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Original Research Article

Connection of Body Mass Index (BMI) Against Angle Shape Arch Pedis Longitudinal on Students of The Faculty of Medicine, Universitas Wijaya Kusuma Surabaya

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Abstract

Physical growth during adolescence will occur at more than 20% of total height growth, and 50% of bone mass has also been achieved during this period. Body Mass Index (BMI) to control normal body weight is achieved by adjusting body height. BMI can be used to interpret the possibility that the person is at risk of developing risk of weight-related diseases. The human feet are the most important part of supporting our body and can be correlated with body weight. The aim of this research is to determine the relationship between Body Mass Index (BMI) and the shape of the longitudinal arcus pedis angle in medical students in Surabaya. An analytic observational method with a cross-sectional research design was used with a sample size of 53 students. The results of this study conclude that there is a significant relationship between Body Mass Index and the shape of the longitudinal curve of the pedis in students (p-value: 0.009). An increased BMI will cause the pedis angle to widen which will result in the feet becoming flatter, thus affecting the body's balance when standing for a long time. Strong legs are associated with a normal Body Mass Index.

INTRODUCTION

Changes from adolescence to the transition period or development from time from childhood to adulthood or adulthood. Adolescents can no longer be said to be children, however, they cannot yet mature enough to be considered adults. According to World Health Organization Growth and development is divided into three stages, namely early adolescence (11-14 years), middle adolescence

(14-17 years), and late adolescence (17-20 years). Youth in Latin is called adolescence, derived from the word adolescence which means "to grow or grow to reach maturity (Sumara et. al., 2021) (Handayani et al., 2017).

Physical growth will occur in someone who is heading into adolescence. More than 20% of the total growth in height and also 50% of bone mass has been achieved during this period towards adolescence. (Briawan, 2018). There is very rapid physical growth and development during adolescence, specific changes occur in adolescents, namely height gain, changes in body composition, and changes in body systems, this system consists of the circulation and respiratory systems. In addition to increasing height, there is also weight gain that occurs due to increased fat mass, increased muscle mass, and changes in body composition(Batubara, 2016; Damayanti et al., 2017).

BMI or Body Mass Index is a technique for calculating a person's body weight index including in the obese, normal, and thin groups. Measurement of BMI is one of control body weight, so that normal weight is achieved by relating height. BMI is a statistical calculation using estimates applied to individuals that used to interpret that person's likelihood of being at risk for weight-related diseases (Arini & Wijana, 2020). By means of a comparison of body weight (kg) to height (meters) and then squared is the result obtained in the calculation of the Body Mass Index (BMI). This body weight is used as a benchmark indicator to determine the value of a person's health. (Niswatin et al., 2021; Widyastuti & Rosidi, 2018).

The foot is one part of the human body that has a very important role in human activities and daily life. The feet are the most important part to support our body. The structure of the body as a whole will be damaged if the legs as a support for the body are not sturdy (Bachiar, 2012; Wilianto & Algozi., 2010). A good, complete and healthy anatomical structure is needed to support human activity optimally, especially in terms of standing and walking (Saadah, 2019; Sadondang & Komalasari, 2018). The human foot is a part of the human body that has certain uniqueness for each individual and can even be correlated with body weight and support (Rafki et al., 2016; Fira & Parinduri, 2020). As time goes by and the development of an increasingly advanced era there are also many problems faced, one of which is a problem in the health sector. One of the most common health problems is musculoskeletal disorders (Desnita et al., 2020). The World Health Organization (WHO) provides a statement that there are hundreds of millions of people whose lives are disrupted due to musculoskeletal disorders (Ismi & Pasaribu, 2023; Antara et al., 2017). Musculoskeletal disorders that are often found are abnormalities in the feet starting from the shape of the soles of the feet, for example, flat feet or commonly called flat feet (Standring, 2016). In the process of walking with a flat foot where the lever with a flat arch will provide an unbalanced footing. The presence of an abnormal foot arch causes balance when standing and the feet will feel tired quickly if made to walk for a long time, pain in the soles of the feet and wearing shoes on the os calcaneus will cause the surface of the heel to wear out quickly. If flat feet are suffered, it is not only difficult for a person to walk, but also experience problems with body balance (Niswatin et al., 2021). A study conducted in Taiwan found that 8,700 adult individuals aged 30 years and over experienced various problems due to complications in the feet (Roth et al., 2013). This occurs due to abnormalities in the damage to the feet slowly and new complaints will appear when 5-10 years, not all flat feet conditions cause a person to experience balance disorders (Wilianto & Algozi., 2010; Haryoko, 2022). Therefore knowledge about the growth of the arch of the foot is useful for preventing further deformities, early diagnosis, management, and prediction of growth because the activities of adolescents use more of the legs, the feet are the part that functions to support body weight (Matin & Veria, 2013; Antara et al., 2017). If the support is not sturdy, it is not impossible that the body will often fall and eventually damage the body structure (Rafki et al., 2016; Bachtiar, 2013). This study aims to find out whether there is a relationship between Body Mass Index (BMI) and the shape of the longitudinal arch angle of the pedis in students of the Faculty of Medicine, Wijaya Kusuma University, Surabaya, which is useful in providing information as early as

possible about the importance of a balanced foot shape so it can function to prevent the occurrence of abnormalities that can be caused due to the uneven shape of the feet.

MATERIALS AND METHODS

This study used an analytic observational research methodology and used a cross-sectional research design (Notoatmodjo, 2012; Widia, 2017). This research was conducted on class 2021 students at Wijaya Kusuma University, Surabaya, starting in February - July 2022. The sample for this study used a total sample of 53 class B class 2021 students and then collected data by random sampling on both male and female students randomly using time attendance sequence is following an anatomy practicum. The research inclusion criteria were active class B students from class of 2021 who were willing to become respondents, fill out informed consent and have normal feet, meaning there were no defects or injuries to the soles of their feet.

The exclusion criteria in this study were class B students of 2021 who had an abnormal foot shape, meaning that the soles of the feet had wounds or defects and were not willing to take part in this study. The independent variable of this study is the Body Mass Index of the respondents, using body weight measurements to measure the respondent's weight using the Kilogram (Kg) measuring scale and measuring body height using the Meter (m) measuring scale, categories are divided into four, namely category one is called thin if BMI figure less than 18.5, Category two is called normal if the BMI is in the range of 18.5 – 24.9, category 3 is fat category if the BMI is in the range of 25.0 – 29.9; and category four is called obesity if the BMI is in the range of 30.0 or more (Matin & Veria, 2013; Utami et al., 2022; Sugiritama et al, 2015). For the dependent variable, namely the plantar arcus pedis, by measuring two parts, namely the arcus medialis longitudinal and plantar pedis lateralis will form an image of the foot print, which will form staheli's arch index (Standring S., 2016). With the category of high arch (0.1 – 0.4), normal arch (0.5 -0.7) and Low arch (0.8 -1.2)(Dewi, 2021). Then the collected data will be processed using SPPS and the Spearman test scale (with a correlation coefficient value of > 0 - 0.25: very weak correlation; > 0.25 0.5: moderate correlation, > 0.5 - 0.75 : strong correlation, > 0.75 - 0.99 : very strong correlation strong) with a level of significant value (α = 5% or 0.05) (Latief, 2013; Nurfadillah, 2020; Maulina & Al Fadhil, 2018; Pradeka R., 2012).

RESULTS

After carrying out research at Wijaya Kusuma University, Surabaya, Faculty of Medicine, the following results were obtained:

Body Mass Index (BMI)

Based on the data presented in Table 1, it is known that from a total of 53 respondents in this study, the results showed that the value Body Mass Index (BMI) owned by the lowest respondent was 19.53 and the highest score was 35.16. The average value of Body Mass Index (BMI) owned by respondents is 24.5526 with a standard deviation of 4.05934. The standard deviation value which is smaller than the average indicates that the value varies Body Mass Index (BMI) among respondents tends to be small. The category value of BMI is thin if the BMI is less than 18.5 2; Category two is called normal if the BMI is in the range of 18.5 – 24.9 3; 3, fat category if the BMI is in the range of 25.0 – 29.9; 4 and category four is called obesity if the BMI is in the range of 30.0 or more (Antara et al., 2017; Sugiritama et.al., 2015).

Table 1. Body Mass Index (BMI)

Variable	N	Minimum	Maximum	Mean	Std. Deviation
BMI	53	19.53	35.16	24.5526	4.05934

Table2. Category of Body Mass Index

Category	Frequency	Percentage (%)
Thin	0	0
Normal	36	67.9
Fat	11	20.8
Obesity	6	11.3

Based on the data presented in Table. 2, it is known that out of a total of 53 respondents in this study, the results showed that most of the respondents had Body Mass Index (BMI) in the Normal category, namely 67.9%. Then 20.8% of respondents have Body Mass Index (BMI) in the Fat category. The remaining 11.3% of respondents have Body Mass Index (BMI) in the Obesity category.

Angle shape Arch Pedis Longitudinal
Based on the data presented in Table. 3, it is known that from a total of 53 respondents in this study, the results showed that the average value Staheli's Arch Index (A/B) owned by the lowest respondent is 0.37 and the highest value is 1.38. average grade point average Staheli's Arch The index (A/B) of the respondent is 0.8304 with a standard deviation of 0.25536. The standard deviation value that is smaller than the average indicates that the average value varies Staheli's Arch Index (A/B) among respondents tends to be small. Where is the value of staheli's arch index in the category of high arch (0.1 - 0.4), normal arch (0.5 -0.7) and Low arch (0.8 -1.2) (Munawarah et al., 2021; Rosdiana et al., 2022).

Table 3. Mean of Staheli's Arch Index

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Staheli's Arch Index (A/B)	53	0.37	1.38	0.8304	0.25536

Based on the data presented in Table. 4, it is known that out of a total of 53 respondents in this study, the results showed that the majority of respondents had an Arcus Pedis Longitudinal angle in the Low Arch category, namely 56.6%. Then 39.6% of the respondents had an angular shape of the Arcus Pedis Longitudinal in the Normal Arch category (Netter, 2023). The remaining 3.8% of respondents have an angular shape of the Arcus Pedis Longitudinal in the High Arch category. The category of footprints uses staheli's arch index, with high arch (0.1 - 0.4), normal arch (0.5 -0.7), and low arch (0.8 -1.2) (Munawarah et al., 2021; Irawan et al., 2020)

Table 4. Shape Category Arcus Pedis Longitudinal

Category	Frequency	Percentage
High Arch	2	3.8
Normal Arch	21	39.6
Low Arch	30	56.6

The research results obtained were then analyzed statistically using analysis Crosstab and proceed with the Spearman correlation test (Sedgwick, 2014). Analysis Crosstab used in this study to explain the relationship between Body Mass Index (BMI) against the shape of the angle Arch Pedis Longitudinal for Class B UWKS FK Students Batch 2021 using a frequency distribution. Following are the results of the analysis Crosstab.

Table 5. Crosstab Result Between Body Mass Index (BMI) & Arcus Pedis Longitudinalis

Category BMI	Category Arch Index :			Total: N(%)
	High Arch	Normal Arch	Low Arch	
Normal	2 (5.6%)	18 (50%)	16 (44.4 %)	36 (100%)
Fat	0 (0%)	2 (18.2%)	9(81.8%)	11 (100%)
Obesity	0 (0%)	1 (16.7%)	5 (83.3%)	6 (100%)
Total	2 (3.8%)	21 (39.6%)	30 (56.6%)	53(100%)

(N: Respondent)

Based on the results of the Crosstab analysis, it can be seen that the majority of respondents with a Normal BMI category of 16 respondents had an Arch Pedis Longitudinal Normal Arch of 44.4%. Then as many as 9 respondents in the Fat Category had an average low arch pedis of 81.8% and as many as 5 respondents in the Obesity category had a Longitudinal Low Arch Pedis shape of 56.6%. a total of 53 respondents consisting of 30 respondents of 56.6% had a low arch, 21 respondents had a normal arch of 39.6% and 2 respondents had a high arch of 3.8% (Sedgwick, 2014; Latief, 2013).

Spearman correlation analysis is used to determine the relationship between two variables for ordinal scale data. In the Spearman Rho correlation test, two variables are declared to have a significant relationship if the probability value << the significance level (α = 5%). Following are the results of the Spearman rho correlation test in this study. spearman test scale (with a correlation coefficient value of > 0 – 0.25: very weak correlation; > 0.25 ± 0.5 : moderate correlation, > 0.5 – 0.75: strong correlation, > 0.75 – 0.99: very strong correlation) with a significance value < level of significant (α = 5% or 0.05) means that there is a relationship between the two (Ali & Al-Hameed, 2022; Sedgwick, 2014).

Table 6. Correlation result between Body Mass Index (BMI) and Arcus Pedis Longitudinalis

Variable 1	Variable 2	Coefficient	*P value*
Body Mass Index (BMI)	Angle shape*Arch Pedis Longitudinal*	0.357	0.009

Based on Table. 6 it can be seen that the relationship between Body Mass Index (BMI) and the shape of the Longitudinal Pedis Arch angle obtained a coefficient value of 0.357 means > 0.25 0.5 is included in the moderate correlation category with a significance of 0.009, meaning that it has a significance value < level of significant (α = 5% or 0.05) it can be concluded that there is an adequate and significant correlation between Body Mass Index (BMI) and the shape of the Pedis Longitudinal arch angle in Class B FK UWKS Students Batch 2021 (Sedgwick, 2014).

DISCUSSION

Arch Pedis is part of the sole of the foot that is segmented, and has a function as a spring force. Function Arch Pedis on the soles of the feet are as a support for the weight of the body and as a shock absorber when the part of the foot is in contact with the ground. With parts Arch Pedis on the soles of the feet, causing part of the body and body weight to be divided into two equal parts to the front and back of the soles of the feet. With a part of Arch Pedis In this case, a person can move or move quickly by running from one position to another because of its function as a shock absorber when it comes into contact with the ground (Makmun & Pratama, 2021).

The shape of the sole of the foot is measured using the index Stahelli, that is, determines the widest distance from the regio posterior (hindfoot), and the narrowest distance from the central region (midfoot) footprints (Ismi & Pasaribu, 2023). From the results of these measurements, the width of the central region of the foot (A) andheel region (B) on the millimeter scale (mm). Staheli's Plantar Arch Index is calculated by dividing the value of A by B (PAI = A/B (DiGiovanni & Greisberg, 2007). The shape

of the foot based on the Stahelli index is divided into 3 categories, namely high arch (high arch) with a result of 0.1 – 0.4, normal curvature (normal arch) with a yield of 0.5 – 0.7, and a flat curve (low arch) with a yield of 0.8 – 1.2.

The results showed that most of the respondents had an angular shape Arch Pedis Longitudinal in categories Low Arch namely as much as 56.6%. Flat foot/ pes planus is a condition when the arch of the foot is not visible which can be observed with a flat foot shape. Flat feet can be seen when the feet support the weight of the body, in some flat foot shapes can still be seen Arch Longitudinal Medial when the feet are not supporting the weight of the body (Niswatin et al., 2021). The cause of the occurrence flat foot of them is obesity (Netter, 2023). In this study, it is known that 20.8% of respondents have Body Mass Index (BMI) in the fat category and 11.3% of respondents have Body Mass Index (BMI) in the obesity category. This result is also proven by the results Crosstab that most of the respondents with the category of fat and obese BMI have an angular shape Arch Pedis Longitudinal category Low Arch.

Based on the results of Spearman's correlation analysis, it can be concluded that there is an adequate and significant relationship between Body Mass Index (BMI) and the shape of the Longitudinal Pedis Arch angle in Class B FK UWKS Class Students Batch 2021. The coefficient value is positive if it means that Body Mass Index (BMI) increases, followed by an increase in the shape of the Longitudinal Arch Pedis angle. Body weight that tends to increase towards obesity will put excessive pressure on the pedestal of the shape of the Lateral Longitudinal Arch which will widen and the Medial Longitudinal Arch which looks stuck to the ground, this will result in the plantar pedis being flat and will cause the plantar pedis to become weak. balanced, so that the soles of the feet become unstable when standing for a long time become weak and easily hurt. Strong, sturdy feet are affected by balanced body weight and uneven angles of the plantar pedis arc. The results of this study are supported by previous research conducted by Annisha Ramadany & Pasaribu in 2021 which concluded that there was a significant relationship between BMI and the arch index of the feet in UISU FK students (Ramadany & Pasaribu, 2021; Widyastuti & Rosidi, 2018). With the increasing increase in BMI which means an increase in body weight will result in the shape of the pedis longitudinal angle becoming wider and flatter which makes the feet unable to stand for long and tends to affect the balance of the body when the feet stand upright supporting the body, it becomes in people with excess weight until obesity results in legs that are not sturdy.

CONCLUSIONS

There is an adequate and significant correlation between the relationship between Body Mass Index (BMI) and the shape of the longitudinal pedis arch angle in students of the Faculty of Medicine, Wijaya Kusuma University, Surabaya. With an increase in Body Mass Index or an increase in body weight, it will put greater pressure on the pedis longitudinalis arch angle, the lateral longitudinal arch angle becomes wider and the medialis longitudinal angle becomes more elongated which results in the plantar pedis being uneven, the effect on the foot being not sturdy will affect the balance of the body when standing on the feet becomes unable to stand for a long time. So sturdy legs are affected by normal BMI. It is hoped that the results of this study can be used as input to provide related information about Body Mass Index or with normal weight it will affect the shape of the longitudinal pedis arch angle which is useful for maintaining balance in the plantar pedis.

CONFLICT OF INTEREST

All authors declare that there is no conflict of interest in this study

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