ORIGINAL ARTICLES. SPORT

The effect of water exercise and sand exercise training methods on agility in basketball athletes

Muhammad Nasihul Waffak 1ABCD, Pamuji Sukoco 2ACD, FX. Sugiyanto 3BCD

1,2,3 Yogyakarta State University, Yogyakarta, Indonesia

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

DOI: https://doi.org/10.34142/HSR.2022.08.02.04

Corresponding author: Muhammad Nasihul Waffak, waffakikor2016@gmail.com
http://orcid.org/0000-0003-2561-8803, Yogyakarta State University, Yogyakarta, Indonesia

How to Cite

Abstract

Purpose: to examine the water and sand exercise models to maximize athletes’ training ability as exercise media.

Material and Methods: This research is experimental research with a “Two Groups Pretest-Posttest” design that includes a pre-test before the subjects are given treatment and a post-test after the treatment. The research populations were twenty male athletes from a basketball club in Yogyakarta, selected using a random sampling technique. All samples were subjected to a pre-test to determine the treatment group, ranked by their pre-test scores, then matched with the A-B-B-A pattern in two groups with ten athletes each. The sampling technique used in this dividing step was ordinal pairing. This research was conducted 18 times in treatment. The instrument used was an agility test using the Lane agility test. The movements for each number are as follows, (1) Sprint, stunt step, (2) Right slide (running with a guard position to the right side), (3) Run backwards, (4) Left slide, (5) Right slide, (6) Sprint, stunt step, pivot, (7) Right slide, (8) Sprint.

Results: The research used normality, homogeneity, and hypothesis testing. To test the hypothesis, the researchers used the two types of t-tests, namely paired sample test and the independent sample test. The T-test is a statistical analysis technique that can be used to determine whether there is a significant difference between two sample means or not. The results revealed that the t count was 2.335 with a p significance value of 0.031. Because the t-count was 2.335 and the significance value was <0.05, these results indicated a significant difference.

Conclusions: There was a significant difference in the effect of the exercise methods (water exercise and sand exercise) on agility. The sand exercise training method was higher (better) than the water exercise training method on the agility of basketball athletes.

Keywords: water exercise, sand exercise, agility, basketball
Aнотація

Мухаммад Насіхул Ваффак, Памуджі Сукоко, FX. Сугіянто. Вплив вправ у воді та методів тренування вправ на піску на спритність у баскетболістів

Мета. Автор спробував дослідити моделі вправ у воді та піску, щоб максимізувати тренувальні здібності спортсменів як засоби вправ.

Матеріал та методи. Це дослідження є експериментальним дослідженням із задумом «Дві групи попереднього тесту-посттесту», який включає попереднє тестування до того, як суб'єктам буде призначено лікування, і пост-тест після лікування. Дослідницькі популяції складали двадцять спортсменів-чоловіків з баскетбольного клубу в Джок'якарті, відібраних за допомогою техніки випадкової вибірки. Усі зразки були піддані попередньому тестуванню для визначення групи лікування, ранжованих за результатами попереднього тестування, а потім зіставлялися за зразком А-В-В-А у двох групах по десять спортсменів у кожній. Методом вибірки, використаним на цьому етапі поділу, було порядкове парування. Це дослідження проводилося 18 разів під час лікування. Використовуваним інструментом був тест на спритність за допомогою тесту на спритність Лейна. Рухи для кожного номера такі: (1) Спринт, крок трюка, (2) Праве ковзання (біг із позицією захисника з правого боку), (3) Біг назад, (4) Ліворуч, (5) Праворуч слайд, (6) Спринт, трюковий крок, поворот, (7) Правий ковзання, (8) Спринт.

Результати. У дослідженні використовувались перевірки нормальності, однорідності та гіпотези. Щоб перевірити гіпотезу, дослідники використали два типи t-тестів, а саме парний вибірковий тест і незалежний вибірковий тест. Т-тест – це метод статистичного аналізу, який можна використовувати, щоб визначити, чи існує значна різниця між двома середніми вибірками чи ні. Результати показали, що кількість t становила 2335 із значенням значущості р 0,031. Оскільки число t становило 2,335, а значення значущості було <0,05, ці результати вказували на значну різницю.

Висновки. Була суттєва різниця впливі методів вправ на піску на спритність. Метод тренувань на піску був вищим (кращим), ніж метод тренувань у воді на спритність баскетболістів.

Ключові слова: упражнения на воде, упражнения из песка, аджилити, баскетбол

Аннотация

Мухаммад Насихул Ваффак, Памуджі Сукоко, FX. Сугіянто. Влияние упражнений в воде и методов тренировки упражнений на песке на ловкость у баскетболистов

Цель. Автор попытался исследовать модели упражнений в воде и песке, чтобы максимизировать тренировочные способности спортсменов как средства упражнений.

Материал и методы. Это исследование является экспериментальным исследованием с замыслом «Две группы предварительного теста-посттеста», который включает предварительное тестирование до того, как субъектам будет назначено лечение и пост-тест после лечения. Исследовательские популяции составляли двадцать спортсменов-мужчин из баскетбольного клуба в Джокьякарте, отобранных с помощью техники случайной выборки. Все образцы были подвергнуты предварительному тестированию для определения группы лечения, ранжированных по результатам предварительного тестирования, а затем сопоставлялись по образцу А-В-В-А в двух группах по десять спортсменов в каждой. Методом выборки, использованным на этом этапе разделения, было порядочное спаривание. Это исследование проводилось 18 раз во время лечения. Используемым инструментом был тест на ловкость с помощью теста на ловкость Лейна. Движения для каждого номера следующие: (1) Спринт, шаг трюка, (2) Правое скольжение (бег с позицией защитника с правой стороны), (3) Біг назад, (4) Спринт, крок, поворот, (7) Правый скольжение, (8) Спринт.

Результаты. В исследовании использовались проверка нормальности, однородности и гипотезы. Чтобы проверить гипотезу, исследователи использовали два типа t-тестов, а именно чётный выборочный тест и независимый выборочный тест. Т-тест – это метод статистического анализа, который можно использовать, чтобы определить, существует ли разница между двумя средними выборками или нет. Результаты показали, что количество t составило 2335 со значением значимости p 0,031. Поскольку число t составляло 2,335, а значение значимости было <0,05, эти результаты указывали на значительную разницу.

Выводы. Была существенная разница в влиянии методов упражнений (упражнения в воде и упражнения на песке) на ловкость. Метод тренировок на песке был выше (лучше), чем метод тренировок в воде на ловкость баскетболистов.

Ключевые слова: упражнения на воде, упражнения из песка, аджилити, баскетбол
Introduction

Today basketball is developing rapidly, proven by the more clubs and activities being established in the school environment and the holding of regional, national and international basketball championships [1, 2]. Basketball is a fast-paced game where the objective is to put the ball into the basket. Although the concept is simple, the game’s specific offensive and defensive aspects are executed differently based on the level of play and the game situation [3, 4].

Perfect abilities must support today’s basketball game. A good player is a player who can display a consistent performance from start to finish in every half [5, 6]. The good physical quality is needed through training and loading, so that muscle fitness will be created to support every biomotor component in the athlete [7, 8]. The biomotor components of athletes include speed, strength, endurance, and flexibility. [9] Stating that “The results of the combination of these biomotor components will produce derivatives of other biomotor components, for example, the results of the combination of speed and strength will produce power, the combination of strength and endurance will produce strength endurance or stamina, while the combination of speed, flexibility and coordination will produce agility.

One of the most important physical components in achieving optimal performance is leg muscle power and good agility to develop basketball achievements. For example, a basketball player must be able to change movements from dribble quickly and then jump to jump shoot, rebound both offensive rebounds and defensive rebounds, free himself from the guard of the opponent without the ball or with the ball, and vice versa do good guarding with the opponent without or with the ball [10, 11]. This component means that the working muscles must be able to contract maximally in a short time. The provision of training must be specific, according to the characteristics of the physical condition to be developed.

The players in the game of basketball require a very high level of agility. Some forms of activity on the field require agility when dribbling the ball quickly towards the basketball hoop and passing several opponents who are guarding around the ring with a particular formation [1]. This aspect is reinforced by [12] saying that “agility is the ability which makes it possible for an athlete to change direction, make quick stops and perform fast, smooth, efficient and repetitive movements.” Therefore, it can be said that an athlete must have good agility in a basketball game. Agility is instrumental when doing rebounds, driving jump shots, and changing speed (sudden speed changes).

When athletes have good agility, their skills, both basic techniques and basic movements, will increase because the basketball game is closely related to changes in speed. For example, a defender must always be as fast as possible to follow the attacking player’s movements when doing defense. On the other hand, when attacking, it is helpful to do a v-cut (cutting/ability to change direction suddenly) to free himself from the opponent’s guard. Applying several different training methods to provide a variety of exercises and avoid athlete saturation can be done to improve and develop an athlete’s agility [13, 14, 15]. An athlete is expected to achieve optimal performance with excellent and varied training methods.

So far in practice, athletes aged 16-18 years, especially in basketball clubs in Sleman, Yogyakarta, still have low agility, evidenced by the many traveling violations caused by lack of control when changing speed, the number of fouls due to the slow-motion of the slide defense and many more. This fact is strengthened by data that researchers will display during fact observations in the field during the KONI Cup inter-club competition in Yogyakarta City.

Perbakas Kalasan and Ayaba are clubs located in the city of Yogyakarta. Both clubs have a whole age group, including KU 14 boys and girls, KU 16-18 boys and girls, and KU Senior boys and girls. In initial observations, on April 9, 2016, Saturday at 15.30 in Ayaba, and on April 10, 2016, Sunday in Perbakas Kalasan, it could be seen that many athletes ignored the basic movements of basketball athletes, especially the 16-18-year-old age group. Their stances defense was too high, rebounds were still careless, cutting movements and change of direction were still broken, resulting in athletes quickly passing by opponents who only have ordinary dribbling abilities and much loose dribbling, one of which was due to the level of inadequate agility.

Based on the match statistics data above, it shows that the turnover rate by athletes is very high, more than 30 times in one match. Turnover itself consists of several elements: improper passing, traveling violation, and being hit by stealing [16]. The dominant thing that occurs is traveling violation or being hit by steals due to the athlete’s inability to pass the opponent so that the athlete tends to make mistakes [17]. This means that athletes often do fouling due to stances/foot stances when the defense is not strong enough, thus forcing them to use their hands to stop the opponent’s pace, which is
prohibited in basketball. Moreover, the number of rebounds is small, resulting in the gap between the coach’s instructions against the intended target and the athletes’ execution results on the field.

Agility is essential in all activities and sports [18]. Individual and team sports involve quick starts and stops, rapid change of directions, efficient footwork, and quick adjustment of the body or body parts [2, 19]. Agility is the ability to maintain control body position while quickly changing direction during a series of movements [20]. Agility is one of the elements of physical condition that plays an important role, especially in sports, including basketball, when being guarded by an opponent. A player must be able to move quickly to change direction or to escape [21]. Thus, explosive movements will extensively allow players to control the ball, pass the opponent’s obstacles, and breakthrough the tight opponent’s defense.

Based on observations during his time as a trainer, he only used a field with a hard texture during training, and there was still a lack of use of other training models for training. The more diverse training models offered to athletes, the more stimulating athletes will not feel bored while practicing. The use of the exercise model must also be adjusted to the training media used so that the exercise results will be more optimal. Therefore, the author will examine the water and sand exercise model to maximize the athlete’s ability to train as an exercise medium.

Water has different pressures depending on the formation compound and depth or volume [22]. The pressure contained in the water can be used to provide a load during exercise [23]. In addition to using water pressure as a training load, exercising in the water is also easier and safer from injury to muscles or joints because, in the water, the players are better able to control the given load [24]. It also provides freedom of movement of muscles and joints, reducing pressure (resistance) caused by hard steps such as when exercising on land.

Exercise using water media is not only used for various swimming techniques (crawl, backstroke, breaststroke, or butterfly) but also exercises with water media offer many other movement possibilities such as walking, jogging, or jumping [25, 26]. This will make it possible to stimulate the metabolic and neuromuscular systems, followed by physiological adaptation processes. Some studies have shown that a program of jumps in water increases power, peak concentric torque, vertical jump height, and speed. These performance improvements may be due to the forces resisting forward movement (increased load) generated during water jumps [27]. Buoyancy reduces the effect of weight-bearing on skeletal joints and reduces compressive joint forces the more significant density of water (compared to air), and the drag force provides loading during all movements [28].

Likewise, in sand exercise, sand can also function to reduce the pressure (resistance) caused by a tricky footing, such as when exercising on a hard textured field [29, 30]. Exercise in the sand can also be a medium for implementing strength, speed, endurance, or power training [31, 32]. Compared to regular handball training, supplemental jump and sprint exercise training on sand substantially improved sprinting, agility, jumping, repeated sprinting, and balance in male handball players. Weak foundations such as those found in sand or water have properties as resistance so that apart from helping reduce pressure, they also have an effect as a burden so that they will be helpful in the practice process. Sand also drives athletes to test the limits of their anaerobic thresholds [33]. Running and jumping activities on the sand make the result faster than the same activities on any other surface. The leg and hip muscles are forced to work much harder when planting and pushing off in the sand [34].

Research by [35, 36] shows that “10 weeks of agility training on a sand surface resulted in significant improvements in agility tests conducted on both sand and firm ground surfaces, suggesting that the physiological and biomechanical adaptations unique to sand training can also have a positive effect on firm-ground agility performance”. That is, ten weeks of agility training performed on the surface of the sand showed a significant improvement.

Therefore, there was a need for research using water exercise and sand exercises influenced by leg muscle power on agility which would then be developed with the title “The effect of water exercise and sand exercise training methods on agility in basketball athletes.”

**Material and methods**

This study is included in experimental research, examining the relationship between the cause-and-effect variables. The design used in this study was “Two Groups Pretest-Posttest,” which contained a pre-test for the subjects before they were given treatment and a post-test after the treatment. In this study, 18 meetings were conducted. After being given treatment, more accurate results are gained because they can be compared with what was held before being treated.

The research population was all-male athletes from a basketball club in Yogyakarta,
determined using a random sampling technique. All samples were subjected to a pre-test to determine the treatment group, ranked by their pre-test scores, then matched with the A-B-B-A pattern in two groups with ten athletes each. The sampling technique used in this study was ordinal pairing.

In addition to the racetrack’s start and finish transition gates, a third gate was also placed at the initial point of slaloms (Figure 1). Participants were assessed for initial sprint-reverse ratings, slalom ratings, second sprint-reverse ratings, and the total Illinois agility test ratings [37].

![Image of Illinois agility test](image)

**Fig. 1.** Transition gate locations in the Illinois agility test (A–B–C)

The analysis techniques used were normality, homogeneity, and hypothesis testing. The hypothesis was tested using the t-test, a statistical analysis technique that can be used to determine whether there is a significant difference between two sample means. The t-tests used were the paired sample test and the independent sample test (two groups of unpaired samples).

### Results

Statistical descriptions of the agility test result on male athletes of basketball clubs in Yogyakarta are presented in Table 1.

Based on Table 1, the mean pre-test and post-test of water exercise decreased, which means that the data/research group experienced an increase in speed. The mean pre-test and post-test sand exercise data also decreased, which means that the data/group also experienced an increase in speed.

**Table 1**

Descriptive Table of Agility Test Results Statistics

<table>
<thead>
<tr>
<th>Statistics indicators</th>
<th>Pretest Water Exercise</th>
<th>Posttest Water Exercise</th>
<th>Pretest Sand Exercise</th>
<th>Posttest Sand Exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Mean</td>
<td>19,04</td>
<td>17,71</td>
<td>19,00</td>
<td>16,77</td>
</tr>
<tr>
<td>Median</td>
<td>19,10</td>
<td>17,54</td>
<td>19,12</td>
<td>16,87</td>
</tr>
<tr>
<td>Mode</td>
<td>18,47a</td>
<td>16,46a</td>
<td>19,12</td>
<td>15,25a</td>
</tr>
<tr>
<td>Std, Deviation</td>
<td>0,33</td>
<td>0,71</td>
<td>0,39</td>
<td>0,75</td>
</tr>
</tbody>
</table>
Minimum | 18,47 | 16,46 | 18,53 | 15,25  
Maximum | 19,45 | 18,58 | 19,54 | 17,59  
Sum     | 190,43| 177,13| 190,02| 167,73  

Multiple modes exist, The smallest value is shown

Table 2

<table>
<thead>
<tr>
<th>Data</th>
<th>Significance</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Exercise</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretest</td>
<td>0.354</td>
<td>Normal</td>
</tr>
<tr>
<td>Posttest</td>
<td>0.391</td>
<td>Normal</td>
</tr>
<tr>
<td>Sand Exercise</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretest</td>
<td>0.123</td>
<td>Normal</td>
</tr>
<tr>
<td>Posttest</td>
<td>0.164</td>
<td>Normal</td>
</tr>
</tbody>
</table>

The results of the normality test used the Shapiro-Wilk test. From the results of the Table above, it can be seen that the pre-test and post-test data have a p-value (sig.) > 0.05., and then the variable is normally distributed.

Table 3

<table>
<thead>
<tr>
<th>Data</th>
<th>Homogeneity test</th>
<th>Homogeneity test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest-Posttest Water Exercise</td>
<td>0.655</td>
<td>Homogen</td>
</tr>
<tr>
<td>Pretest-Posttest Sand Exercise</td>
<td>0.246</td>
<td>Homogen</td>
</tr>
</tbody>
</table>

Useful for testing the similarity of the sample that is uniform or not the variance of the sample taken from the population. The results of the homogeneity test of this study can be seen in Table 3 as follows: From table 3 above, it can be seen that the value of sig. Pre-test and post-test significance > 0.05, so the data is homogeneous.

Table 4

<table>
<thead>
<tr>
<th>Agility</th>
<th>Average</th>
<th>( t_{count} )</th>
<th>sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest</td>
<td>19.04</td>
<td>6.593</td>
<td>0.000</td>
</tr>
<tr>
<td>Posttest</td>
<td>17.71</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Based on the analysis results in Table 3 above, it can be seen that the \( t_{count} \) is 6.593 with the p significance value of 0.000. Because the \( t_{count} \) is 6.593 and the significance value is 0.000 < 0.05, this result shows a significant difference. Thus the alternative hypothesis (Ha), “There is a significant effect of Water Exercise on agility,” is accepted.

Table 5

<table>
<thead>
<tr>
<th>Agility</th>
<th>Average</th>
<th>( t_{count} )</th>
<th>sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest</td>
<td>19.00</td>
<td>11.132</td>
<td>0.000</td>
</tr>
<tr>
<td>Posttest</td>
<td>16.77</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Based on the analysis results in Table 3 above, it can be seen that the \( t_{count} \) is 11.132 with the p significance value of 0.000. Because the \( t_{count} \) is 11.132 and the significance value is 0.000 < 0.05, this result shows a significant difference. Thus the alternative hypothesis (Ha), “There is a significant effect of sand exercise on agility,” is accepted.
The hypothesis of Differences in the Water Exercise and Sand Exercise Effect on Agility will be Explained in Detail in the Table below

<table>
<thead>
<tr>
<th>Groups</th>
<th>Mean Gain</th>
<th>t count</th>
<th>sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Exercise</td>
<td>1,33</td>
<td>3,163</td>
<td>0,005</td>
</tr>
<tr>
<td>Sand Exercise</td>
<td>2,23</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Based on the analysis results in Table 3 above, it can be seen that the t count is 3.163 with a p significance value of 0.005. Because the t count is 3.163 and the significance value is 0.005 < 0.05, this result shows a significant difference. Thus the alternative hypothesis (Ha), “There is a significant difference between Water Exercise and Sand Exercise on agility,” is accepted. The Sand Exercise group is better than the Water Exercise for basketball agility.

**Discussion**

Based on the hypothesis testing, it is known that the water exercise and sand exercise have a significantly different effects on agility. The analysis results show that the sand exercise method is better than the water exercise method. Sand exercise is another method to improve the leg muscles’ ability [38]. Training on sand can reduce the stress placed on the skeletal muscle system during exercise, limit the degree of exercise-induced muscle damage, and associated negative side effects such as increased muscle soreness and reduced performance capacity [39, 40, 41, 43]. When the footsteps are on the sand, the athlete will receive a more significant stimulus through the resistance pressure generated during training.

Exercise in the sand can also be a medium for implementing strength, speed, endurance, or power training [29]. Training in the sand also puts pressure and weight on it to feel heavier than training on a regular field [31]. The plant foot (front) sinks into the sand instead of regular ground reaction forces to stabilize the body and provide efficient forward propulsion when sprinting through the sand. [30, 32].

Sand sprinting is another common training method used to develop sprint speed [44]. Soviet research on Olympic sprinters theorized that sprinting in the sand was one of the best ways to develop the hamstrings [45, 46]. The sand surface is also expected to reduce stride frequency slightly, as athletes maintain almost the same movement pattern and range of motion during stride [47]. The lower horizontal speed on the sand surface means the athlete takes longer to make a move, hence having a longer time in contact with the sand surface [48]. The high shock absorptive qualities of sand can also limit maximal movement speed in sprint training and jumping performance [49]. This means that sand therapy can also reduce the pressure (resistance) caused by a hard footing, such as when exercising on a hard-textured court here, where the sand absorbs more pressure on the joints which usually occurs in hard-textured courts.

Research by Gortsila et al. in [50] shows that “10 weeks of agility training on a sand surface resulted in significant improvements in agility tests conducted on both sand and firm ground surfaces, suggesting that the physiological and biomechanical adaptations unique to sand training can also have a positive effect on firm-ground agility performance”. Furthermore, [51] adds, “soft sand running has provided the most conclusive evidence to date, by identifying a significantly greater contribution of the lower leg muscles to the exercise bout when compared to the firm ground running.”

Agility is needed in sports that are games, as it is related to body movements involving footwork and rapid body position changes. Agility, in principle, plays a role in activities that involve changing body movements while maintaining balance. An athlete or player who has good agility will be able to perform movements more effectively and efficiently.

Prospects for further research. For trainers, the results of this study can add to the existing knowledge and training methods. This research is expected to contribute to science, especially in the sport of basketball, and explain scientifically the influence of the training methods given.

**Conclusions**

Based on the results of the research and the results of data analysis, there is a significant difference in the effect of the water exercise with sand exercise methods on agility. The sand exercise training method is higher (better) than the water exercise training method on the agility of basketball athletes.
Acknowledgments

The authors would like to thank the male athlete clubs in Yogyakarta for permitting the authors to complete the research and all of the students involved in our research.

Conflict of interest

The authors declared no conflicts of interest in preparing this article. The result of this study was not affected by any parties or sponsors.

References

1. Smith-Ditizio A, Smith AD. Olympic Games, media coverage and brand image/performance from fan and gender perspectives. Benchmarking An Int J. Published online 2022.
3. Robbins M. We’re All in This Together: Creating a Team Culture of High Performance, Trust, and Belonging. Hay House, Inc; 2022.
25. Fernandes MMP, Cruz ACL da, Nunes BPM, et al. Physiological effects of land and water treadmill
exercise in dogs. Ciência Rural. 2022;52.


35. Glossop-von Hirschfeld C. Proprioception, jumping capacity and agility in beach versus indoor volleyball players. Published online 2021.

36. Holtgeerts RN. The Impact of Recovery Time on Performance in Division I Collegiate Beach Volleyball Players. Published online 2019.


45. Talukdar K, McGuigan M, Harrison C. Practical Strategies in Developing Strength and Plyometric Training to Improve Sprinting Speed in Female Student Athletes Within a School Curriculum. Strength Cond J. Published online 2022:10-1519.


Information about authors

Muhammad Nasihul Waffak  
waffakikor2016@gmail.com  
http://orcid.org/0000-0003-2561-8803  
Yogyakarta State University  
Jl. Colombo Yogyakarta No.1, Karang Malang, Caturtunggal, Kec. Depok, Kabupaten Sleman, Daerah Istimewa Yogyakarta 55281, Indonesia

Pamuji Sukoco  
pamuji_sukoco@uny.ac.id  
https://orcid.org/0000-0001-8122-0598  
Yogyakarta State University  
Jl. Perum Purwomartani Baru Jl. Brotojoyo No.17 Kalasan, Sleman, Yogyakarta, Indonesia

FX. Sugiyanto  
fx.sugiyanto56@gmail.com  
https://orcid.org/0000-0002-1223-2875  
Yogyakarta State University  
Jl. Perum Mapan Sejahtera, Gondang Legi Wedomartani Kec. Ngemplak, Sleman, Yogyakarta, Indonesia

Інформація про авторів

Мухаммед Насіхул Ваффак  
waffakikor2016@gmail.com  
http://orcid.org/0000-0003-2561-8803  
Університет штату Джок'якарта  
Jл. Коломбо Джок'якарта № 1, Каранг Маланг, Катургунггал, Кеч. Депок, регентство Слеман, особливий регіон Джок'якарти 55281, Індонезія

Памуджі Сукоко  
pamuji_sukoco@uny.ac.id  
https://orcid.org/0000-0001-8122-0598  
Університет штату Джок'якарта  
Jл. Перум Пурвомартани Бару Jл. Бротоджойо № 17 Каласан, Слеман, Джок'якарта, Індонезія

FX. Сугіянто  
fx.sugiyanto56@gmail.com  
https://orcid.org/0000-0002-1223-2875  
Університет штату Джок'якарта.  
Jл. Перум Мапан Седжахтера, Гонданг Легі Ведомартані Кеч. Нгемплак, Слеман, Джок'якарта, Індонезія

Інформация об авторах

Мухаммад Насикул Ваффак  
waffakikor2016@gmail.com  
http://orcid.org/0000-0003-2561-8803  
Университет штата Джокьякарта  
Jл. Коломбо Джокьякарта №1, Каранг Маланг, Катургунггал, Кеч. Депок, регентство Слеман, особый регион Джокьякарты 55281, Индонезия

Памуджи Сукоко
This work is licensed under a Creative Commons Attribution 4.0 International License (CC BY 4.0)