the competence and training capacity and motivation of users in independent training.

Validation Material

The researcher validated the application design involving a material expert, namely Dr. Budiman Agung, M.Pd is physical trainer tennis at Regional Student Education and Training Center Bogor Regency and west Java Physical Trainer and Australian Strength and Conditioning Association ASCA level 1 certified as material. From the results of material expert validation, it can be seen in Table 2.

Table 2. Results Material Validation

Respondent				
Respondent	1	2	3	Amount
Of Experts Material	29	24	9	62
Percentage	86,70%	96%	90%	95,4%

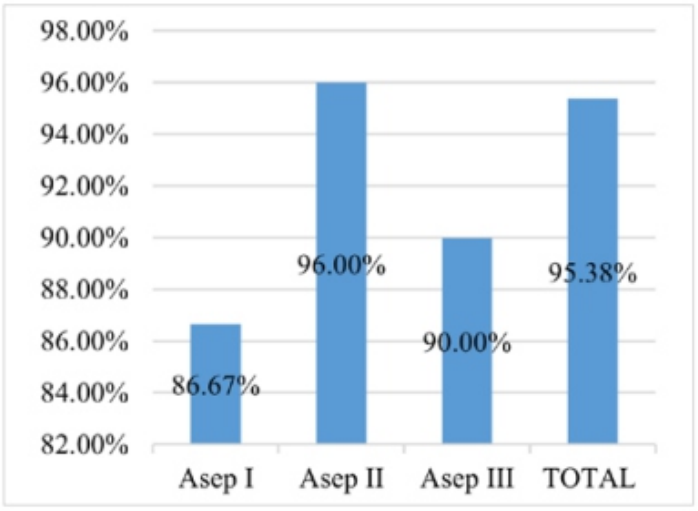

Figure 1. Expert Validation Results Materials

Based on the results table 2, it can be seen the histogram of the percentage of supervisory expert assessments of application products, as shown in Figure 1.Products that were developed previously must be validated by experts to determine the feasibility, weaknesses, and strengths of the resulting product. Validation from material experts is in the form of assessments and suggestions for improvements needed so that the material aspects of the products developed are feasible. Based on the results of discussions and initial assessments from material experts regarding the product, it can be obtained as follows;

1. Assessment of the material aspect obtained 86.70% (very feasible),
2. Aspects of human resources for sports personnel obtained 96% (Very Eligible),
3. The mechanism for implementing the physical exercise program is 90% (Very Eligible),
4. The overall percentage was obtained at 95.4% (very decent).

Therefore, it can be concluded that following the previous problem formulation which touched on the effectiveness and efficiency of the product development of general preparation physical exercise programs based on Android, the content in product development is appropriate and effective in terms of the aspect of material expert assessment. It is stated that the general preparation physical exercise program application media has in a good category.

Media Expert Validation

On the validation of Media expert Fikri Aldi as a Modeling and Animation expert at the Smart School Vocational School, he assessed the application product for an Android-based general preparation physical exercise program, which can be seen in Table 3. Based on the results table 3, it can be seen the histogram of the percentage of experts assessments supervision of application products, as shown in Figure 2.

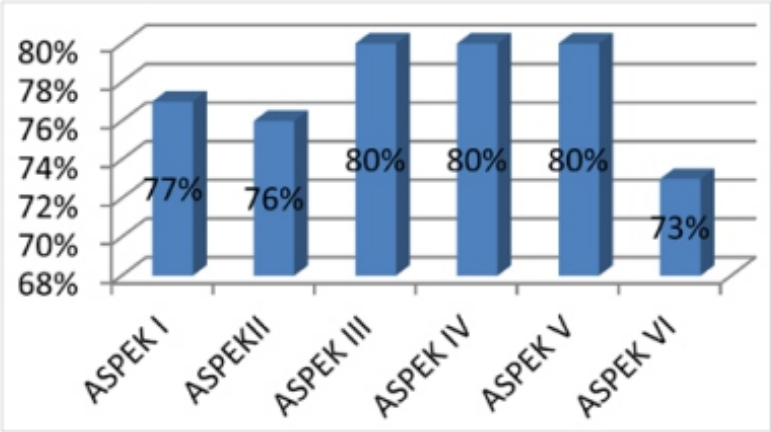

Figure 2. Percentage of Expert Assessment Results Media

Data is expert validation obtained by providing a questionnaire containing display aspects accompanied by the product. Media developed to media experts. In addition, media experts were given comments and suggestions general to improve the developed media so that it could be used as a product for general preparation physical exercise program applications. Assessment of media experts from various aspects is as follows:

1. Display 72.2% (Decent),
2. Dye 77.7% (very Eligible)
3. Image (Photo/video) 80% (Decent),
4. The letters 80% are very decent,
5. Menu 80% (Decent),
6. Convenience 73.3% (Decent)
7. The usefulness of the 96% aspect of the media expert's assessment stated that the android-based general preparation physical exercise program application media was very feasible.
8. Overall the percentage obtained is 79% with category decent.

Table 3. Results Media Expert Validation

Indicators Assessment								
Aspect	1	2	3	4	5	6	7	Amount
Of Media Experts	22	35	16	24	27	19	19	157
Percentage	72,2%	77,7%	80 %	80 %	80 %	73,3%	96 %	79 %

The results of media validation are guidelines for developing product quality applications for generalpreparatory physical exercise programs before entering trials individual. Suggestions and inputs were given by media experts on products physical exercise program application are:

1. Loading is too long.
2. There is a user display when loading.
3. The menu biodata on the dashboard/home does not need to be displayed.
4. The button terms/conditions and application guide cannot be accessed.

5. Need to add application usability information.
6. The buttons available on the dashboard cannot run when the button is pressed.
7. The button registrations a trainer does not run properly when pressed.
8. The search button on the trainer list doesn't work very well either.

4. Discussion

Products that will be developed previously must be validated by experts to determine the feasibility,weaknesses, and strengths of the resulting product. Validation from material experts is in the form of assessments and suggestions for improvements needed so that the material aspects of the products developed are feasible. Based on the results of discussions and initial assessments from material experts regarding the product, it can be obtained as follows; 1) Assessment of the material aspect obtained 86.70% (Very Eligible); 2) Aspects of human resources for sports personnel obtained 96% (Very Eligible); 3) The mechanism for implementing the physical exercise program is 90% (Very Appropriate);. 4) The overall percentage is 95.4% (Very Decent). Therefore, it can be concluded that following the previous problem formulation which touched on the effectiveness and efficiency of the product development of exercise programs general preparation physical based on Android, the content in product development is appropriate and effective in terms of the aspect of material expert assessment. It is stated that the media general preparation physical exercise program application has in a good category.

Furthermore, the media expert who became the validator in this study was Fikri Aldi, an expert and modeling teacher at the Smart School Vocational School. Media expert validation data was obtained by giving a questionnaire containing display aspects accompanied by media products developed to media experts. In addition, media experts were given general comments and suggestions to improve the developed media so that it could be used as a product program application for general preparation physical exercise. Assessment of media experts from various aspects is as follows: display 72.2% (Decent), coloring 77.7% (Very Decent), pictures (Photos/videos) 80% (Decent), letters 80% (Very Decent), menu 80% (Decent), convenience 73.3% (Eligible), the usefulness of the 96% aspect of the media expert's assessment stated that the android-based general preparation physical exercise program application media was very feasible, and the overall percentage obtained was 79% with a decent category.

The results of media validation are guidelines for developing product quality applications for general preparatory physical exercise programs before entering trials individual. Suggestions and inputs were given by media experts on application products physical exercise program are: loading too long;, there is a user display when loading;, the biodata menu on the dashboard/home does not need to be displayed;, the terms/conditions button and application guide not can be accessed;, required added information on the use of the application, the buttons available on the dashboard cannot run when the button is pressed, the button registration as a trainer cannot run properly when pressed, and the search button on the coach list also doesn't work well.

5. Conclusions

This development research was carried out in several stages, where the stages were carried out starting from the implementation of preliminary studies, product development designs, to the product validation and revision stages. Results of material experts assessment of material aspects obtained 86.70% (Very Feasible); 2) Aspects of HR sports personnel obtained 96% (Very Eligible); 3) The mechanism for implementing the physical training program is 90% (Highly Appropriate);. 4) Overall percentage 95.4% (Very Appropriate), media expert assessment results Display 72.2% (Decent), Coloring 77.7% (Very

Decent), Pictures (Photos/Videos) 80% (Decent), Letters 80 % (Very Decent), Menu 80% (Decent), Convenience 73.3% (Decent). So from the results of the validation of the two experts, it can be concluded that this exercise development research can be applied to trainers such as playing tennis. This research is effective and efficient as well as new findings so that originality is maintained.

6. Suggestion

Based on the conclusions above, it is recommended: (1) This research should be continued at a stage the next development, namely the trial stage and the implementation stage product. (2) On the implementation of the coach and player trials in maintaining physical condition as a tennis player as expected. (3) Development of Application. This android-based general preparatory physical exercise program can be disseminated through the application Google Play Store after this research is completed at the product effectiveness stage. (4) This research is expected to be continued in the future for research on trial people. (5) For the development of this research science as a reference for other research and teaching of Physical Condition courses and others. (6) The researcher would like to thank the Chancellor of the State University of Medan who has approved this research to be carried out. (7) This research received research grants from State University PNBP funds in Medan accordance with the Decree of the Head of LPPM Unimed number 123/UN33.8/KEP/PPKM/2021.

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Physical Fitness of Futsal Athletes in Competition Preparation

Dedi Supriadi, Gita Febria Friskawati*, Vicki Ahmad Karisman
Department of Physical Education, Health and Recreation, STKIP Pasundan, Jln. Permana No.32 B Citeureup, Cimahi, Jawa Barat, 40512, Indonesia

ABSTRACT

The purpose of this study was to reveal the physical fitness of futsal athletes in the match preparation stage. This study was a descriptive research with 22 futsal athletes from Cimahi, West Java, Indonesia. As the research sample, we included 12 male futsal athletes and 10 female futsal athletes. The used instruments to measure physical fitness are; (1) Speed (i.e. run test for 30 meters); (2) Flexibility (i.e. sit and reach); (3) Arm strength (i.e. medicine ball); (4) Leg strength (i.e. vertical jump); (5) Arm muscle endurance strength (i.e. 1-minute push up); (6) Abdominal muscle endurance strength (i.e. 1- minute sit up); (7) Back muscle endurance strength (i.e. 1-minute back up); (8) Abdominal muscle endurance strength (i.e. 1-minute half squat); and (8) VO2 Max (i.e. Yoyo test). Collected data were analyzed descriptively and analytically using SPSS version 24. The result showed that physical fitness male athletes in Cimahi have an average completion of each component of 73%, categorized as Fair. Meanwhile, the female athletes in Cimahi only have an average completion of each component of 63%, categorized as Poor. Some factors such as genetics, training, gender, age, body fat, and daily activities affect physical fitness. A physical fitness training program should be arranged, organized, and implemented properly and systematically to work up the dominant physical fitness in preparing for a competition.

Keywords Physical Fitness, Futsal, Competition Preparation

1. Introduction

Physical fitness is a basic need for every sports activity, especially professional sports. The components, such as speed, strength, endurance, and flexibility, along with other physical fitness, are essential for excellence in professional sports [1]. Athletes in every sport need great physical fitness to support the implementation of techniques and tactics when practicing or competing. Great physical fitness is one of the ways to gain achievement [2,3]. Sports coaches highlight the improvement of athletes' physical fitness and motoric quality, called conditioning [4]. A good conditioning program relies on the overall professional sports coaching responsibility. Physical fitness is divided into general physical fitness and special physical fitness. General physical fitness is related to the competence qualities needed by every athlete, such as speed, strength, flexibility, endurance, and coordination. Every sport demands certain ability qualities, as in this case, futsal [1].Futsal is a sport that involves intermittent periods of high intensity over two periods, 20-minute periods per game. The sport requires sudden changes in movement patterns, fast sprints, and quick decision-making to gain or maintain possession of the ball. This research shows that agility appears to be a critical component of a successful play [5–7]. Furthermore, all three playing areas (e.g., guard, winger, pivot) must be able to change their position effectively during the game, which emphasizes the need of agility performance [8]. In other words, regardless of the specific task of their main game, all futsal players must have extraordinary agility with and without the ball.

The pattern of futsal activity may differ from other sports as each player must carry out attacking and defensive tasks constantly at a high tempo. Futsal is a sprint sport with a higher intensity phase than other intermittent sports. However, compared with other sports, it has its own limitations. Some useful

comparisons could be made with similar intermittent team sports such as football, basketball, and handball [9,10]. As an example, the total-covered distance at high intensity and maximum speed is greater in futsal than in football or handball. It reflects the nature of the high intensity of a futsal game [11]. The ratio of playing to rest in futsal is approximately 1:1, where rest means the player is not moving, walking, or jogging, and the covered distance is at moderate, high, or maximum speed [12,13]. From these findings, it could be concluded that futsal is an anaerobic sprint sport where high-intensity exercise has a greater proportion of match time than in soccer and some other sports such as sprinting. The previous research has provided important information about the physical fitness of futsal athletes in competition preparation to planning and setting the futsal training, but it is primarily concerned with either the pre-season [1–3].

Therefore, a consecutive test is needed to acknowledge the status of futsal athletes' physical fitness [14], in which this research focused on the physical fitness of futsal athletes in Cimahi, West Java, Indonesia, as some research findings showed that physical fitness affects athletes' performance [1,3,7]. Some physical components may not be possessed properly through the analysis of the characteristics of the futsal game, but there should be more dominant components possessed by futsal players, namely endurance, strength, and speed, without leaving other components, 1]. The general preparation stage is the foundation stage for building the dominant physical fitness component. The stage plays the most strategic role in the overall training program as several research results state that the general preparation stage is a crucial phase in building the great physical fitness of the athletes [15,16].

Research findings are needed to uncover the result of the physical fitness test of futsal athletes in the competition preparation stage to determine the types and proportions of the training in the general preparation stage. Thus, this study was conducted to reveal the physical fitness of futsal athletes in the match preparation stage.

2. Materials and Methods

This study used descriptive analysis. The sample in this research was 22 futsal athletes in Cimahi, West Java, Indonesia, consisting of 12 male futsal athletes and 10 female futsal athletes. Total sampling was used in this research to unveil the overall physical fitness of the futsal athletes in Cimahi. The used instruments to measure physical fitness are; (1) Speed (i.e. run test for 30 meters); (2) Flexibility (i.e. sit and reach); (3) Arm strength (i.e. medicine ball); (4) Leg strength (i.e. vertical jump); (5) Arm muscle endurance strength (i.e. 1-minute push up); (6) Abdominal muscle endurance strength (i.e. 1-minute sit up); (7) Back muscle endurance strength (i.e. 1-minute back up); (8) Abdominal muscle endurance strength (i.e. 1minute half squat); and (8) VO2 Max (i.e. Yoyo test). [17]. Collected data were analyzed descriptively and analytically using SPSS version 24. The test result was analyzed and shown in the form of a bar diagram.

3. Results

The result data from the test physical fitness wereanalyzed based on the type of test and shown by the percentage on every item, so the comparison between male futsal athletes' and female futsal athletes' results could be identified.

Table 1. Physical fitness result of male futsal athletes

Test Items	Test Result		Norm		Achievements	Category
speed	4,7	sec	3,75	100	80%	Good
flexibility	49	cm	53,9	100	91%	Excellent
agility	14,7	sec	10,76	100	73%	Fair
Strength (leg)	50,11	cm	66	100	77%	Good
Endu. strength (abdominal muscle)	33	rep	49	100	68%	Poor
Endu. strength (back muscle)	44	rep	50	100	79%	Good
Endu. strength (leg muscle)	35	rep	45	100	67%	Fair
VO_2 Max	42,20	ml/kg/sec	51,13	100	83%	Fair

Table 1 describes the test results of the physical fitness of the male futsal athletes for the test results on speed reaching 80% in the Good category; Flexibility reached91% in the Excellent category; Agility reached 73% in the Fair category; Strength (leg) reached 77% in the Good category; Endurance strength (abdominal muscle) reached 68% in the Poor category; Endurance strength (back muscle) reached 79% in the Good category; Endurance strength (leg muscle) reached 67% in the Fair category, and VO2Max reached 83% in the Fair category. Figure 1 describes an image of a spider web to unfold the achievement of the physical fitness of male futsal athletes compared to the existing norms to be able to make a form of exercise that is suitable for their best performance.Based on Figure 1, the achievement target of the physical fitness of the male futsal athletes from each component still has to be improved, with an average achievement of each component of 73% in the Fair category. The results revealed that the agility component, which should be important for a futsal player, only reaches 73%. This achievement target must be carried out in every practice before the competition season.

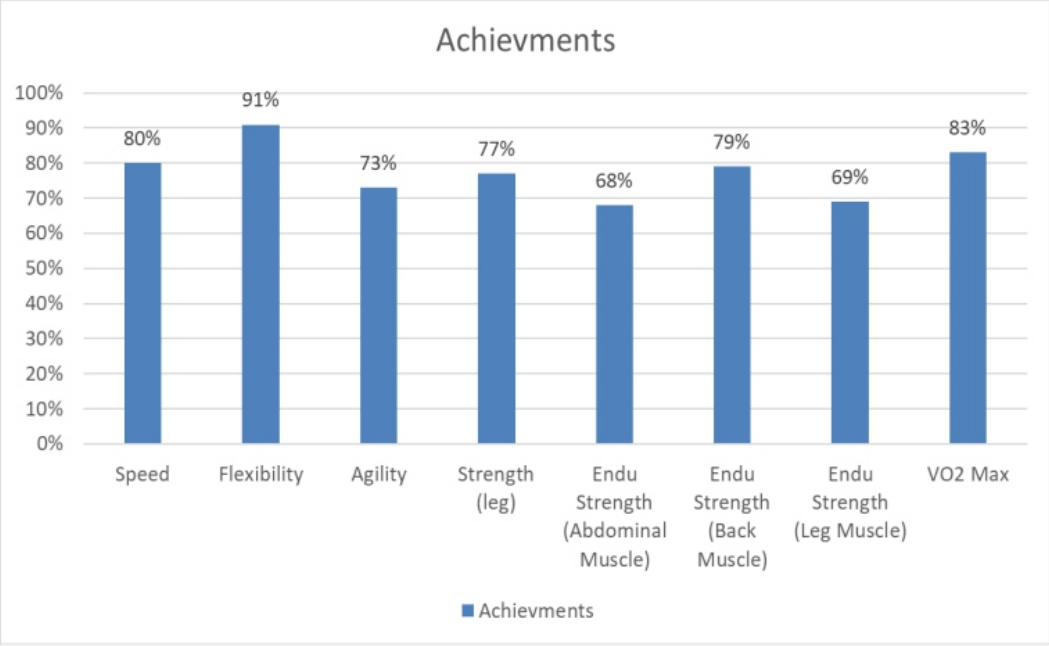

Figure 1. Diagram of physical fitness result of male futsal athletes

Table 2. Physical fitness result of female futsal athletes

Test Items	Test Result		Norm		Achievements	Category
speed	5,77	sec	3,75	100	65%	Fair
flexibility	25	cm	53,9	100	46%	Poor
agility	13,72	sec	10,76	100	78%	Good
Strength (leg)	35	cm	66	100	53%	Poor
Endu. strength (abdominal muscle)	33	19	42	100	46%	Poor
Endu. strength (back muscle)	29	rep	47	100	61%	Poor
Endu. strength (leg muscle)	30	rep	40	100	74%	Fair
VO_2 Max	39,05	ml/kg/sec	51,13	100	76%	Good

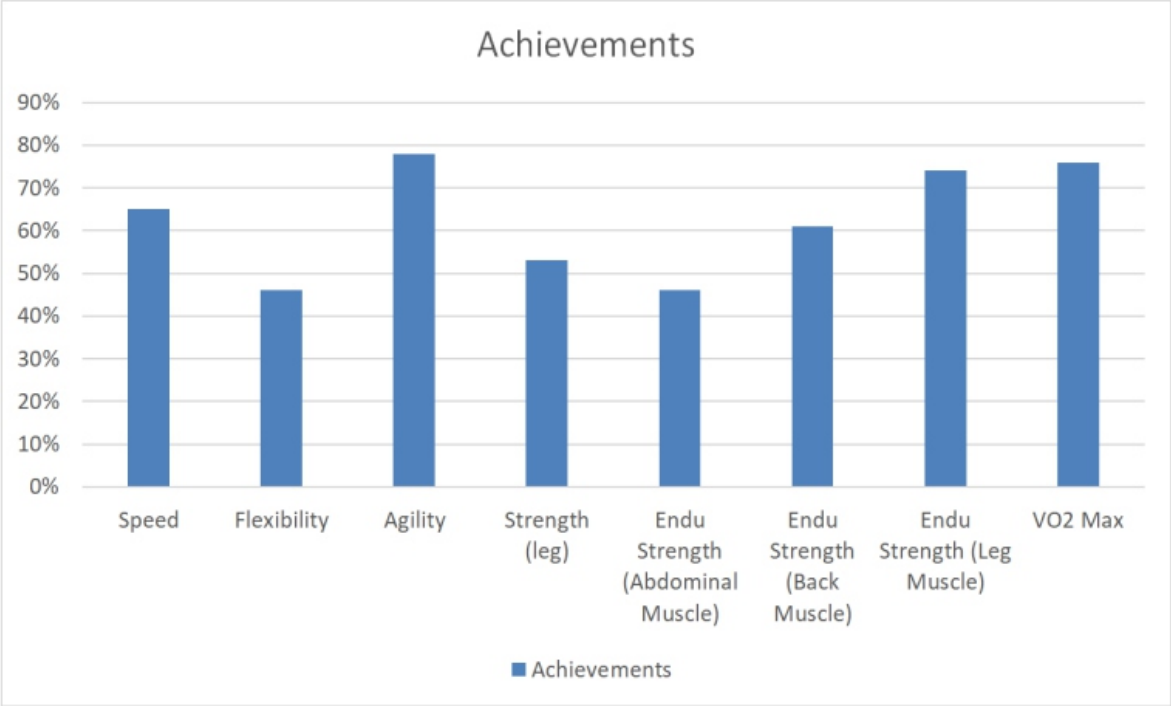

Figure 2. Spider Diagram of physical fitness result of female futsal athletes

Table 2 explains the test results of the physical fitness of female futsal athletes for the test results on speed reaching 65% in the Fair category; Flexibility only reached 46% in the Poor category; Agility reached 78% in the Good category; Strength (leg) reached 53% in the Poor category; Endurance strength (abdominal muscle) reached 46% in the Poor category; Endurance strength (back muscle) reached 61% with Poor category; Endurance strength (leg muscle) reached 74% in the Fair category, and VO2 Max reached 76% in the Good category. Figure 2 shows a picture of a spider web to present the achievement of the physical fitness of female futsal athletes compared to the existing norms to be able to make a form of exercise that is suitable for their best performance.Based on Figure 2, the achievement target for the physical fitness of female futsal athletes from each component still has to be improved, with the average

achievement of each component as much as 63% in the Poor category. It requires the achievement target to be carried out in every practice before the competition season comes. The results revealed that the components that were lacking, such as flexibility, strength, endurance strength (abdominal muscle), and endurance strength (back muscle), must be increased in each training session.

4. Discussion

In general, the level of physical fitness of men futsal players is in the Fair category (73%) in the competition preparation stage. Physical fitness is also influenced by several influencing factors such as genetics, exercise, gender, age, body fat, and daily activities [18,19]. On the other hand, factors influencing achievement are physical, technique, tactics, mental, and body constitution [6]. It is obvious that looking at the circumstances, a solution must be found for the problem of the level of the physical fitness of players to increase the achievement at the national and international level, one of which is improving physical fitness at the training stage [20]. Considering the status of a professional player, improving physical fitness is necessary, especially the components of physical fitness that were lacking to achieve higher achievements in the future [21]. The results reveal that the other physical fitness of male futsal athletes with sufficient category was agility. Endurance strength muscle and VO2 Max should be in the

Good category for the futsal player and become the dominant physical fitness component that must be possessed [6]. Therefore, the physical fitness training program must be arranged, organized, and implemented properly and systematically to improve the dominant physical fitness of futsal and increase the required biomotor abilities [22]. Physical fitness highly supports players in a competition to avoid significant fatigue and injuries that could interfere with their performance [9]. The factor of physical fitness is very important to the achievement of a player or team. Additionally, it is necessary to face competition with a busy schedule. It is hoped that with excellent physical fitness, the players could play better and increase their achievements [6,10].Differently, the result of physical fitness tests of female futsal athletes was still far from expectations. It only shows the average of 63% in the Poor category on each component. Therefore, every practice's achievement target must be achieved before the competition season. The results revealed that the lacking components were flexibility, strength, endurance strength (abdominal muscle), and endurance strength (back muscle). Those components must be increased in each training session. Physical fitness could not be improved and developed only in a relatively short period. Experts say that good physical fitness requires continuous and progressive exercise [1,23].

The physical fitness components should not be all properly possessed. The type of movement in the futsal game requires the player to manage maximum aerobic energy to avoid fatigue in the futsal game, which is a hard and long-term-draining-energy game [7,10]Futsal is a very complex sport, requiring great physical fitness, good technique, and an understanding of tactics.Additionally, the difference in the physical fitness of futsal with other sports makes it difficult for players to excel if they do not have good physical fitness, no matter how good the players' techniques and tactics they have [24,25]. The coach must acknowledge and understand physical fitness and its factors before the training stage [1]. Physical demands in futsal could be evaluated from each player's movements during the competition. It is meant to find out each player's similar or different activity in a competition.

Each player has a different type of physical activity and physical fitness. This necessity is used for data analysis of activity movements in futsal [26].Factors of exercise and training have a great influence on improving an athlete's physical fitness. A person who regularly trains according to his needs and achieves physical fitness from the effort is called training. On the other hand, a person

who lets his muscles limp hanging and is in poor physical fitness is called untrained [1]. The results show that male futsal athletes fall into the Good category since these players were used to physical fitness training even with less intensity so that during the test, these players could do better than other players [10]. The different portions of exercise and lifestyle caused the fact that female futsal athletes are classified as Poor before joining the training camp. It was improper to get the optimal results from previous training [16]. The limitation of this research relies on the physical fitness test instrument for male and female futsal athletes which may not be following their regular training. Therefore, they were not familiar with the used test instrument.

5. Conclusions

The physical fitness of the men futsal athletes in Cimahi, West Java, Indonesia, has an average achievement of each component of 73% in the Fair category, while the physical fitness of the female futsal athletes only has an average achievement of each component of 63% in the Poor category. Several factors affect the physical fitness of futsal athletes in preparation for this competition, such as genetics, training, gender, age, body fat, and daily activities. The solution must be found for relatable problems. Therefore, the level of physical fitness of male and female futsal players to increase achievement at the national and international levels could be achieved in the competition preparation stage. One of the solutions includes improving physical fitness at the more intensive training stage.

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Reverse Periodization Model to Increase Anaerobic and Aerobic Capacity

Dikdik Zafar Sidik , Fitri Rosdiana
Department of Coaching Education, Faculty of Sport and Health Education,
Universitas Pendidikan Indonesia, Bandung, Indonesia

A B S T R A C T

Circuit training is a training method used to efficiently maximize training time while providing more comprehensive, greater, and faster benefits in shaping, developing, and improving the work function of an athlete's body. This study aimed to increase anaerobic and aerobic capacity which includes speed, agility, power, power endurance, and endurance through the circuit training method applied to the Reverse periodization model. The method used in this research is an experiment with a One-Group Pretest-Posttest design. The sample in this study was a university's Women's Futsal Student Activity Unit with a total of 14 Students. The research instrument was in the form of anaerobic and aerobic ability tests. results showed a significant effect of the circuit method on the reverse periodization model on anaerobic and aerobic capacity. To get optimal results, athletes must manipulate a small volume of exercise at the beginning and keep increasing until the end of the meeting. Moreover, the high intensity at the beginning of the meeting was followed by a decrease until the end of the meeting. Indeed, this also should be supported by utilizing the forms of agility and power movements at each post in a structured, measured, orderly manner and interspersed activity.

Keywords Circuit Training, Reverse Periodization, Aerobic, Anaerobic

1. Introduction

Futsal is a physically dominant sport in this case following some literature which shows that the physical demands on the futsal sport are an important factor that must be considered by the coach in terms of training carried out for later participation in competitions [1,2,3,4]. The demands of physical ability include anaerobic and aerobic capacity consisting of speed, agility, power, power endurance, and endurance. Futsal activities are carried out with high intensity by doing a lot of repeated acceleration, running, and changing directions, and each player must attack and defend his skills consistently. Thus, a player is required to have excellent skill endurance because the characteristics of futsal itself require high aerobic ability supported by good anaerobic ability [5].

Aerobic physical ability as a fundamental and very important factor in improving athlete performance is seen from the analysis of movement demands in futsal that the players run more than 4,500 meters during the match [6,7]. And players 8.9% run (speed 25 km/h-L) with a high intensity of their total distance. In addition, players make a low-intensity effort every 14 seconds, a medium-intensity effort every 37 seconds, a high-intensity effort every 43 seconds, a maximum intensity effort every 56 seconds, and change the movement activity every 3.3 seconds [8]. From these findings, it can be concluded that futsal is an anaerobic multiple-sprint sport where high-intensity training makes up a larger proportion of a

of a match.

Aerobic respiration releases much more energy than anaerobic respiration. Anaerobic respiration releases less energy than aerobic respiration, but it does this more quickly. This reaction is lactic acid. This builds up in muscles causing pain and tiredness, which can lead to cramps. If the intensity of anaerobic exercise continues to be increased, it will cause fatigue resulting from high lactate; this is at risk of causing easy injury. However, intense anaerobic workouts can also increase fast twitch muscle size and quantity, improving muscle power, strength, and size. Anaerobic exercise helps build tolerance to the lactic acid that causes fatigue, improving muscle endurance. According to the theory that aerobic capacity will be better if there is progress in anaerobic capacity, and anaerobic capacity will be better if aerobic capacity has progressed better because of a faster recovery period. Thus, anaerobic and aerobic abilities are interrelated.

Aerobic endurance performance depends on maximal oxygen uptake (VO2 max). VO2 max is defined as the highest oxygen uptake a person achieves during exercise [9-11]. One way to improve anaerobic and aerobic abilities is the Circuit Training method. Circuit training is an exercise program consisting of several posts and at each post, an athlete performs a predetermined type of exercise. Exercises usually consist of 9-12 posts arranged in the form of a circuit [12]. This circuit training method is applied periodically which is planned in a structured, measurable, and regular program based on the stages of training, because the physical condition can reach an optimal point if the exercise is done repeatedly, and continuously periodically under the principles and norms of correct and good practice. Training that has long-term, medium-term, and short-term planning is usually called periodization. According to literature [13], it defines periodization is a systematic planning process of short and long-term training programs by varying the training and recovery load. According to Williams et al.[14] periodization is a method for organizing training into sequential phases to increase the potential for achieving goals. Later Deweese et al. [15] periodization was considered an integral part of the training process and provided a conceptual framework for designing training programs.

In a base of Periodization, there are several forms of periodization models including linear (traditional) and nonlinear (non-traditional) periodization, but all periodization models have the same principle consisting of three phases, including the preparation phase, the competition phase, and the transition or recovery phase [16,17]. Non-traditional/non-linear periodization models include Reverse periodization and block periodization models [18]. Non-linear periodization is based on the concept that volume and load changes are more frequent (daily and weekly) to allow for a longer recovery period because lighter loads are carried out more often [19]. The linear periodization model works starting from low-intensity and high volume with gradual changes in volume and intensity [18,20]. In the reverse periodization model, the training program starts with high intensity and the volume is low, and gradually the intensity decreases and the volume increases, or au intensity is maintained and volume increased depending on the sport [21-23]. The reverse periodization is based on a low training volume combined with high-intensity, initiating high-intensity application from the start of the macrocycle [24].

Several studies showed that reverse periodization is a specific and efficient training strategy for training sprinters because it shows a significant value above the traditional periodization average value [25]. Then, this study showed that a gradual increase in volume and decrease in intensity was the most effective program for increasing muscle endurance [26]. Then, Circuit Training resulted in a significant increase in VO2 max [27]. Several studies stated that concerning the reverse periodization model, linear

periodization presented more positive effects on body composition [28] and increased VO2 max in the block periodization group [29].

Based on the above explanations, there are still many factors that must be studied further regarding the application of the Circuit Training method in the reverse periodization model to increase anaerobic and aerobic capacity to ensure all these conclusions. Therefore, this research can be developed and applied as an alternative or solution to various problems in the field.

2. Materials and Methods

The method used One-Group Pretest-Posttest Design.
The tests were carried out before and after the treatment to understand the impact of the treatment [30]. The research was carried out for four weeks with 12 meetings (the training was carried out three times a week. This research was conducted at Universitas Pendidikan Indonesia Jl. PHH Mustofa, No. 200, Padasuka, Bandung from 29 March 2022 to 23 April 2022.

The population in the study was all members of the University's Women's Futsal Student Activity Unit with a total of 14 people. The considerations or characteristics of the sample in this study are 1) Women's Futsal athletes who are active in training, 2) Those willing to follow the research to the end, 3) Athletes who have been trained, and 4) Those having good achievements. The sampling technique in this research is the purposive sampling technique. Based on the literature [31], the use of this sampling technique has a purpose or is done intentionally. Thus, the sample can represent previously known population characteristics.

In the implementation of the initial stage, we conducted initial testing and measurements to determine the initial condition of the subject. The test was carried out after the sample was warmed up. Then, the test was carried out before carrying out other strenuous exercise activities. The sample was given circuit training method treatment through a reverse periodization model (reverse) for 12 months. After the treatment finished, the final stage of testing and measurement was carried out with a final test to understand the progress of the results of the training treatment. The steps taken in data collection followed the test procedure. The type of data collected is quantitative analysis. Aerobic capacity data collection was carried out using a test instrument, namely the bleep test [32]. The anaerobic capacity collection instrument uses several instruments consisting of a speed test in the form of Speed (i.e. 20-m dash sprint test), speed in Agility form (i.e. shuttle run 4 m x 5 rep) [33], Leg power (i.e. Vertical Jump which has taken into account the unit of watts) [34], and the Power Endurance (i.e. Multi-Stage Hurdle Jump Test) [35]. The data were analyzed using SPSS software. The analytical technique used is Paired Sample T-Test

3. Results

This test is conducted to test whether there is a difference or influence. When evaluating the effect of increasing the circuit training method on the reverse periodization model on the increase in anaerobic and aerobic capacity, the first step was to perform a normality test using Shapiro Wilk. Then because the distribution of the subjects was normal, it was continued by testing the paired sample T data (see Table 1).

Table 1. Research Result Data

Component	circuit training method on the reverse periodization model			
	Mean		Correlation	Sig.
	before	After		
Anaerobic	2.50	2.74	0.788	0.001
Aerobic	33.42	37.47	0.854	0.000

The mean score for the anaerobic pretest was 2.50, which is less than the posttest (2.74). The mean score for aerobics was 33.42 and 37.47 for pre-test and post-test. Thus there is a difference in the average results of the exercise between the pretest and post-test. The value of the anaerobic correlation coefficient is 0.788 with a significance value of 0.001, and the aerobic correlation coefficient is 0.854 with a significance value of 0.000. Because of Sig. value < 0.05 probability, there is a relationship between the pretest and post-test variables. To prove whether the difference is significant or not, it is necessary to interpret the results of the paired sample T-test as shown in Table 2

Table 2. The results of paired sample t-test

Components of	circuit training method on the reverse periodization model		
	Results	Sig.	Note
Anaerobic	Improved	0.000	Significant
Aerobic	Improved	0.000	Significant

Based on the test table above, the value of Sig.
Anaerobic (2-tailed) value of 0.000 (< 0.05), it can be concluded that there is an average difference between the pretest and post-test, which means that there is an effect of the Circuit Training method on the reverse periodization model on increasing anaerobic ability. Then, Sig. the (2-tailed) aerobic value was 0.000 (< 0.05), which indicates that there is a difference in means of the pretest and post-test. This means that there is an effect of the Circuit Training method on the reverse periodization model on increasing aerobic ability. For more details, the improvements are presented in Figures 1 and 2.

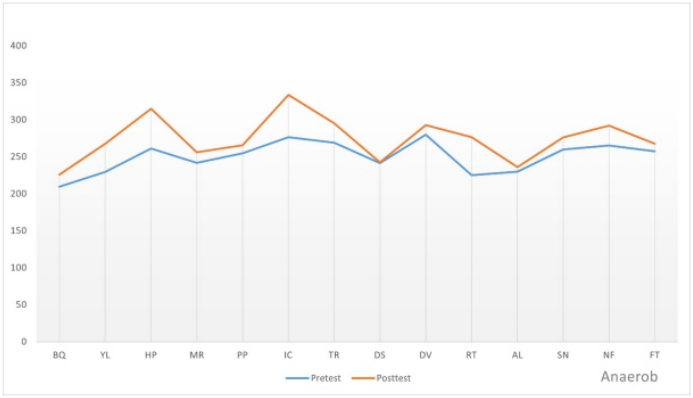

Figure 1. The percentage of the initial test and final test of anaerobic ability improvement influenced by the circuit training method on the reverse periodization model.

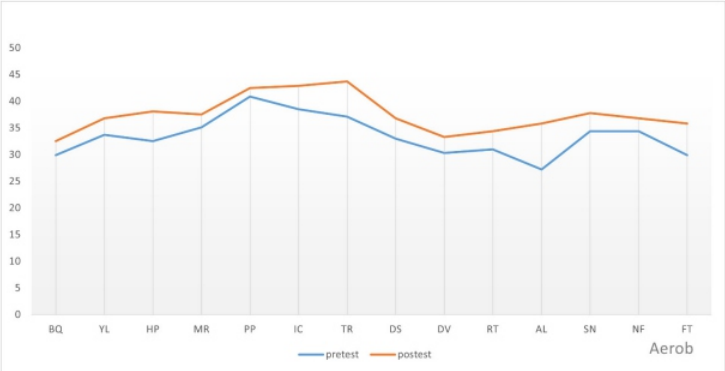

Figure 2. The percentage of the initial test and final test of aerobic ability improvement influenced by the circuit training method on the reverse periodization model.

4. Discussion

Based on the data results regarding the average aerobic and anaerobic ability with the circuit training method applied to the reverse periodization model, there is a difference in the average scores. This is the first study to analyze the effect of the circuit training method by applying it to the reverse periodization model on increasing the aerobic and anaerobic capacity of female futsal players. The circuit method training on the reverse periodization model has a significant impact on physiological changes in anaerobic and aerobic capacity. According to Martin et al.,[24] reverse periodization initiates high-intensity application from the beginning of the macrocycle and later gradually increases volume and decreases intensity [36]. Several results regarding reverse periodization reported that reverse periodization training was found to be an effective and efficient strategy to improve primary performance [37]. Then, reverse periodization is a specific and efficient training strategy for sprinters when it reduces the volume of training load significantly [26]. Judging from the explanation above, the character of this reverse periodization encourages players to move faster at each post in the circuit practice.

This circuit training is one of the most popular methods, consisting of several posts. There are usually 9-12 posts. In each post, an athlete performs a predetermined type of exercise [12]. Circuit training is one of the beneficial forms of cardiorespiratory exercise because these forms of circuit training are a combination of all physical elements. According to literature [38], circuit training is an anaerobic endurance training method and aerobics. Its purpose was to improve cardiopulmonary and musculoskeletal health.

Then, high-intensity circuit training can increase muscle endurance in a reasonably fit population [39] and can significantly increase VO2 max [27].

The circuit training carried out between posts does an active recovery (by jogging) between posts allowing players to recover because they have a fairly good basic endurance. Towards the final week of the meeting when the intensity is lowered and the volume of training is increased, players feel better physiological adaptations, especially in recovery, so that anaerobic capacity can be better. This point is underpinned by the theory which says that aerobic capacity will be better if there is progress in anaerobic capacity, and anaerobic capacity will be better if aerobic capacity has progressed better because of a

faster recovery period [40]. This will provide an opportunity for anaerobic training to get more density.

From several research results regarding circuit training, reverse periodization which influences anaerobic and aerobic capacity is in line with this study. In this study, the circuit training method applied in the reverse periodization model can also affect physiology.

Further research with a longer trial period and larger sample size are needed in several populations of sports. Indeed, this is a relatively unexplored area of research and there is a great opportunity for further research intending to maximize the development and improvement of athletes' performance in sports over the long term.

5. Conclusions

The character of the reverse periodization is rooted at the beginning of the macrocycle, the exercise is started at high intensity and low volume and gradually volume is increased, and intensity is decreased. The conclusion of this study is that the application of the circuit training method in the reverse periodization model has a significant effect on increasing anaerobic and aerobic capacity based on the manipulation of small exercise volumes at the beginning of the meeting The increasing trend will not end until the end of the meeting, while the high intensity at the beginning of the meeting will be followed by a decrease until the end of the meeting. The way it works is utilizing the forms of agility and power movements at each post in a structured, measurable and regular manner and interspersed with active rest (jogging) at intervals from post to post.

For further research, research on circuit training methods in this periodization model can be adapted to the training needs of each sport. Furthermore, further research needs to be done with a longer trial period and larger sample size.

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Sports Massage: How does it Affect Reducing Lactic Acid Levels in Athletes?

Wilda Welis1,*, Darni2, Deby Tri Mario2
1Department of Health & Recreation, Faculty of Sport Science, Universitas Negeri Padang, Indonesia
2Department of Sport Education, Faculty of Sport Science, Universitas Negeri Padang, Indonesia

ABSTRACT

Increased lactic acid levels in the blood and muscles during high-intensity training and sports competitions cause muscles to get fatigued, which affects physical performance and is made worse by a greater risk of injury. Therefore, a solution is needed. The purpose of this study was to analyze the effect of sports massage on reducing lactic acid levels in athletes. This research is a true-experimental design with a pretest-post-test control group design. A total of 24 football athletes from the Faculty of Sports Science, Padang State University, Indonesia were used as research samples. Sports massage treatment was given after the athlete did a 1.500 meter run (experimental) and without sports massage (control). Sports massage is given to the back, back of the neck, shoulders, upper extremities, and lower extremities. The techniques used include effleurage, petrissage, shaking, tapotement, walken, vibration, and skin-rolling. Each was given 6 repetitions. Then, accutrendlactacid was used to measure lactic acid levels. Data were analyzed using a t-test. The results showed that lactic acid levels in both groups increased after running 1500 meters. However, after being given a sports massage in the experimental group, lactic acid levels decreased by 1.94 mmol/L. Meanwhile, the lactic acid level in the control group was 5.43 mmol/L. The difference in mean lactic acid levels from the post-test data of the two groups showed a significant result of 6.16 mmol/L ($p < 0.05$). In conclusion, giving sports massage after exercise and sports competition (high intensity) is very effective in reducing lactic acid levels in athletes. The results of this study are expected to be useful for coaches, sports health teams, and athletes to reduce lactic acid levels so that they can improve performance during exercise (sports competition), and minimize the occurrence of a high risk of injury.

Keywords Sport Massage, Lactic Acid, Football, 1.500 Meter Run

1. Introduction

A distinction between anaerobic and aerobic energy systems is made based on the frequency, degree of intensity and kind of muscle fibers used [1]. Lactic acid levels in muscle cells can rise as a result of anaerobic exercise. Adenosine triphosphate generation and metabolic capacity are both reduced as a result of the rise in lactic acid, which also lowers cell pH and slows the pace of the catalytic process [2]. Lactic acid is produced during anaerobic glycolysis as a result of incomplete glucose breakdown [3]. Anaerobic tiredness can develop during high-intensity exercise as a result of the buildup of lactic acid [4,5]. The neuromuscular junction prevents nerve stimulation to muscle fibers as a result of lactic acidosis, which is caused by lactic acid in muscle cells. The muscles are unable to contract as a result [6,7].

Recovery after training and sports competitions is an important component to support better performance to prepare for the next training or competition [8]. Increased recovery time can help athletes maintain their health and improve their performance [9]. Rapid recovery from muscle fatigue is very important in sports performance, especially when athletes need maximum energy to promote better

performance during competition. Therefore, athletes need to be given treatment that has a direct impact on muscle recovery, in addition to fulfillment and adequate nutritional intake [38-41]. If muscle care is applied incorrectly, it can lead to decreased physical performance and an increased risk of injury during competition [10]. Several muscle recovery methods have been suggested for professional athletes, including the use of heat/cold therapy, stretching techniques, and sports massage. Of this type of recovery method, sports massage has been considered the most natural technique, which is directly applied to the area/body part to increase the elasticity of muscles and joints [11]. Sports massage is one of the most widely used tools, both in the field of rehabilitation therapy and in sports. This is because, muscle fatigue in athletes often occurs during and after training (sports competition) [12].Sports massage is very well known in Indonesia, and almost all massage therapists for national athletes have practiced, where the manipulation techniques used are effleurage, petrissage, shaking, friction, tapotemen, walken, vibration, stroking, and skin-rolling [13]. The purpose of sports massage before and after competition is to improve athlete performance and reduce the risk of injury. Previous studies examined sports massage in increasing immunoglobulin-A (IgA) [13], acceleration and sprint performance in athletes [14], knowledge and perceptions of athletes about Sport Massage Therapy (SMT) [15], pain relief, ROM, and pelvic function in chronic pelvic injuries [16], the effect of sports massage and cold water immersion for recovery from the match [17], depression, anxiety and stress [18], performance, muscle recovery and injury prevention [19], treat myofascial syndrome [20], the effectiveness of Chinese cupping massage during the early stages of lipodystrophy [21], different order of changes in the level of blood circulation in the upper extremities [22], roentgenometric parameters of sagittal spinopelvic balance in patients with sacroiliac joint dysfunction [23], electromyogram, muscle tension, and pain [11], the benefits of the mechanism of massage [24], and the effectiveness of massage therapy for back pain [25].

However, there are only a few studies that discuss how sports massage can help athletes' lactic acid levels.This study aims to analyze the effectiveness of sports massage on reducing lactic acid levels in athletes, with the hope that it can be useful for coaches, sports health teams, athletes, and athletes an effort to reduce lactic acid levels, so as to improve performance during exercise (sports competition), and minimize the risk of high injury.

2. Materials and Methods

2.1. Study Design

This research is true-experimental using a pretest-post-test control group design (Figure 1). The group in this study consisted of an experimental group and a control group. The experimental group was the group that was given a sports massage after running 1.500 meters,while the control group is the group without being given a sports massage after running 1.500 meters. The control group was intended as a comparison group so that the experimental results were purely based on the effect of the treatment, namely sports massage.

R	O_1	X	O_2
R	O_3		O_4

Figure 1. Experimental design

Note:
R = Random
X = Sports massage treatment
O1 = Pretest data on lactic acid levels in the experimental group
O2 = Post-test data on lactic acid levels in the experimental group after being given a sports massage
O3 = Pretest data on lactic acid levels in the control group
O4 = Post-test data on lactic acid levels without being given a sports massage

2.2. Participant

This study involved 24 athletes from the Faculty of Sports Science, Padang State University, Indonesia, who were randomly recruited. The average age of the sample was 21.6 years, weight 62.1 kg, and height 169.2 cm. The sample was recruited based on considerations, namely athletes who were actively participating in training and had competed in student sports events at the provincial level. Then, written consent was carried out so that the sample's involvement in the study was voluntary.

2.3. Procedure

The procedure in this study consisted of several stages.

2.3.1. Stage 1 (pretest)

At this stage, pretest data were collected on lactic acid levels in the sample. Then, the sample was divided into two groups, namely the experimental group (n = 12) and the control group (n = 12), with the aim that the pretest data of the two groups did not have a significant average difference.

2.3.2. Stage 2 (treatment)

This stage includes: (1) both groups run 1.500 meters, (2) after running 1.500 meters, both groups are given a 30-minute rest period, (3) the experimental group is given a sports massage for 60 minutes, while the control group is not given a sports massage. The sports massage given is the back, back of the neck, shoulders, and upper and lower extremities. The sports massage techniques used include effleurage, petrissage, shaking, tapotement, walken, vibration, and skin-rolling [26]. The implementation of each movement technique was repeated 6 times.

2.3.3. Stage 3 (post-test)

At this stage, post-test data were collected on lactic acid levels in the sample after running 1.500 meters, so that it was known that the increase in lactic acid levels after 1.500 runs, and a decrease in lactic acid levels after sports massage treatment.

2.4. Instrument

Lactic acid levels in the blood were measured using accutrendlactacid with units of mmol/L [27]. Measurements were taken 2 times, namely before and after running 1.500 meters. The equipment needed is cotton, betadine, and lancet's blood. Blood samples from respondents were taken using BM-Lactate/lactic acid strip, which aims to store blood after the fingertip of the sample is pricked using lancets blood. Then, the lactate strip was inserted and checked using accutrend lactate.

2.5. Statistic Analysis

Data were analyzed using t-test, namely paired samples t-test and independent samples t-test. Paired samples t-test was used to determine differences in lactic acid levels in pretest and post-test data

from both groups (experimental and control). Then, testing the normality and homogeneity of the data is a test of requirements before this test, which aims to determine whether the pretest and post-test data are normally distributed and homogeneous. Each used the Shapiro-wilk test and the F test. All these stages were analyzed using the statistical program IBM SPSS version 24.

3. Result

The purpose of the data description is to characterize the lactic acid levels in both the experimental group and the control group. In addition, the data description is to characterize the data form the pretest and post-test.Table 1 shows that there are variances in the means of each study group, with the experimental group's post-test data showing superior results to the control group in lowering athlete's lactic acid levels.

Figure 2 compares the post-test results from the experimental group with the control group, and displays the average difference in lactic acid levels. The experimental group which was given sports massage treatment after running 1.500 meters, showed a significant decrease in lactic acid levels (post-test mean difference = 6.16 mmol/L).The analysis requirements test showed that the pretest and post-test data were normally distributed and homogeneous (experimental and control) (Table 2).

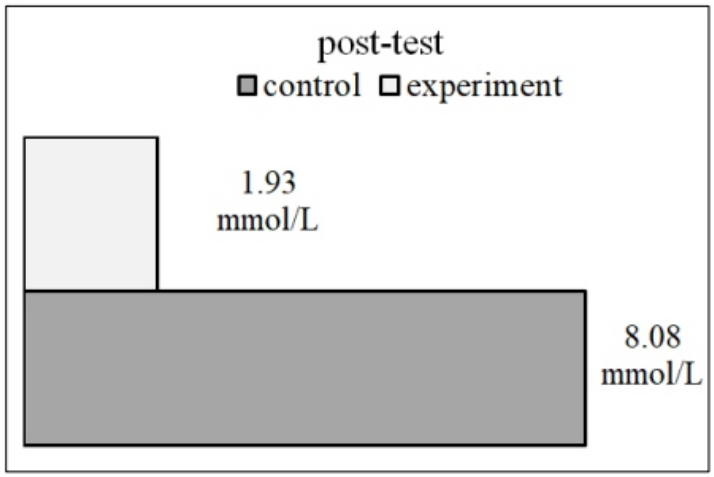

Figure 2. The difference in the average post-test data

Table 1. Descriptive statistics of lactic acid level data

Data	N	Experimental group				Pretest-post-test mean difference*	Post-test mean difference*
		Min*	Max*	$\dot{X}$*	SD *		
Pretest	12	2.0	5.5	3.87	1.07	1.94	
Post-test	12	.7	3.8	1.93	.93		
Data	**N**	**Control group**					6.16
Pretest	12	1.5	3.9	2.65	.81	5.43	
Post-test	12	6.2	10.2	8.08	1.21		

Note.*- data description is translated in mmol/L units

Table 2. Summary of normality and homogeneity tests of data

Test	Group	Data	p*
Normality	Experiment	Pretest	.956
		Post-test	.472
	Control	Pretest	.620
		Post-test	.335
Homogeneity	Experiment	Pretest-post-test	.185
	Control	Pretest-post-test	.254
	Experimen-conrol	Post-test	.568

Note.*- data is normally distributed and homogeneous ($p > 0.05$)

The results of the paired samples t-test showed that there was a significant difference between the pretest and post-test data from the experimental group and the control group, with all values significantly different ($p < 0.05$) (Table 3). Lactic acid levels in the experimental group decreased after being treated with sports massage, namely 1.94 mmol/L (pretest-post-test mean difference) (Table 1). Meanwhile, the level of lactic acid in the control group (without being given a sports massage) was 5.43 mmol/L (pretest-post-test mean difference) (Table 1).Then, Table 4 also shows that there are significant differences between the two post-test data in the experimental and control groups. After completing 1.500 meters of running, the experimental group's lactic acid levels were 6.16 mmol/L higher than those of the control group (based on the post-test means of the two groups) (Table 1). In other words, it was demonstrated that delivering a sports massage to the experimental group would lower the athletes' lactic acid level.

Table 3. Paired samples t-test for pretest-post-test data for the experimental group and the control group

Pretest-post-test	Paired differences					t	df	p*
	Ẋ	SD	SE	95% Confidence				
				Lower	Upper			
Experiment	1.9417	.6960	.2009	1.4994	2.3839	9.663	11	.000
Control	5.4333	.8172	.2359	5.9526	4.9141	23.031	11	.000

Note.*- the difference is significant ($p < 0.05$)

Table 4. Independent samples t-test for the post-test data of the experimental group and the control group

		t-test for Em						
		t	df	p*	Ẋ1-Ẋ2	SED	95% Confidence	
							Lower	Upper
lactate level	Equal variances assumed	13.96	22	.000	6.16	.44	7.07	5.24
		13.96	20.71	.000	6.16	.44	7.07	5.23

Note.*- the difference is significant ($p < 0.05$)

4. Discussion

Based on the results of our research, lactic acid levels in both groups (experimental and control) increased after running 1.500 meters. However, after being given a sports massage in the experimental group, lactic acid levels decreased by 1.94 mmol/L. Meanwhile, the lactic acid level in the control group was 5.43 mmol/L. The difference in mean lactic acid levels from the post-test data of the two groups showed a significant result of 6.16 mmol/L ($p < 0.05$). The findings of this study are consistent with those of other studies that suggested sports massage may be a significant treatment for muscular exhaustion because it can influence fluid mobility in muscle tissue, boost nutrition flow, and remove waste to encourage muscle repair [12]. Previous studies have reported that sports massage is widely used to minimize injury, recovery, relaxation, and increase sports performance [25], and recovery after intense training [15]. The findings of this study are also consistent with those of other investigations. These investigations have shown that sports massage can improve blood flow and peripheral perfusion to the nearby limbs [28], sports massage can provide an increase in body temperature to help stimulate blood flow [29–31], and reduce muscle pain [32].

Sports massage can have a positive influence on athletes' performance when competing [33]. Previous studies have reported that massage and physiotherapy exercises are an effective part of improving body health [34]. Many coaches, athletes and other professionals state that sports massage has several benefits. Sports massage is for athletes for improved sports performance and recovery [24]. Previous studies reported that athletes believed that sports massage can aid in recovery, due to the various physiological, neurological, and other systems that sports massage activates [17]. Various studies show that sports massage can increase the range of movement [14]. The results of this study are consistent with other research that suggested athletes perform better after receiving a sports massage [35]. It is regarded as one of the most widely utilized methods to speed recovery following demanding training sessions [36]. Thus, sports massage plays an important role in the performance and physical health of athletes, possible disease prevention, and rehabilitation [37].

Based on the data we obtained while in the field, we believe that giving sports massage after exercise, and high-intensity sports competitions are very effective in reducing lactic acid levels in athletes. However, we recognize some limitations that need to be validated for future research. These limitations include, the size of the sample used, so it is necessary to involve a wider sample size. The athletes who were sampled were only in football, so it was necessary to involve athletes in other sports. In the post-test data collection, lactic acid levels were measured after a 1.500 meter run, with a 30-minute rest interval. Then, it is necessary to involve other treatment groups as comparison groups, so that the effectiveness of giving sports massage can be known.

5. Conclusions

The conclusion from the results of this study, giving sports massages after exercise and high-intensity sports competitions are very effective in reducing lactic acid levels in athletes. The experimental group which was given sports massage treatment after running 1,500 meters, showed a significant decrease in lactic acid levels (post-test mean the difference = 6.16 mmol/L). Lactic acid levels in the pretest and post-test data of the experimental group decreased after being given a sports massage, which was 1.94 mmol/L. Meanwhile, the levels of lactic acid in the pretest and post-test data in the control group were higher, namely 5.43 mmol/L. In other words, giving sports massage is very effective in reducing lactic acid levels in athletes. The results of this study are expected to be useful for coaches, sports health teams, athletes, and athletes in an effort to reduce lactic acid levels, to improve performance and minimize the risk of high injury. In addition, we believe that this study will give the way for other researchers to prove the effectiveness of sports massage in sports performance, by involving other treatment groups as

comparisons.

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Conflict of Interest
The authors declare no potential conflicts of interest.

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