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EFFECT OF THE EIGHT-WEEK SAND SURFACE EXERCISE, WATER SURFACE EXERCISE, AND POWER LEG MUSCLES TRAINING METHODS TOWARD AGILITY OF BASKETBALL PLAYERS FOR ADOLESCENT PLAYERS

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

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Abstract

Study purpose. Agility plays an essential role in basketball so increased agility needs to be a concern in the physical conditioning exercises of basketball players. To achieve the best results possible with an exercise, the type and manner of the exercise must be considered. The more varied is the training model offered to athletes, the more will it further encourage athletes not to feel exhausted while training. However, the training model used is still limited to hard textured courts. Though the use of textured fields such as water and sand has an impact other than power load, it lowers the rate of injury.

Materials and methods. The method used in this study was a 2×2 factorial design experiment. This study involved 36 men's basketball athletes ages 16-18. The leg power instrument used a vertical jump, agility assessment used an agility test, and analysis of this study data used the ANOVA test.

Results. (1) the sand exercise method shows higher results than the water exercise method; (2) athletes who have high limb power are better in agility testing than athletes who have low limb power; and (3) there is an interaction of water exercise and sand exercise methods and power of the limbs against agility.

Conclusions. The results of this study could prove that sand exercise methods are more effectively used in increasing agility to be an alternative for coaches.

Keywords: sand exercise, water execise, agility, basketball, adolescent.

Introduction

The perfect ability must support the game of basketball. A good player is a player who can display consistent performance from start to finish in every quarter. Basketball is an aerobic-based anaerobic activity that includes both high-intensity activities like jumping (for rebounds, blocks, and shots), turns, dribbles, sprints, and screens, as well as low-intensity movements like walking, stopping, and jogging (Alemdaro lu, 2012; Delextrat, Anne and Cohen, 2009). Agility is a very complicated talent that correlates with other elements such as coordination, strength, speed, explosiveness, endurance, and balance (Sekulić et al., 2013; Milenkovic, 2022). Agility can present itself in a variety of ways, ranging from the movement of a single body part to the rapid movement of the complete muscle system in a specific direction (Sopa & Pomohaci, 2016). The players in the game of basketball require a very high level of agility, some form of on-court activity that involves skill when dribbling the ball quickly towards the basketball hoop past several opponents who are guarding around the ring with certain formations.

Basketball is a fast-paced team sport that combines physical, mental, technical, and tactical elements. Basketball players must have superior motor skills and athletic ability to succeed in matches and tournaments (Ostojic et al., 2006). Basketball necessitates agility and high jumping ability (Bal et al., 2011) so that in the game of basketball, an athlete

must have good agility, it is very useful when displaying a range of physical performance attributes for both specific movement patterns (dribbling, shooting, passing, throwing, rebounding, and blocking) and fundamental movement (running, jumping, change of direction). Agility has been characterized as the capacity to depart rapidly, stop, and change direction, or the capacity to rapidly and precisely change direction (Domenico et al., 2019). Basketball players' performance is influenced by various elements, including strength, speed, agility, endurance, and mobility (Ozen et al., 2020). Agility is an ability performed in a constantly changing environment. Responding to unforeseen inputs, such as opponents' movements, places a greater demand on the athlete's perceptual and decision-making abilities and the capacity to react rapidly (Kovacikova et al., 2021).

The utilization of the exercise model must also be adjusted to the training media to be used so that the results of the exercise will be more optimal. The development of a uniform system of accounting training loads is a critical prerequisite for effective training process management (Koryahin et al., 2021). Conditioning coaches vary the content and style of agility training in various ways to produce maximum gains in agility performance (Kovacikova et al., 2021). Some critical activities must be completed before effective management of the training process of basketball players can be executed (Koryahin, Blavt, Dorodhenko & Stadnyk, 2020). The more diverse the training model offered to athletes will further stimulate athletes not to feel saturated while training. Water exercise is not only used for various swimming techniques (crawl, backstroke, breaststroke, or butterfly); exercises with water media offer many other movement possibilities such as walking, jogging, or jumping. Water is a unique exercise medium because it provides a reduced-gravity environment that reduces impact pressures on joints while creating resistance to movement (Anista et al., 2018). This will stimulate the metabolic and neuromuscular systems, followed by physiological adaptation processes (Torres-Ronda & Schelling I Del Alcázar, 2014). Some studies show that jumping in water can help you get stronger, reach higher peak torque, and jump higher; speed and agility can also improve (Colado et al., 2010), and a study from (Anista et al., 2018) shows a considerable gain in skill and strength among preadolescent boys due to water exercise.

The sand reduces pressure or resistance caused by hard footings, such as when training on a hard textured field. Sand also challenges athletes to push their anaerobic thresholds to the maximum. Running and jumping on sand produce faster results than the same actions on any other surface (Vinoth & Nageswaran, 2015) and demand more force and a greater range of motion from your ankles and hips (Kapur & Sharma, 2017). Exercises in the sand can also be one medium in implementing strength, speed, endurance, or power training. Soft foundations such as those in sand or water have properties like resistance. In addition to being useful to reduce pressure, it also provides an effect as a load to be useful in practice. According to research from (Binnie, 2013), ten weeks of agility training on a sand surface led to significant gains in agility performance on both sand and firm ground surfaces, implying that the physiological and biomechanical changes associated with sand training may potentially benefit solid-ground agility performance. Sand training is a fantastic way to improve strength and power, increase lower body muscle, and generate competition-specific adaptations (Sultana, 2014).

However, many athletes aged 16-18 years in basketball clubs in Sleman district, Yogyakarta, still have low agility. This is evidenced by the number of traveling violations caused by lack of mastery during speed changes many fouls due to a slow slide defense motion. Based on match statistics, the turnover rate of athletes is very high, above 30 times in one match. Turnover itself consists of several elements: improper passing, traveling violation, and exposed steal. The dominant thing that occurs is traveling violation, told to steal due to the inability of athletes to pass opponents so that athletes tend to make mistakes. There is a gap between the coach's instructions to the intended target and the results of athletes' execution on the field. This study aimed to examine the effect of 8 weeks of sand exercise and water exercise on leg muscle power in adolescent basketball athletes using an agility training method. Our other aim is to prove that training models using sand or water media can improve the agility of teenage basketball players to be a choice for coaches.

Materials and methods

Study participants

The 36 basketball athletes were taken using random sampling techniques to divide the group in the limb power test. This test is used to determine the power level of the leg muscles owned by the athlete. After the limb muscle power data is collected, an analysis is then conducted to identify the group of athletes with high and low leg muscle power using the overall test score of the limb muscle power possessed by the athlete by ranking. Based on these rankings are further determined 27% of the upper group and 27% of the lower group of test results (Miller, 2008). Thus the grouping of samples were taken from athletes who had high leg muscle power as much as 27% and athletes who had low leg muscle power as much as 27% of the data that had been summarized. Based on this, 10 athletes have the high leg muscle power, and 10 have low leg muscle power. Then each of the data is divided into two groups by random and obtained. Each of the 5 athletes with high leg muscle power is treated with water and sand exercise methods. The same is also done for athletes with low leg muscle power.

Study organization

This study uses experimental methods with research design in 2×2 factorial. The factorial experiment is almost or all the levels of a factor combined or crossed with all levels of every other aspect present in the investigation. The design can be seen in table 1:

Table 1. Factorial Design

Leg Power Muscle (B)	Training Method (A)	
	High (A1)	Low (A2)
High (B1)	A1. B1	A2. B1
Low (B2)	A1. B2	A2. B2

A1B1: Groups of athletes with high category leg power are given the treatment of leg training methods with water exercise.
A2B1: Groups of athletes with high category leg power are given leg training methods with sand exercise.
A1B2: Groups of athletes with low category leg power are given the treatment of leg training methods with water exercise.
A2B2: Groups of athletes with low category leg power are given leg training methods with sand exercise.

Two types of data must be collected following the variables studied: the limb muscle power test and the agility test. Concentration data collection techniques and limb muscle power tests, and agility tests use tests and measurements. The leg muscle power instrument uses the Sargeant Vertical Jump Test. Sargeant Vertical Jump Test with the validity of 0.978 and reliability of 0.989. In contrast, the agility test uses an agility test with a validity of 0.947 and a reliability of 0.973.

Statistical analysis

The analysis technique used by ANOVA was two ways (two ways ANOVA) at the significance level of significance $\alpha = 0.05$. Before the variance analysis technique is used, the analysis prerequisite test is first carried out, including the normality and homogeneity tests. The normality test uses the Kolmogorof-Smirnov test. The variance homogeneity test uses Levene's test. To test the hypothesis using a two-way ANOVA (ANOVA two-way), and if there is evidence of interaction, a follow-up test will be carried out, namely the Tukey test, using the SPSS version 20.0 for windows software program with a significance level of 5% or 0.05.

Results

Descriptive pretest statistics and posttest agility test results on male basketball club athletes in Sleman County are presented in Table 2:

Table 2. Descriptive Statistics Pretest and Posttest Agility Test

Leg Power Muscle	Statistic	Pretest	Posttest
High (A1B1)	Jumlah	71.07	64.23
	Rerata	14.2140	12.8460
	SD	0.41241	0.46522
Low (A1B2)	Jumlah	70.45	66.90
	Rerata	14.0900	13.3800
	SD	0.41707	0.21249
High (A2B1)	Jumlah	68.73	59.96
	Rerata	13.7460	11.9920
	SD	0.32493	0.59162
Low (A2B2)	Jumlah	70.97	67.23
	Rerata	14.1940	13.4460
	SD	0.34681	0.16227

Prerequisite Test Results

Normality test

The data normality test in this study used the Kolmogorov Smirnov method. Normality test results presented in Table 3:

Table 3. Normality test

Data	P	Notes
Pretest A1B1	0.601	Normal
Posttest A1B1	0.699	Normal
Pretest A2B1	0.621	Normal
Posttest A2B1	0.636	Normal
Pretest A1B2	0.952	Normal
Posttest A1B2	0.877	Normal
Pretest A2B2	0.979	Normal
Posttest A2B2	0.768	Normal

Based on table 3 above, all pretest and posttest data were obtained from the normality test results of the data significance value $p > 0.05$, which means the data is a normal distribution.

Homogeneity Test

The homogeneity test is intended to test the similarity of variants between pretest and posttest. The homogeneity test in this study was the Levene Test. Homogeneity test results are presented in Table 4:

Table 4. Homogeneity tes

Group	Sig.	Notes
Pretest	0.955	Homogen
Posttest	0.084	Homogen

Based on table 4, the pretest obtained a significance value of $0.307 \geq 0.05$ and in posttest received a significance value of $0.216 \geq 0.05$. This means that in the data group, there are homogeneous variants.

Hypothesis Test Results

Research hypotheses are tested based on data analysis and two-track ANOVA (ANOVA two-way) analysis interpretation. Hypothesis Test Results are presented in table 5:

Table 5. ANOVA Test

Source	Type III Sum of Squares	F	Sig.
Training method	0.776	4.867	0.042
Leg Power	4.940	30.976	0.000
Training method *Leg Power	1.058	6.634	0.020

The first hypothesis reads, "There is a difference in the influence between the method of exercise (water exercise and sand exercise) on agility." From the results of the ANOVA test, it can be seen that Fhitung = 4,867, while the significance value p is 0.042. Since the significance value p is $0.042 < 0.05$, ho is rejected. Thus there is a significant difference in influence between the exercise method (water exercise and sand exercise) on agility. Based on the analysis results, it turned out that the sand exercise method was higher (good) with a posttest average value of 12,719 seconds compared to the water exercise method with a posttest average value of

13,113. This means that the research hypothesis that there is a significant difference in influence between water exercise methods (water exercise and sand exercise) on agility has been proven.

The second hypothesis reads, "There is a difference in agility ability between athletes who have high leg muscle power and low leg muscle power." From the results of the ANOVA test, it can be seen that Fcalculate = 30,976, while the significance value p is 0.000. Since the significance value p is 0.000< 0.05, ho is rejected. Based on this, there is a significant difference in agility ability between athletes with high leg muscle power and low leg muscle power. Based on the analysis results, athletes with high leg muscle power are higher (good) with a posttest average value of 12.419 seconds compared to athletes who have low limb muscle power with a posttest average value of 13.413 seconds. This means that the research hypothesis has been proven that there is a significant difference in agility ability between athletes with high leg muscle power and low leg muscle power.

The third hypothesis reads, "There is an interaction between the exercise method (water exercise and sand exercise) power of the limb muscles (high and low) to agility." From the results of the ANOVA test, it can be seen that Fcalculate = 6.634, while the significance value p is 0.020. Since the significance value p is 0.020 < 0.05, Ho is rejected. Based on this, the hypothesis that there is an interaction between the exercise method (water exercise and sand exercise) and the power of the leg muscles (high and low) to agility has been proven.

A Diagram of the results of the interaction between the exercise method (water exercise and sand exercise), power of the leg muscles (high and low) to agility can be seen in Figure 1:

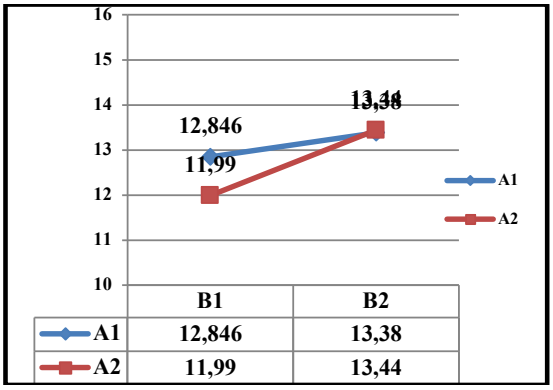

Fig 1. Results of Interaction Between Exercise Methods (Water Exercise and Sand Exercise) with Leg Muscle Power (High and Low)

After testing, there is an interaction between the exercise method (water exercise and sand exercise), power of the limb muscles (high and low) to agility. Then, it is necessary to do further tests using the Tukey test. The results of the additional test can be seen in table 6.

Based on table 6, Tukey test calculation results on asterisk marks (*) show that pairs that have interactions or pairs that differ markedly (significantly) are: (1) A1B1-A2B1, (2) A2B1-A1B1, (3) A2B1-A1B2, (4) A2B1-A2B2, (5) A1B2-A2B1, (6) A2B2-A2B1. The other pairs are stated to be no different: pair (1) A1B1-A1B2, (2) A1B1-A2B2, (3) A1B2-A1B1, (4) A1B2-A2B2, (5) A2B2-A1B1, (6) A2B2-A1B2.

Table 6. Poshoc Test Results

Group	Interaction	Std. Error	Sig.
A1B1	A2B1	0.25257	0.018
	A1B2	0.25257	0.191
	A2B2	0.25257	0.122
A2B1	A1B1	0.25257	0.018
	A1B2	0.25257	0.000
	A2B2	0.25257	0.000
A1B2	A1B1	0.25257	0.191
	A2B1	0.25257	0.000
	A2B2	0.25257	0.993
A2B2	A1B1	0.25257	0.122
	A2B1	0.25257	0.000
	A1B2	0.25257	0.993

A1B1: Groups of athletes with high category leg power are given the treatment of leg training methods with water exercise.

A2B1: Groups of athletes with high category leg power are given leg training methods with sand exercise.

A1B2: Groups of athletes with low category leg power are given the treatment of leg training methods with water exercise.

A2B2: Groups of athletes with low category leg power are given leg training methods with sand exercise.

Discussion

Based on hypothesis testing, it is known that the method of exercise (water exercise and sand exercise) has a significant difference in influence on agility. Training in the sand can reduce stress on the skeletal muscle system (Binnie et al., 2014). Exercise can limit movement to minimize damage and related negative side effects such as increased muscle pain. So that sand exercise is another way to improve the ability of leg muscles and agility. The surface of the sand is also expected to reduce the frequency of steps even slightly because athletes maintain almost the same movement patterns and range of motion during stepping. The lower horizontal speed on the sand surface means that athletes take longer to make such movements, so they have a longer time when in contact with the sand surface. Sand's great shock absorption properties can also limit maximal movement speed in sprint training (Barrett et al., 1998) and jumping performance (Bishop, 2003).

Agility is required in sports that are game in nature. Agility is concerned with gestures involving footwork and rapid changes in body position. Agility in principle plays a role in activities that involve changing body movements while maintaining balance. An athlete or player with good agility will perform movements more effectively and efficiently.

Based on the results that have been put forward in this study, there is an interaction between the method of exer-

cise (water exercise and sand exercise), power of the limb muscles (high and low) to agility. From the results of the form of interaction, it appears that the main factors of the study in the form of two factors show significant interaction. In the results of this study, interactions mean that each group has a difference in the influence of each group that is paired. The interaction results showed that the group of athletes who had high leg muscle power was better treated with the sand exercise training method and the group of athletes who had low leg muscle power was better treated with the water exercise training method. The pairs that have interactions or significantly different partners are as follows: (1) The group of athletes with high leg power given the sand exercise training method is better than the group of athletes who have high leg power given the water exercise training method, with a significance value of 0.018 <0.05, (2) The group of athletes with high leg power who were given the sand exercise method was better than those who had low leg power who were treated with the water exercise method, with a significance value of 0.000 <0.05, (3) The group of athletes with high leg power was treated with the sand exercise method, which was better than the group of athletes with low leg power treated with the sand exercise method, with a significance value of 0.000 <0.05.

Conclusions

Based on the research results and the results of data analysis that has been done, the following conclusions were obtained: (1) There is a significant difference in the influence of exercise methods (water exercise with sand exercise) on agility. The sand exercise method is higher (good) than the water exercise method. (2) There is a significant difference in the influence of agility ability between athletes who have high leg muscle power with low leg muscle power. Athletes with high leg muscle power are higher (good) than athletes with low high leg muscle power. (3) There is a significant interaction between water exercise methods (water exercise and sand exercise) with the power of the limb muscles (high and low) to agility. The interaction results showed that the athletes with high leg muscle power were better treated with sand exercise methods. The athletes with low leg muscle power were better treated with water exercise methods. The implications of this study could prove that sand exercise methods are more effectively used in increasing agility to be an alternative for coaches. The results of the research can practically be used as consideration for coaches, as well as basketball coaches, in making appropriate training programs to improve agility. Thus the exercise will be effective and will result in what is expected by the coach.

Conflict of interest

The authors declare that there are no conflicts of interest.

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ВПЛИВ МЕТОДІВ ВИКОНАННЯ ВПРАВ НА ПІЩАНІЙ ПОВЕРХНІ, ВИКОНАННЯ ВПРАВ НА ВОДНІЙ ПОВЕРХНІ ТА СИЛОВИХ ТРЕНУВАНЬ М'ЯЗІВ НІГ ПРОТЯГОМ ВОСЬМИ ТИЖНІВ НА РОЗВИТОК СПРИТНОСТІ В БАСКЕТБОЛІСТІВ ДЛЯ ГРАВЦІВ ПІДЛІТКОВОГО ТА ЮНАЦЬОГО ВІКУ

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Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 7 с., 6 табл., 1 рис., 23 джерела.

Мета дослідження. Спритність відіграє суттєву роль у баскетболі, тому підвищенню спритності потрібно приділяти окрему увагу у вправах із фізичної підготовки баскетболістів. Для досягнення якнайкращих результатів за допомогою певних вправ необхідно брати до уваги тип і спосіб виконання таких вправ. Що різноманітнішою буде модель тренувань, пропонована спортсменам, тим більше вона буде додатково сприяти відсутності в спортсменів відчуття виснаженості під час тренувань. Проте модель тренувань, яку використовують, досі обмежена майданчиками з твердою поверхнею. Хоча використання таких типів поверхні майданчика, як вода й пісок, має не такий вплив, як силове навантаження, воно знижує частоту випадків травматизму.

Матеріали та методи. У дослідженні використовували метод експерименту з факторним планом 2×2. У дослідженні брали участь 36 баскетболістів чоловічої статі віком 16-18 років. Для вимірювання сили ніг використовували стрибки у висоту, для оцінки спритності – тест на спритність, а для аналізу даних дослідження – дисперсійний аналіз.

Результати. (1) метод виконання вправ на піску показує кращі результати, ніж метод виконання вправ на воді; (2) спортсмени з високими показниками сили кінцівок показують кращі результати в тестуванні на спритність, ніж спортсмени з низькими показниками сили кінцівок; та (3) існує взаємозумовленість між методами виконання вправ на воді та виконання вправ на піску й силовими показниками кінцівок у зіставленні з результатами тестування на спритність.

Висновки. Результати цього дослідження можуть підтверджувати, що використання методів виконання вправ на піску є ефективнішим для покращення показників спритності та може буде альтернативним рішенням для тренерів.

Ключові слова: вправи на піску, вправи на воді, спритність, баскетбол, підліток.

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