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# The Relationship of Arcus Pedis Form with Running Speed in Markentho's Football Running Community at Manahan Stadium

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## Abstract

**Background:** Running speed refers to a person's ability to perform consecutive movements to cover a distance in the shortest possible time. This speed is influenced by the arch of the foot (arcus pedis), which can be classified as low, high, or average, and functions as a shock absorber when the foot contacts the ground. Common deformities in abnormal foot structures include pes cavus and flat feet.
**Aim:** To determine the relationship between the condition of the arcus pedis and running speed in the Anak Buah Markentho running community at Manahan Stadium.
**Methods:** This research was conducted on 25 members of a running community. The normality test was performed using the Shapiro-Wilk test, and the hypothesis was tested using Spearman's correlation.
Results: The analysis yielded a significance value of 0.000 ($p < 0.05$), indicating a significant correlation between the shape of the arcus pedis and running speed. The Spearman correlation coefficient was 0.691, showing a positive and strong correlation.
**Conclusion:** Greater deviations in the arch shape are associated with lower running speed, demonstrating a significant and strong correlation. This suggests a clear relationship between the shape of the arcus pedis and running speed.

**Keywords:** cavus foot, flat foot, normal foot, running speed

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**Introduction**

Sport is an activity that prioritizes physical training. Sport is a physical activity that can help optimize body development through movements based on muscle movement (Hammado et al., 2020). Apart from that, sport is a medium to make a person's health condition much better and more maintained (Putra et al., 2015). Someone whose hobby is sports is often channeled by joining sports clubs or communities, such as football clubs and running communities. A running community is a group of people who have the same activity, namely running (Rahmawati et al., 2019).

Running is one of the human movements that plays an important role, both when carrying out daily life and exercising (Putra et al., 2015). There are 3 types of running distance, namely short distance running, middle distance running and long-distance running (Jufinda et al., 2020). What differentiates these three distances lies in the running speed carried out by the runner to get to the finish line.

Running speed is the speed at which a person can quickly move their body from one place to another (Putri & Yuliawan, 2021) total distance when running must be completed in a relatively short amount of time. So for the physical condition factor, speed is really needed by Rasid in (Indardi, 2015) One of the most important parts in running speed and affecting the musculoskeletal structure of the foot is the archus pedis or arch foot (Irawan et al., 2020).

In general, each individual has a different shape to the arcus pedis. Where the arcus pedis is divided into 3 types, namely normal foot, flat foot, and cavus foot. The shape of the normal arch of the foot has a normal anatomical structure with strong ligaments and a deep arch. Because the normal foot has a deep arch, this is able to provide greater strength in supporting body weight and carrying out movements (Ismi & Pasaribu, 2023).

Research in Europe states that 16.1% of people suffer from flat foot disorders. In men, 17.5% had flat feet and 14.5% in women. The prevalence of flat feet in Indonesia reaches 10.2%. In the general population, flat feet with flexible flat foot conditions are more common than rigid flat foot conditions (Purnama et al., 2024).

Flat foot is a flat foot shape caused by the loss of the longitudinal arch. In someone who experiences flat feet, symptoms of an abnormal walking pattern will appear which will cause the person to get tired easily and their balance will be disturbed. Low balance ability can result in reduced running speed and obstacles when running (Ismi & Pasaribu, 2023). Previous research with respondents with an average age of 21 years with a sole length of 23.6 cm and a sole width of 9.68 cm showed that there were indications of flat foot as much as 47.5% (Salsa & Ismail, 2021).

In flat feet, you will see flatness in the medial longitudinal arch, forefoot valgus, and calcaneal eversion. In contrast, the cavus foot form is usually known as a foot that has a high arch, forefoot varus, and calcaneal inversion. Unlike a flat foot, a cavus foot is able to provide a rigid lever for propulsion but is not efficient as a shock absorber (Kim et al., 2017). Cavus foot or pes cavus is a foot deformity that may have different etiologies and clinical presentations. Pes cavus is defined as a foot that has a high arch (Pandya et al., 2021). In pes cavus the force vector has a larger vertical component compared to normal foot and flat foot. This causes anterior and posterior movements to be slower when running (Buldt et al., 2015).

Based on a preliminary study conducted by researchers at the Anak Buah Markentho running community at Manahan Stadium, there were runners who experienced foot abnormalities. There were 9 runners who had flat foot and 3 people with pes cavus. These results were obtained from the results of a footprint test carried out by researchers using paper and ink as media.

Therefore, researchers are interested in conducting research on the relationship between the shape of the arcus pedis and running speed in the Anak Buah Markentho running community at Manahan Stadium.

**Methods**

This research is a type of research, quantitative observational analytical research, cross sectional research design to determine the relationship between the shape of the arcus pedis and running speed. With a total population of 34 running athletes and a research sample of 25 people obtained through purposive sampling technique by determining inclusion and exclusion criteria.

The inclusion criteria in this study were that the subject had a normal BMI, age 20-25 years, and no foot deformities such as equinus. The exclusion criteria in this study were that subjects had respiratory problems and had a problem with their legs.

The wet footprint test was used to determine the condition of the subjects' arches. The results from this test were then analyzed to assess the arch condition based on the degree of the medial longitudinal curve. Additionally, the 100-meter dash test was used to measure running speed. The study began with an assessment of each subject's arch type, followed by a measurement of their running speed. Finally, the running speeds were compared across the three arch groups.

**Results**

A total of 25 runners were identified as having different types of foot arches. The research results explain the relationship between arch shape and running speed within the Anak Buah Markentho running community at Manahan Stadium. This study presents respondent characteristics, normality tests, and hypothesis testing to address the research questions.

Before testing the hypothesis, the characteristics of the respondents will be explained to get a general picture of the respondents used as research samples. The characteristics of these respondents include body mass index, arcus pedis shape and age.

**Table 1. Characteristics of body mass index**

| BMI | Frequency | Percentage |
|---|---|---|
| Normal | 25 | 25% |
| Total | 25 | 100% |

(Source: Primary Data, 2024)

Characteristics based on body mass index showed that all subjects had a normal body mass index, this was in accordance with the predetermined inclusion criteria.

**Table 2. Characteristics based on arcus pedis shape**

| Arc shape | Frequency | Percentage |
|---|---|---|
| Normal feet | 12 | 48 % |
| *Cavus foot* | 3 | 12 % |
| *Flat feet* | 10 | 40 % |
| Total | 25 | 100% |

(Source: Primary Data, 2024)

Based on the table above, the results show that the subjects in this study had various forms of arcus pedis, where the shape of the normal foot arch dominated the overall percentage figures.

**Table 3. Characteristics by age**

| Age | Frequency | Percentage |
|---|---|---|
| 20 | 4 | 16% |
| 21 | 6 | 24% |
| 22 | 2 | 8% |
| 23 | 6 | 24% |
| 24 | 2 | 8% |
| 25 | 5 | 20% |
| Total | 25 | 100% |

(Source: Primary Data, 2024)

Based on the table above, it was found that the subjects were in the age range of 20-25 years because members of the Markentho Boys running community at Manahan Stadium had an

age range in the adult category which was predominantly 21 years and 23 years.

Then the research subjects whose initial measurements had been taken were then measured for their running speed using a predetermined instrument. The data obtained from the measurements is then processed with descriptive statistics.

***Table 4. Average running speed according to the shape of the arcus pedis***

| Arc shape | Frequency | Min | Max | Mean Running speed |
|---|---|---|---|---|
| Normal feet | 12 | 9.08 | 12.00 | 10.57 |
| *Cavus foot* | 3 | 11.14 | 11.73 | 11.40 |
| *Flat feet* | 10 | 11.34 | 14.16 | 12.84 |
| Total | 25 | | | |

(Source: Primary Data, 2024)

From the results of the statistical analysis above, subjects who have a normal arcus foot shape have a faster running speed when compared to subjects who have an arcus cavus foot and flat foot shape, seen from the measurement results in seconds.

The data was then tested for normality of the data using Shapiro Wilk because the number of research subjects was <50.

*Table 5. Data Normality* Shapiro-Wilk

| | *P value* | Form |
|---|---|---|
| Arc shape | 0,000 | Abnormal |
| Speed | 0.580 | Normal |

(Source: Primary Data, 2024)

The results in the table above use the Shapiro-Wilk normality test. The significance value for the arc shape was 0.000 ($p < 0.05$) while the speed significance value was 0.580 ($p > 0.05$), so from the results of the normality test it was found that the data in this study were not normally distributed. Because the data is not normally distributed, the hypothesis test uses the Spearman correlation test.

Table 5. Spearman correlation test results

| | Strength of correlation | *Significance* |
|---|---|---|
| Arcus pedis shape | 0.691 | 0,000 |
| Speed | | |

(Source: Primary Data, 2024)

From the Spearman test results above, a significance value of 0.000 ($p<0.05$) was obtained, which shows that the correlation between the shape of the arcus pedis and running speed is significant. The Spearman correlation value is 0.691, which indicates that the direction of the correlation is positive with moderate strength.

**Discussion**

The results of this study show that the shape of the arcus pedis is related to running speed in the Anak Buah Markentho running community at Manahan Stadium. The results of the Spearman correlation test obtained a value of $p=0.000$ where $p<0.05$. So it can be concluded that there is a relationship between the shape of the arcus pedis and running speed in the Anak Buah Markentho running community at Manahan Stadium. In general, there are three forms of arcus pedis, namely normal foot, flat foot and cavus foot. The differences in the shape of the arcus pedis can affect the function of the arcus pedis which influences running speed.

In this study, the results showed that respondents who had a normal arch foot shape were in the best category. For respondents, the arcus cavus foot shape was in the below normal category, while those with flat foot arches were in the worst category in terms of the arcus shape itself. Subjects with normal arcus foot shape had the fastest running speed with an average speed of 10.57 seconds. It can be concluded that the more normal the arcus shape, the smaller the second value, which means the run is faster. Meanwhile, the flatter the shape of the arc, the greater the second value or the slower the run.

This is because the normal foot has sufficient arch height. When viewed from the

posterior, the Achilles tendon forms a straight line at a 90-degree angle when the foot touches the ground. A person who has normal feet is able to run efficiently and ergonomically, because the body weight will fall on the lateral side or rare foot and then move to the medial side or mid foot so that the impact can be dampened (Hermawan & Tarsono, 2017). People who have normal arches of the soles of the feet are said to be better because the pressure from body weight is distributed equally across the soles of the feet which makes them more stable (Hammado et al., 2020).

When the foot is in extension, the calcaneus is in a vertical position perpendicular to the metatarsal heads. The metatarsals are parallel to the floor, this can happen because they have the function of supporting the body's weight. The position of the metatarsals with the calcaneus means that the shape of the medial longitudinal arch is controlled by plantar aponeurosis. During the push-off phase, the foot experiences increased pressure from the plantar aponeurosis lifting the medial longitudinal arch by supination of the pedis (Griffin et al., 2012). When running the foot will make a heel strike and step on the runway on the outside of the heel then an inward rotation occurs which functions to reduce the impact when running. It can be concluded that someone who has a normal arcus foot has the fastest speed compared to an arcus cavus foot and flat foot (Devi et al., 2020).

Subjects with cavus foot conditions had an average running speed of 11.4 seconds. Cavus foot is a condition where the arch of the foot looks excessive, characterized by the lateral longitudinal arch not touching the ground when weight is applied by the body. In people who have normal feet the lateral longitudinal arch appears to touch the ground (Hermawan & Tarsono, 2017). In a cavus foot, the back of the foot will appear to experience varus and inversion at the subtalar joint so that there is a weight bearing push that is more to the lateral side.

*The center of pressure* affects foot speed. During the pre-swing phase, the speed of the center of pressure of the cavus foot increases compared to the center of pressure of the flat foot. This shows that the speed of the center of pressure on a cavus foot is higher than on a flat foot. So it can be concluded that when running, people who have an arcus cavus foot shape have higher speed than those who have an arcus flat foot shape (Menz et al., 2018).

Subjects with arcus flat feet had the slowest running speed with an average speed of 12.84 seconds. The shape of the flat foot arch is because the medial longitudinal arch is low and does not even have a curve. Flat feet can occur on one foot or even both feet at once. Flat feet have a special characteristic in the form of hyperpronation of the feet. Weakness that occurs in the plantar flexor muscles in someone who has flat feet can reduce the effectiveness of the push-off ability when walking and running (Hermawan & Tarsono, 2017).

In flat feet, the back of the foot will experience valgus and eversion at the subtalar joint which causes little or no support from the ligaments which causes instability of the foot as a support for the body. This can affect normal movement when walking, resulting in fatigue and pain (Hermawan & Tarsono, 2017).

The musculoskeletal anatomy of the foot works together to support the body during foot strike and push off. This anatomy helps in absorbing impact and preparing to achieve lever rigidity. However, the structure of the arch of the flat foot, which is wide without any arch, can cause the body's lever components to become stiff when walking and running. This causes someone who has an arcus flat foot to experience balance problems when walking, especially running.

Musculoskeletal components in the ankle joint, subtalar joint and midtarsal joint work together to support lever rigidity during foot strike and push off. Muscle movement greatly influences gait parameters including stride length, cycle time, step length, Candance and

speed. Foot movement is influenced by the shape and bones that make up the archus pedis which function to help the foot absorb shock, increase elasticity and flexibility and regulate balance when standing, walking and running.

Based on the research results, it can be concluded that runners who have a normal arcus foot, flat foot and cavus foot have different meanings. The more deviation there is in the arc, the smaller the resulting speed value. The arcus flat foot has poorer speed compared to normal foot and cavus foot. This proves that runners with normal arches can be said to be faster than runners who have flat foot and cavus foot arches. This is in line with research conducted by Iqra 2017 entitled "The Relationship between Foot Arc Height and 100 Meter Sprint Running Speed in the Makassar Indonesian Running Community with Overweight Body Mass Index" which states that runners who have normal foot arches and high foot arches have higher running speed. tall one. This statement is in line with research conducted by (Ismi & Pasaribu, 2023) that people who have a normal arcus are able to exert more strength in holding body weight and carrying out movements.

**Conclusion and Recommendation**

The conclusion of this research is that there is a relationship between the shape of the arcus pedis and running speed. The suggestion in this research is that the subject considers using shoes of the same type or the same type when running.

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