

Application Of Principal Component Analysis (PCA) On Factors That Influence The Performance Of Taekwondo Athletes In North Sumatra

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Abstract: *The goal of this research is to evaluate the factors that influence the performance of Taekwondo athletes, specifically focusing on physical training factors. There are several physical components that affect athlete performance, including flexibility using the V sit and reach test, flexibility of the shoulder and wrist, abdominal muscle endurance, arm muscle endurance, arm muscle explosive power, explosive power of the right leg muscles, explosive power of the left leg muscles, speed, core test, and aerobic endurance (VO₂max). This research will use Principal Component Analysis (PCA). The sample consists of 16 Taekwondo athletes from North Sumatra. The results of the Bartlett's test using RStudio indicate that there are several physical training factors that significantly influence the performance of Taekwondo athletes in North Sumatra, namely flexibility (V sit and reach), shoulder and wrist flexibility, abdominal muscle endurance, and leg muscle endurance. Based on the PCA analysis conducted through RStudio, each component has its own variance, with a total variance of 0.8 or 80% for the four components.*

Keywords: Taekwondo , Performance, Physical Components, NorthSumatra.

1. INTRODUCTION

Taekwondo is a modern martial art sport originating from Korea. Taekwondo is a type of sport that focuses on kicking as its physical activity, where the concept of taekwondo combines skill and strength. There are three important numbers in taekwondo, namely Taekwondo, Poomsae, kyukp, Kyoruki [1]. Taekwondo has two competitions: sparring and forms. The sparring competition, known as kyorugi, involves physical contact to determine the victory in a match. And for the forms category, it is called poomsae, where athletes perform taekwondo patterns without physical contact to achieve victory.

In taekwondo, physical components greatly influence the athletes' performance, including flexibility, abdominal muscle endurance, arm muscle endurance, arm muscle explosiveness, leg muscle explosiveness, speed, balance, and endurance. In this study, the researchers will examine the influence of physical training on the performance of taekwondo athletes in North Sumatra using PCA analysis.

In taekwondo competitions, there are two techniques: fist technique and foot technique, which lead to the opponent's body movement [2]. Punching techniques (fist technique) are directed towards the body, while kicking techniques (foot technique) are allowed to target the legs and head. Taekwondo is a contact sport that often results in injuries for athletes. Taekwondo players have a higher chance of injury incidence in low limbs compared to other segments, because kicking and

jump kicking are the most dominant techniques due to jumping and landing on the supporting leg [3]. Therefore, proper technique training and good physical condition are important for taekwondo athletes to reduce the risk of injuries.

There are many factors that influence the performance of an athlete, including mastery of techniques, physical condition, psychological factors, and strategies during matches. In this study, the focus will be on the physical condition of taekwondo athletes. There are eight points that affect the physical condition of a taekwondo athlete, including flexibility, abdominal muscle endurance, arm muscle endurance, arm muscle explosiveness, leg muscle explosiveness, speed, core test, and aerobic endurance (VO₂ Max).

Flexibility is the ability of joints and muscles to move freely with maximum range of motion. It is also the ability of muscles and joints to move freely without hindrance [4]. Higher flexibility in taekwondo athletes is beneficial as it reduces the risk of muscle and joint injuries, aids in performing complex movement coordination, and develops speed and agility in matches. To measure flexibility, the V sit and reach test and shoulder & wrist test will be used.

Abdominal muscle endurance needs to be trained as taekwondo is a martial art where attacks can target the abdomen. Abdominal muscle endurance can be trained with various exercise variations theoretically. The abdominal muscles can provide the best results to support athletes' movements [5]. To measure the level of abdominal muscle strength, the researchers will use the 2-minute sit-up test.

Arm muscle endurance is a supporting factor for sustained motion in sports, especially martial arts. Although taekwondo predominantly utilizes kicking techniques, it is also important to train the strength of the arm muscles for athletes. In martial arts, arm muscle endurance is important and needed to maintain the performance of athletes during their movements [6]. To measure arm muscle strength, the researchers will conduct the 1-minute push-up test. As discussed in this journal, arm muscle explosiveness is related to explosiveness. Explosive movement is a movement where strength is combined with speed and performed in a short period of time [7]. Therefore, explosive power is the multiplication of strength and speed, and this movement is referred to as explosiveness. The chest throw medicine ball test will be used to measure explosive power.

Similarly to the previous explanation, but the difference is that leg muscle explosiveness focuses on the leg muscles. Since taekwondo predominantly involves kicking, training leg muscle explosiveness is crucial for athletes. In movements that require leg muscle power, the dominant muscles used are the gastrocnemius muscle and the quadriceps femoris muscle group. The triple hop jump test will be used to measure leg muscle explosiveness in taekwondo [8].

The purpose of agility testing is to measure the speed of athletes. Agility in martial arts is used to perform technical and tactical movements. Speed also serves to find momentum, and it is crucial for agility movements to maintain dynamic balance [9]. Agility in taekwondo is useful for generating momentum, both in attacking and evading, as a more agile athlete will have more opportunities to land successful strikes. The test that will be conducted is a 20-meter sprint.

In the case of taekwondo players, strengthening the core muscles will improve movement and spinal stability, greatly aiding athlete performance. The core muscles generate the power and mobility of the human body and maintain balance with every movement. The movements and stability of the trunk can be maximized by repeatedly stretching and strengthening the core muscles. The test will involve using a 12-level core plank exercise. Core stability exercise is a specific training aimed at improving the balance and stability of the abdominal, pelvic, and shoulder muscles of an athlete [10]. As described in another journal, "In the case of taekwondo players, strengthening the core muscles would improve spinal movement and stability and greatly help to improve athletic performance. The core muscles generate all the power and mobility of the human body, as well as maintaining balance every time we move, and the movements and stability of the trunk can be maximized by repeatedly stretching and strengthening the core muscles [11].

Aerobic endurance is the ability of an athlete to engage in physical activity for a prolonged period. In taekwondo, aerobic endurance plays an important role because taekwondo matches have a considerable duration, so it is important to regulate tempo in a match [9]. To measure an athlete's aerobic endurance, the bleep test is commonly used.

2. METHOD

2.1 Method

The main focus of this research involves the implementation of Principal Component Analysis (PCA) method, but illustrating this method as applied to sports requires relevant data to be analyzed. Therefore, this section will begin with a brief description of the impact of physical training in taekwondo. Subsequently, the PCA method will be outlined using a taekwondo dataset.

The samples used in this study consisted of 16 taekwondo athletes from North Sumatra. The data was collected during the physical test conducted for athletes in North Sumatra in April 2022 at the multipurpose building in Medan.

2.2 Results

Based on the results from R Studio, there are 10 variables that will be processed in the data analysis. Among them are flexibility using V sit and reach, flexibility of shoulder and wrist, abdominal muscle endurance, arm muscle endurance, explosive power of arm muscles, explosive power of the right leg muscles, explosive power of the left leg muscles, speed, core test, and aerobic endurance (VO₂max).

After conducting the Bartlett's test, we obtained a p-value of 0.004. Since the p-value is less than 0.05, which is the significance level commonly used, we can conclude that the null hypothesis (H₀) is rejected. This indicates that the data is suitable for further analysis using the PCA (Principal Component Analysis) test.

After that, we calculate the eigenvalues for each variable, where: (1) 4.33824969 (2) 1.38479427 (3) 1.23785458 (4) 1.01635375 (5) 0.62573894 (6) 0.5664138 (7) 0.41319208 (8) 0.25997550 (9) 0.12837862 (10) 0.02900117. Based on the results shown in the above figure, it can be observed that the chi-square value is 74.08641, which is higher than the chi-square table value of 26.2962. Additionally, the p-value of 0.04071549 is lower than the significance level of 0.05. Therefore, it can be concluded that there are several physical training factors that significantly influence the performance of Taekwondo athletes in North Sumatra. These factors include flexibility (V sit and reach), shoulder and wrist flexibility, abdominal muscle endurance, and lower limb explosive power. It can be further concluded that each component has its own variance, and the total variance explained by the four main components is 0.80 or 80%.

3. DISCUSS

Based on the data analysis results, the research shows that among the 10 test variables, they include V sit and reach, shoulder and wrist flexibility, abdominal muscle endurance, arm muscle endurance, arm muscle explosive power, explosive power of the right leg muscles, explosive power of the left leg muscles, speed, core test, and aerobic endurance (VO₂max). Then, a Bartlett's test was conducted, resulting in a p-value of 0.004. Since $0.004 < 0.05$, if the p-value is less than 0.05, it means that the null hypothesis (H₀) is accepted, and the data

can proceed to PCA analysis. The PCA results show that there are four factors significantly influencing the performance of Taekwondo athletes in North Sumatra, namely V sit and reach flexibility, shoulder and wrist flexibility, abdominal muscle endurance, and leg muscle endurance.

This journal emphasizes the importance of physical training, stating that The physical training undergone by the samples in this research has a positive impact on body muscle strength and athlete's physical condition. This is because the exercises performed in the subgroup of physical activity movements are carried out regularly and repeatedly [8]. Another journal highlights the importance of flexibility in Taekwondo, stating that "In Taekwondo, to score high points, an athlete needs to direct their kicks towards the opponent's head, which is why flexibility is highly necessary to perform movements widely through optimal joint range [9].

In another study, leg muscle explosive power is discussed, stating that In Taekwondo, a strong stance is crucial before delivering kicks. Leg muscle strength is a key factor in performing a stance before delivering kicks [12]. In a subsequent research, abdominal muscle endurance is explained, stating that Abdominal muscle strength is the ability of muscles to contract maximally to overcome resistance or load. In Taekwondo, it is useful for withstanding attacks and plays a role in executing specific attacking movements, especially kicks [13]. Based on the above research, it can be concluded that these four components have an influence on the performance of Taekwondo athletes.

4. RESULT

Based on the discussion and data analysis above, we can conclude that the factors influencing the performance of Taekwondo athletes in North Sumatra are the flexibility of V sit and reach, shoulder and wrist flexibility, which contribute to generating kicks with a longer range. Additionally, abdominal muscle endurance is essential for withstanding attacks and plays a crucial role in executing kicking movements. Lastly, leg muscle endurance significantly affects how frequently athletes can perform kicks. In a sport dominated by kicking techniques, the explosive power of the leg muscles greatly influences the performance of Taekwondo athletes..

5. REFERENCES

1. achrezzy, F., Maslikah, U., Safadilla, E., Reginald, R., & Hendarto, S. (2021). Physical Fitness of Poomsae Taekwondo Athletes in Terms of Agility, Balance, and Endurance. *Kinestetik: Jurnal Ilmiah Pendidikan Jasmani*, 5(1), 111–119. <https://doi.org/10.33369/jk.v5i1.14364>
2. Sabatini, D. (2019). Factors Affecting Speed, Strength, and Power in Taekwondo Kicks. *Jurnal Pendidikan Olahraga*, 8(2), 85–95. <https://doi.org/10.31571/jpo.v8i2.1120>
3. Chang, W.-G., Chang, J.-S., & Tang, W.-T. (2007). Kinematic and Kinetic Analysis of Lower Limbs in Taekwondo Doublejump Roundhouse Kick During Landing. *Journal of Biomechanics*, 40(2), S241. [https://doi.org/10.1016/s0021-9290\(07\)70237-3](https://doi.org/10.1016/s0021-9290(07)70237-3)
4. Maimun Nusufi. (2015). Relationship Between Flexibility and Sabit Kick Speed Ability in Silat Athletes in Aceh Sports Development Program (PPLP and Diklat) in 2015. *Ilmu Keolahragaan*, 14(1), 35–46.
5. Pratama, I. (2020). The Effect of Circuit Training Using Core Stability Static. 5, 44–50.
6. Rustiawan, H., Rohendi, A., & Galuh, U. (2021). The Impact of Rolling Ball Push-up and Tubing Push-up Exercises on Increased Arm Muscle Endurance. 6(1), 74–86.
7. Dimiyati, A. (2016). *Judika (jurnal pendidikan unsika)*, 4(November), 219–230.
8. Handariati, Atik, & Gandika, G. (2021). Relationship Between Age, Gender, Body Mass Index, Training Duration, and Leg Muscle Power in Taekwondo Athletes. 1(12).
9. Sovia wahyuni, D. (2020). *Jurnal Patriot Volume 2 Number 2, 2020. ISSN 2655-4984 (Print) ISSN 2714-6596 (Online) 1VO2MAX, LEG MUSCLE POWER, AGILITY, AND FLEXIBILITY FOR THE NEEDS OF TAEKWONDO ATHLETE'S PHYSICAL CONDITION. Kondisi Fisik*, 2, 1–13.
10. Pardede, A. R. F. (2019). *Journal of Social Sciences and Education. Ilmu Sosial Dan Pendidikan*, 3(3), 209–222.
11. Tayshete, I., Akre, M., Ladgaonkar, S., Kumar, A., & Professor, A. (2020). Comparison of the Effect of Proprioceptive Training and Core Muscle Strengthening on the Balance Ability of Adolescent Taekwondo Athletes. *International Journal of Health Sciences and Research (www.ijhsr.org)*, 10(6), 268. Retrieved from www.ijhsr.org
12. Hanief, N., Puspodari, Lusianti, S., & Aprilianto, A. (2016). Profile of Physical Condition of Junior Taekwondo Athletes at Kediri Regional Training Center in 2016 in Facing the Provincial Sports Week (Porprov) of East Java in 2017. *Jurnal Kejaora*, 1(November 2016), 17–28. Retrieved from <https://ejournal.unibabwi.ac.id/index.php/kejaora/article/view/44/31>
13. Abdulloh, B. H., & Jatmiko, T. (2021). Standardization of Physical Condition of Taekwondo Athletes at East Java Regional Training Center. *Jurnal Prestasi Olahraga*. Retrieved from <https://ejournal.unesa.ac.id/index.php/jurnal-prestasi-olahraga/article/view/40660>