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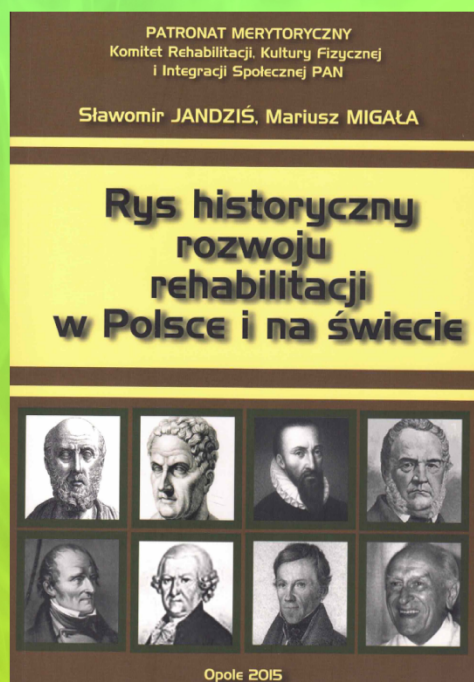
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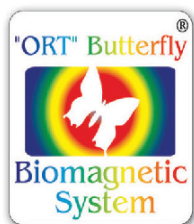
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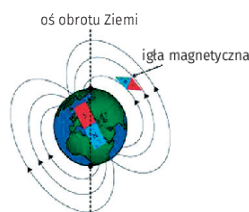
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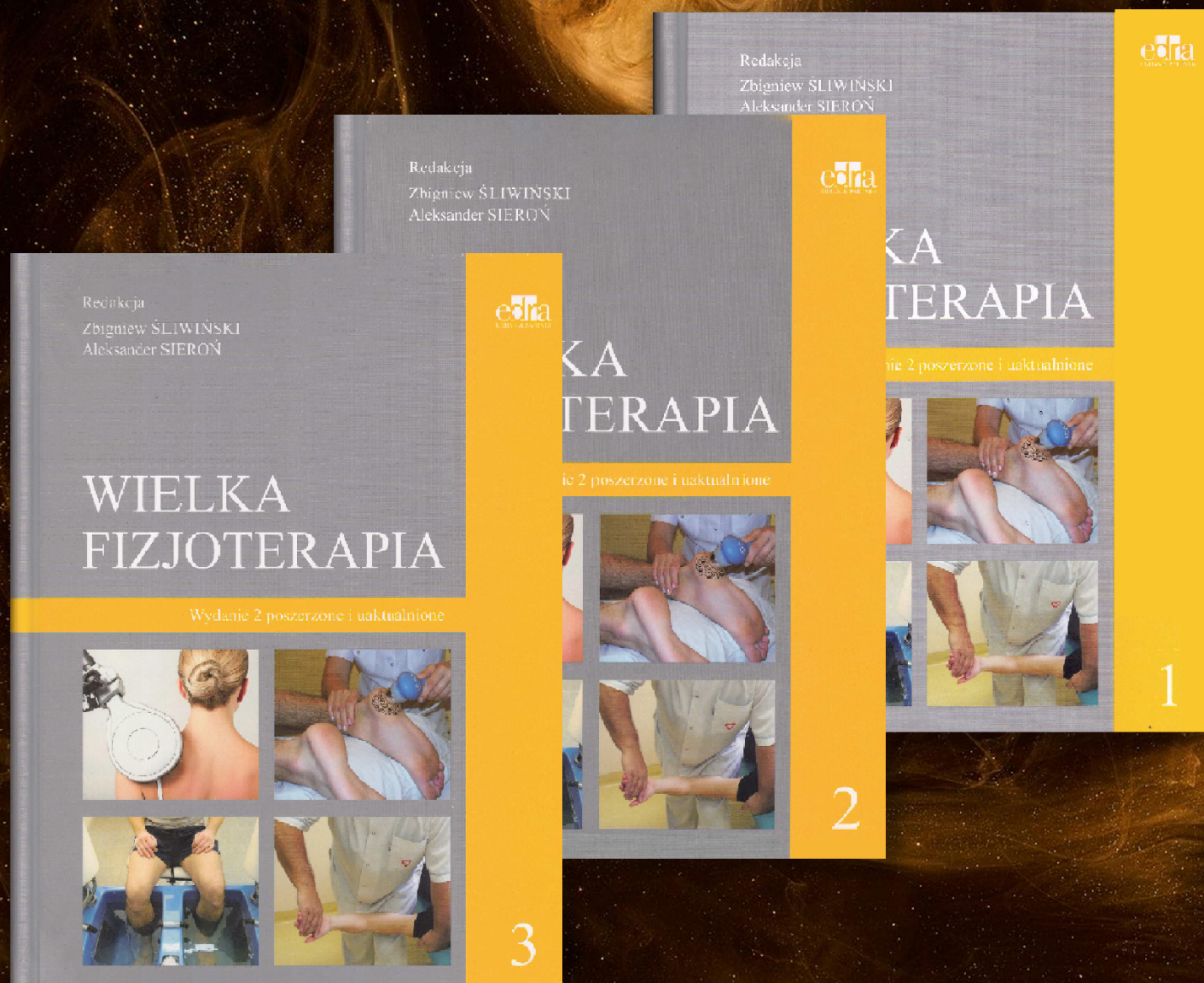
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The effectiveness of application of ice massage to accelerate fatigue recovery in football athletes

Skuteczność stosowania masażu lodem w celu przyspieszenia regeneracji po zmęczeniu u piłkarzy

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Abstract

Introduction. Injuries in soccer players frequently range from minor ones like abrasions, hematomas, grade one strains and sprains, and muscle cramps, where players can continue to play, to severe injuries such as torn ligaments, dislocations, and fractures that prevent players from continuing the game. Based on field observations, some trainers apply ice massage treatments to injured athletes.

Aim. This study aimed to determine the effect of ice massage on accelerating muscle fatigue recovery in soccer athletes, specifically in relation to blood lactate levels.

Method. The research methodology employed in this study is a True Experiment.

Result. Findings indicate that ice massage therapy provided to injured soccer athletes can expedite the healing process and alleviate pain.

Conclusion. Based on data processing and analysis, it's concluded that ice massage significantly accelerates recovery from muscle fatigue in soccer athletes when considering lactate levels and the results from the Visual Analog Scale (VAS) test.

Keywords

football, ice massage, recovery

Streszczenie

Wprowadzenie. Urazy u piłkarzy często obejmują drobne kontuzje, takie jak otarcia, krwaki, naciągnięcia i skręcenia pierwszego stopnia oraz skurcze mięśni, które pozwalają zawodnikom kontynuować grę. Z kolei poważne urazy, takie jak zerwane więzadła, zwichnięcia czy złamania, uniemożliwiają kontynuację gry. Na podstawie obserwacji na boisku, niektórzy trenerzy stosują masaż lodem u kontuzjowanych sportowców.

Cel. Celem tego badania było ustalenie wpływu masażu lodem na przyspieszenie regeneracji mięśniowej u piłkarzy, ze szczególnym uwzględnieniem poziomu mleczanu we krwi.

Metoda. Metodologia badania opiera się na prawdziwym eksperymencie.

Wynik. Badania wskazują, że terapia masażem lodem stosowana u kontuzjowanych piłkarzy może przyspieszyć proces gojenia i łagodzić ból.

Wnioski. Na podstawie przetwarzania danych i analizy można stwierdzić, że masaż lodem znacząco przyspiesza regenerację po zmęczeniu mięśniowym u piłkarzy, biorąc pod uwagę poziom mleczanu oraz wyniki testu Visual Analog Scale (VAS).

Słowa kluczowe

piłka nożna, masaż lodem, regeneracja

Introduction

In the sport of football, commonly occurring injuries range from minor ones, such as abrasions, hematomas, grade-one strains and sprains, and muscle cramps (which allow players to continue playing), to serious injuries like torn ligaments, dislocations, and fractures that prevent further game participation. Soccer, being a body contact sport, has a high likelihood of injuries arising from both internal and external factors. While injuries like strains and sprains are treatable with methods such as sports massage, physiotherapy, and surgery, ice massage remains one of the most widely adopted treatments. Initial observations by the authors reveal that many professional and semi-professional football clubs utilize this method for injury recovery and to reduce lactic acid levels. Fatigue is a common outcome of exercises [1]. Irregularly performed sports activities can actually exacerbate this fatigue [2].

Fatigue, though natural, should be managed well, especially by professional athletes, to expedite recovery post-match or training. An effective recovery system enhances an athlete's performance during matches. Thus, exercise program planning should be tailored to an athlete's physiological and anatomical needs. The primary training objective is to acclimate the human body to varied training and competition loads while minimizing the risks of illnesses, injuries, and fatigue leading up to competition [3]. The effectiveness of given training becomes evident if fatigue is addressed, enabling athletes to adapt to imposed training loads and enhance their capabilities [4]. Moreover, fatigue can be alleviated through interval play during exercises [5].

Brooks pointed out that fatigue results from limited oxygen supply and high-intensity exercises, leading to lactate accumulation [6]. Given that soccer combines anaerobic and aerobic elements, its intensity is undoubtedly high. Elevated lactate levels typically indicate that aerobic ATP production can't sufficiently back anaerobic ATP regeneration in supplying oxygen to muscles for energy generation [7, 8]. Proper recovery, addressing both physiological and psychological aspects, is essential to mitigate fatigue and bolster optimum athletic performance (Stephens et al., 2016). Specialized recovery techniques are crucial for elite athletes to manage or intensify training loads [9].

A frequently employed post-exercise recovery method is ice massage, characterized by its ability to minimize muscle pain, signifying reduced fatigue [10]. Ice massage involves using ice on muscles, moving in slow circular motions from distal to proximal areas, in alignment with blood flow. Muscles typically experience pain post-exercise due to fatigue. Administering ice massage can counter muscle tension and pain from the cold contact, reducing blood flow before an eventual increase in blood volume in the treated area [11]. This method is advantageous due to its ease of application and rapid cooling effects on sore muscle tissues post-eccentric exercise, compared to alternative methods [10]. It is recommended for localized muscle fatigue in athletes [11]. Mental recovery can also be facilitated by light activities such as water immersion or play [12].

Research into ice massage has dwindled due to emerging methods perceived as more effective. Given the varied discour-

ses on ice massage, this paper aims to delve deeper into its effectiveness for soccer athlete recovery. Considering its cost-effectiveness and simplicity relative to other methods, it is hoped that athletes can independently manage post-exercise recovery in the future. Optimal recovery significantly influences the outcomes of training periodization and athletic competition performance. Fatigue manifests as a diminished capacity to maintain required muscle contractions or handle imposed workloads [13]. Reduced muscle functionality stems from fatigue, especially after high-intensity, prolonged, or eccentric exercises (Stephens et al., 2016). Fatigue sources encompass energy supply issues, ATP + PC, anaerobic glycolysis, accumulations like H⁺, lactic acid, mechanical muscle contraction failures, and nervous system alterations.

During physical activities or sports, muscle contractions derive energy from ATP to ADP breakdowns, termed anaerobic exercises. In contrast, aerobic exercises resupply anaerobic exercises with ATP energy. Physical activities spanning 20 - 180 seconds use glucose (from muscle-stored glycogen) to generate energy (ATP), producing lactic acid. An uptick in lactic acid signifies aerobic exercise's inability to support anaerobic exercise for ATP provision [7]. Ice massage, a type of cryotherapy, can be easily applied, offering swift and superficial muscle cooling after exercises compared to other cryotherapy techniques [10]. Exercise triggers local mechanisms that release free radicals from the muscles being trained. Ice applications help counteract performance degradation from exercise-induced heat stress [14]. Ice massage is crafted using a polystyrene cup filled with water, frozen into an ice sphere, and directly applied to the skin in a circular stroking motion on predominantly used muscles [15].

The ice massage targets dominant muscles exhibiting post-exercise fatigue-related pain, applied in slow, circular movements from distal to proximal regions, following blood flow, for 7–10 minutes [11, 16]. Physiologically, ice massage induces vasoconstriction (blood vessel narrowing) that prevents lactic acid spread in the bloodstream. Between 2–6 minutes post-application, vasodilation occurs, expanding blood vessels for broader oxygen distribution [17]. Consequently, ice massage benefits encompass countering overuse, alleviating joint and muscle injury-related pain, promoting tissue mechanical compression for regeneration [14], preventing lactic acid spread, post-exercise recovery, and fostering tissue regeneration [11]. Hence, post-training or competition ice massage therapy is vital for athletes.

Methods

The research method employed was the True Experiment. As articulated by Jack R. Fraenkel (2012), a pivotal element of the True Experiment is the random division of subjects into several groups. Such random assignment effectively controls external influences arising from subject characteristics, thereby bolstering research validity. Subjects were randomly segregated into two groups: the experimental group, which received ice massage treatment, and the control group. The latter served as a benchmark for comparison against the treatment group. The research design implemented was the Randomized Pretest-Posttest Control Group Design. This design enabled a comparison

between the effects on the group treated with Ice Massage and the control group, which underwent a cooling-down routine as part of their training program. Group allocations were randomized using a lottery system, adhering to the True Experiment methodology.

Both groups were initially assessed using the Accutrend Plus system to determine lactate levels (pretest). After undergoing their respective treatments for a specified duration and manner, they were re-evaluated using the same system (posttest). The pretest was essential to discern the initial conditions and subsequent changes. The posttest, conducted post-treatment, assessed alterations from the pretest and evaluated the influence of the treatments on both groups. Changes were visualized through the variance between O2 and O1 scores in each group. The difference between O2 and O1 provided insights into the efficacy of the administered treatments.

This research was undertaken in Makassar City. The study's target population comprised football athletes from South Sulawesi Province. A total of 28 regional athletes were documented. Athletes from South Sulawesi were selected due to the imperative of swift and efficient recovery to augment performance. Participant selection employed a purposive sampling approach — a technique where samples are chosen based on specific criteria deemed pertinent by the researcher. The sampling criteria included: (1) willingness to participate, (2) prior participation in official regional competitions, (3) good health status, and (4) adherence to a robust training regimen. Abiding by these criteria, 26 athletes were chosen as samples.

Data collection instruments comprised blood sampling and questionnaires. Before the initiation of data collection, participants filled out questionnaires detailing their personal information, competition history, achievements, and national-level competition experience. This data served to organize samples according to stipulated criteria. A preliminary phase was also conducted as a precursor to the actual research. This phase's objective was to ascertain if the pre-treatment training conformed to the criteria, ensuring seamless research execution and data acquisition. The preliminary involved lactate level tests post high-intensity training sessions, aligning with the treatment conditions — namely, athletes exhibiting fatigue characterized by lactate tolerance levels exceeding 2 mmol. This was

followed by the Run Based Anaerobic Sprint Test (RAST) to evaluate fatigue post-training. Subsequently, interviews discerning dominant muscle aches (both in the upper and lower body) were conducted, informing the ice massage treatment approach.

Post high-intensity training and pretesting, treatments were administered. The first group, the experimental one, underwent a 10-minute Ice Massage treatment (both upper and lower body). In contrast, the control group was given a 10-minute post-training recovery treatment in line with their training program, specifically a cooling-down session using an ergometer at a slow pace. Treatments were conducted on July 23 and 30, 2022. The efficacy evaluation employed an experimental approach with the research design being the one-group pretest-posttest design. Hypothesis validation was executed using the Wilcoxon nonparametric test, comparing pretest and posttest results of the paired groups. Data analysis was performed using the SPSS version 20 software.

Results

After completing the research stages, empirical data was obtained regarding the effectiveness of applying ice massage to accelerate recovery in fatigued football athletes. Prior to analysis, data was tabulated for ease of subsequent testing. The primary data analysis method employed in this study involved inferential statistical techniques. Additionally, prerequisite tests were conducted, including a normality test, culminating in a hypothesis test using the t-test. This was done to gauge the effectiveness of applying ice massage to accelerate recovery in fatigued football athletes, provided the data adhered to a normal distribution.

Descriptive analysis

Descriptive data analysis was executed to provide an overview of the research data concerning the effectiveness of applying ice massage to accelerate recovery in fatigued football athletes. This made interpreting the results of the data analysis more straightforward. The data description aimed to interpret and elucidate the findings regarding the effectiveness of ice massage in aiding recovery from fatigue for football athletes. The data is detailed in the subsequent table.

Table 1. Results of the analysis of the effectiveness of applying ice massage to accelerating recovery in fatigue in football athletes

Variable	N	Range	Minimum	Maximum	Sum	Mean	Std. Deviation
Pre-test recovery	26	15.00	48.00	63.00	1391.00	53.5000	4.96588
Post test recovery	26	16.00	50.00	66.00	1469.00	56.5000	5.24023

The results pertaining to the effectiveness of applying ice massage to accelerate recovery in fatigued football athletes showed the following for pre-test data: N value is 26, range is 15, minimum is 48, maximum is 63, sum is 1391, mean is 53.5, and the standard deviation is 4.96588. For the post-recovery test data, the values are as follows: N is 26, range is 16, minimum is 50, maximum is 66, sum is 1469, mean is 56.5, and the standard deviation is 5.24023.

Data Normality Test

A prerequisite for utilizing parametric statistics is that the data adheres to a normal distribution. If testing reveals that the data is normally distributed, then the requirements for a parametric statistical analysis are satisfied. The normality of the data was tested using the Kolmogorov-Smirnov test. The results of the data normality test can be found in Table 2.

Table 2. Results of the normality test for the effectiveness of applying ice massage to accelerating recovery in fatigue in football athletes

Variable	N	KS-Z	Asymp.Sig (2 tailed)	Information
Initial recovery test	26	0.455	0.989	Normal
Final recovery test	26	0.645	0.899	Normal

For the variable "Effectiveness of Applying Ice Massage to Accelerating Recovery in Fatigue Football Athletes," the data normality test results are as follows:

Pre-test data on the effectiveness of applying ice massage to accelerating recovery in fatigued soccer athletes yielded an asymp value of 0.989 ($P > 0.005$). With the equation $\text{asymp } 0.989 > 0.005$, it can be concluded that the pre-test data for the effectiveness of applying ice massage to accelerating recovery in fatigued soccer athletes adheres to a normal distribution.

The post-test data regarding the effectiveness of applying ice massage to accelerating recovery in fatigued soccer athletes

revealed an asymp value of 0.899 ($P > 0.005$). By interpreting the equation $\text{asymp } 0.899 > 0.005$, it indicates that the post-test data for the effectiveness of applying ice massage to accelerating recovery in fatigued soccer athletes also follows a normal distribution.

Hypothesis testing

To test the hypothesis, an average difference test between the research groups was conducted, focusing on the application of ice massage to accelerate recovery in fatigued soccer athletes. The statistical technique used was the independent regression test. A summary of the analysis results can be found in Table 3.

Table 3. Summary of the results of the data regression test on the effectiveness of applying ice massage to accelerating recovery in fatigued soccer athletes

Variable	N	Mean	Sig. (2 tailed)
Pre-test recovery	26	53.50	0.000
Post test recovery	26	56.50	0.000
Difference		3	-

The results of the variable regression test on the effectiveness of applying ice massage to accelerating recovery in fatigued soccer athletes obtained an N value (sample) of 26 people, a mean pre-test recovery value of 53.50 and a post-test recovery value of 56.50, with a sig value of 0.000. and obtain a difference of 3. So this difference becomes an influence or increase in the recovery program in the form of ice massage for injured soccer athletes.

Discussion

This study tested giving ice massage as a method to accelerate recovery in muscle fatigue in soccer athletes. Muscle fatigue in question is the effect of training that is given with a long duration or high intensity at that time. When a given exercise has an eccentric component, high volume and intensity will be related to lactate concentrations, indicating that athletes experience symptoms of fatigue which can reduce athlete performance after exercise [11]. In addition, the effects of this exercise can have a physiological impact on the body in the form of muscle pain and decreased muscle function [18]. Therefore, physiologically to measure the level of fatigue in this study seen from lactate levels and pain in the muscles with the VAS (Visual Analog Scale) test. Giving ice massage actually has an impact on reducing fatigue after doing sports activities [19]. Apart from that, massage reduces fatigue for people who do work activities [20]. Giving ice massage is an alternative in breaking down post-exercise fatigue [21].

Prior to data collection, the authors conducted a preliminary (preparation) by testing the training program provided by the coach with high intensity in that week whether it had a significant impact on fatigue on athletes, so that the exercise program carried out was in accordance with the research criteria to be carried out and was right on target. Preliminary was carried out by taking lactate after exercise in 6 samples, namely 3 boys and 3 girls who were randomly selected as representatives of the entire sample. From the results of lactate intake, the lowest lactate was 2.9 mmol and the highest was 12.2 mmol, where an increase in lactate levels of more than 2 mmol indicated that tissue hypoxia had occurred, namely that glycogen would be converted into glucose and then glucose would be converted into lactate, resulting in fatigue. [22].

During the study, there was a reduction of 24 samples due to the failure of samples that did not meet the research criteria, so that 16 samples were successfully studied. The results showed that Ice Massage was able to accelerate the recovery of muscle fatigue. This can be seen from the results of the Wilcoxon test that the Ice Massage treatment has a significant effect ($\text{sig.} < 0.05$) on lactate levels and muscle pain through the Visual Analog Scale (VAS) test. The procedure for measuring lactate levels and muscle pain to determine the level of muscle fatigue in athletes is first carried out a pretest, namely taking blood at the fingertips and measuring lactate levels using accutrend plus and filling in the Visual Analog Scale (VAS) to measure muscle pain. after the participants finished the exercise [23].

Prior to being given treatment, participants will be interviewed first about the muscles that experience dominant pain in both the upper and lower body. Giving this Ice Massage treatment uses a polystyrene cup filled with water and frozen given for 10 minutes (upper body and lower body) and this treatment is more focused on local muscles that experience dominant pain which indicates fatigue in these muscles [11]. During the treatment, the participants experienced pain that came from the cold temperature of the ice, which is called an analgesic effect, which is reasonable because there is a change in temperature on the skin [18]. As previously discussed, the effects of cold temperatures result in hyperemia which helps supply oxygen in the blood thereby eliminating waste products such as lactate [11]. So that the Ice Massage treatment is able to accelerate recovery in muscle fatigue in reducing tissue temperature through cold temperatures that are in direct contact with the skin [14]. In addition, giving ice massage is useful in overcoming fatigue [24].

Conclusion

Based on the results of data processing and analysis, it can be concluded that ice massage has a significant effect on accelerating

recovery in muscle fatigue in soccer athletes in terms of lactate levels and the Visual Analog Scale (VAS) test. The experimental group that was given ice massage and the control group that was given a cooling down treatment according to the existing training program, both of them had the same effect on accelerating recovery in muscle fatigue in football athletes in terms of lactate levels and Visual Analog Scale (VAS) tests and tests. Based on the conclusions that have been discussed, there are several things that can be used as suggestions, namely Ice Massage can be used by coaches in recovery programs for athletes during training camps who have training schedules more than once a day. For future research to pay attention to lactate instruments that are more accurate and fast to reduce failures or biased results during research.

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