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The Relationship Between The Degree Of Arcus Pedis And The Degree Of Vertebral Curve In Children

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ABSTRACT

Background: Spinal health is the most important part of a child's body posture. Age 2-6 years is a period of rapid growth and during this period the vertebral curve will develop rapidly too. The greater the degree of lateral vertebral curve, the more it will result in a posture abnormality called scoliosis. One of the factors that influences body posture abnormalities is the degree of arcus pedis, which normally forms in the first five years of development in children aged 2-6 years. The degree of the vertebral curve can be measured using a scoliometer and the degree of the arcus pedis using the footprint test (Clarke's Angle). This research aims to see whether there is a relationship between the degree of Arcus pedis and the degree of vertebral curve in children 4-6 years old in the Kartasura area. **Methods:** This research is quantitative research with research methods using univariate analysis, data normality and bivariate. The number of respondents was 565, and the method used was purposive sampling with inclusion, exclusion and dropout criteria. **Results:** The results of the correlation test using the Nonparametric Correlation Test with the Spearman Rank Test show that there is no relationship between the degree of the Arcus pedis and the degree of the vertebra with a p-value of 0.228 (p>0.05) and the correlation level is very weak (0.051) and the direction of the relationship is positive or unidirectional. **Conclusion:** There is no relationship between the degree of arcus pedis and the degree of vertebral curve in children aged 4-6 years in the Kartasura area.

Keywords: *Arcus pedis, Vertebral Curve, Posture, Clarke's Angle, Scoliometer*

INTRODUCTION

In the current era, body posture is one of the things that attracts people's attention, so that good posture will increase one's self-confidence (Setiawan et al., 2021). However, in essence, Allah SWT has created the posture of the human body structure in the best possible form, according to the words of Allah SWT in surah At-tin verse 4 which means: "Indeed We (Allah) have created man in the best possible form" (QS 95: 4). It remains only how humans take care of themselves to avoid disease, especially abnormalities in the limbs.

Spinal health is the most important part of a child's posture, where according to Paolucci (2020) young school-age children are very vulnerable to postural abnormalities as they undergo a developmental period that can interfere with normal postural growth, this will cause changes in the shape of the vertebrae which will have an impact on shifting the centre of gravity. At the age of 2-6 years is a period of rapid growth

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and at this time the vertebral curve will develop rapidly as well (Varani, 2022).

The vertebral curve is the curvature of the vertebral bones which normally can only be seen from the side but when viewed from the back of the vertebrae it looks straight, Vertebrae have 4 curves, namely in the cervical area to the anterior, thoracic to the posterior, lumbar to the anterior, and sacrum to the posterior (Yueniwati, 2014). The greater the degree of vertebral curve to the lateral with a curve size greater than 10 degrees will have an impact on postural abnormalities called scoliosis (Sengkey, 2016). According to Peng (2020), About 85% of scoliosis cases are Adolescent Idiopathic Scoliosis (AIS), while the prevalence of AIS in the world is 0.47% to 5.20% while in the general population, it is around 2.5% with a cobb angle> 10 degrees. In Indonesia itself, according to Syabariyah (2022) until now the exact number is unknown, but it can be estimated that the incidence of scoliosis reaches 3%-5%.

One of the factors that influence posture abnormalities is the degree of Arcus pedis, which will affect physical activity (Ismi et al, 2023). Meanwhile, according to Ismi & Pasaribu (2023) Arcus pedis or the arch of the foot is the most important part of the foot that can affect its musculoskeletal and biomechanical structures. This arcus pedis will normally form from the first five years of a child's developmental growth with an age range of 2-6 years (Karandagh et al., 2015). According to Munawarah (2021), the age of 6 years is a critical period for the formation of the arcus, but the arch pedis in some children is not fully developed.

According to its anatomy, the human foot has three parts the Arcus pedis, which include the longitudinal arcus transversalis, longitudinal arcus lateralis, and longitudinal arcus medialis (Munawarah et al., 2021). The shape of the Arcus pedis is generally divided into normal arcus (31°-45°), low arcus (< 31°), and high arcus (> 45°) (Ismi & Pasaribu, 2023). If there is an Arcus pedis abnormality, it will result in a displacement of the human centre of gravity which has an impact on a deformity or shifting of the vertebral curve, this will trigger scoliosis (Romanova et al., 2022). According to Muzafarovna (2022), children who experience scoliosis during their growth period will have a coefficient which shows an increase in the longitudinal arcus pedis.

Therefore, the shift of the vertebral curve to the lateral is a small factor that can be caused by the difference in the degree of abnormal Arcus pedis, where the abnormal arcus is divided into 2, namely low arcus and high arcus, both of which will affect the weight bearing on the plantar which is not balanced. If that happens, it will affect the use of limbs that are not balanced between right and left, this will affect the lifting of the pelvic side. If the pelvic lift is one-sided, it will cause a change in posture where there is a shift in the vertebral curve to the lateral. The explanation is as in Figure 1 below.

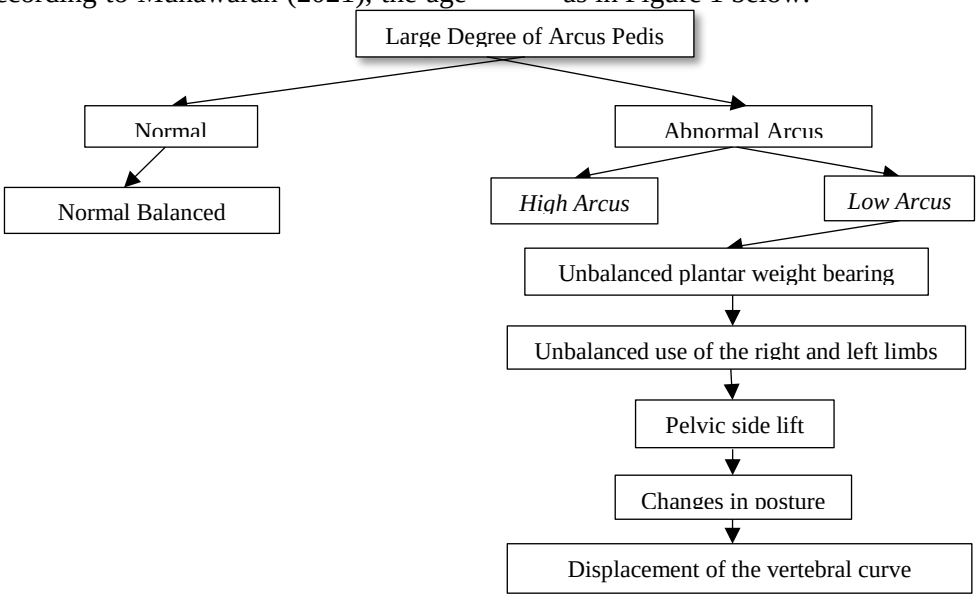

Figure 1. Causes of verterbra curve shifting

Examination of the degree of vertebral curves can be measured using a scoliometer. This is a measuring instrument to measure the angle of rotation of the trunk (Ma et al., 2017). According to Nabila (2020) Measuring using a scoliometer shows a good correlation with radiological measurements. the result of the degree of scoliosis if the result is> 50 and there is a difference in height on the back then it is declared significant (Ma et al., 2017). Examination of the degree of Arcus pedis using the footprint test with measurements using Clarke's Angle. According to Munawarah (2021), Footprint is an effective examination for individual and population studies, which can be carried out using ink media applied to the entire surface of the sole and then walking on paper so that the pedis prints to be measured.

Seeing the many impacts above, it is important to conduct an examination from an early age regarding the degree of vertebral curve and the type of Arcus pedis as further preventive education to parents, so as not to have a more severe impact and as a prevention of scoliosis at a young age. Because parental understanding is very influential in preventing growth and development disorders in children (Rahman et al., 2023). Therefore, researchers are interested in examining the relationship between the degree of Arcus pedis to the degree of vertebral curve in children aged 4-6 years. This is done as an effort to provide understanding for parents, a source of information, and so that parents are more concerned about the development of children's posture in the hope of making an effort to prevent scoliosis at a young age and beyond.

METHODS

Study Design

This study uses a quantitative design with an analytic observational research type and uses a cross-sectional study survey approach. This study consists of independent variables, namely the degree of Arcus pedis which is the arch on the sole which is measured using the Footprint test with Clarke's Angle. The dependent variable is the degree of vertebral curve, seeing the shift of the vertebrae laterally using a scoliometer.

This study took a population of children aged 4-6 years in the Kartasura Region spread across 11 kindergartens, namely Aisyiyah Gonilan Kindergarten, Aisyiyah Ngadirejo II Kindergarten, Aisyiyah Ngadirejo III Kindergarten, Aisyiyah Makam Haji I Kindergarten, Aisyiyah Makam Haji II Kindergarten, Aisyiyah Pabelan Kindergarten, Makarimah Kindergarten, Khoirul Ummah Kindergarten, Aisyiyah Gumpang Kindergarten, Aisyiyah Pucangan I Kindergarten, and Aisyiah Pucangan II Kindergarten. With a total number of 583 children.

The total number of respondents became 565 children because they were taken based on the characteristics of inclusion, exclusion, and drop out criteria. Inclusion criteria are respondents who are willing to be research samples, respondents are healthy children, respondents aged 4-6 years, respondents are children who attend kindergarten in the Kartasura Region, and respondents are able to understand instructions. Exclusion criteria are that the respondent is absent or does not attend the meeting when the research is conducted, and the respondent has physical limitations or disabled children where there are limited problems in the trunk or lower extremities. The drop out criteria are that the respondent has a hypersensitive complaint on the sole of the foot which makes the respondent resign, the results of the footprint carried out by the respondent are not legible because the respondent is not cooperative which makes the data invalid. The existence of this drop out criterion is because during the research the respondent was not cooperative which resulted in the respondent being excluded from inclusion.

Research Instruments

Scoliometer

Examination or measurement of the degree of the vertebral curve can be measured using a scoliometer with the Theratools brand. This is a measuring instrument for measuring the angle of rotation of the trunk, this tool was first promoted by Bunnel in 1984 (Ma et al., 2017). Validity value r=0.7 and interrater reliability r=0.92 interrater reliability r=0.89 (Nabila., 2020) (figure 2).

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Figure 2. Vertebral Curve Degree Measurement using Scoliometer

Footprint test with Clarke's Angle method

Footprints are an effective examination for individual and population studies, which can be carried out using ink media applied to the entire surface of the sole and then walking on paper so that the pedis prints to be measured are visible (Munawarah 2021). Research by Pita-Fernández et al (2015) shows that measurement with Clarke's Angle is an accurate measurement in predicting the type of Arcus pedis where the sensitivity value is 89.9% so this method is suitable for diagnosing the type of Arcus pedis (figure 3).

Figure 3. Arcus Pedis Measurement Using Foot print test with Clarke's Angle

Data Analysis

The data analysis method used in this study is using univariate analysis, data normality, and bivariate. Univariate is used to describe the characteristics of each research variable. Before conducting the relationship test, a normality test was conducted. The relationship test in bivariate uses the Spearman Rank Correlation Test. With the test results seen from the p-value sig. (2 tailed) if <0.05 then there is a relationship. However, if p sig. (2 tailed) >0.05 then there is no relationship between the two variables. This research has had an Ethical Clearance permit or ethical feasibility with Number 066 / KEPK-FIK / XI / 2023.

RESULTS

Respondent Character Test Analysis

Based on the age of respondents of children aged 4-6 years in the kart-asura area there are 565 respondents, the most at the age of 5 years amounting to 246 children (43.5%), while the least at the age of 4 years amounting to 139 children (24.6%). Based on gender, out of a total of 565 children, there were most women with 286 children (50.6%) while men amounted to 279 children (49.4%). Based on the measurement of the right pedicle Arcus, the most number of children is 419 (74.2%) and the left pedicle Arcus is 434 children (76.8%) both of which indicate that the pedicle Arcus at that age is on average low arcus because it is still growing. Based on the Arcus pedis difference value between right and left, the most vulnerable value of 0 °-5 ° amounted to 335 children (59.1%). Based on the scoliometer value, the most was obtained with a value of 1 degree with a total of 198 children (35%) and the lowest at a value of 5 degrees with a total of 11 children (1.9%).

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Table 1. Univariate Analysis of Sample Characteristics

Variable	N	Mean ± Std Dev	Range	Median	Varian	Modus
Right Arcus Pedis	565	21,53 ± 12,499	51	19,39	156,221	10
Left Arcus Pedis	565	21,12 ± 12,419	55	19,46	154,242	10
Arcus Pedis Difference	565	6,92 ± 6,594	33	4,81	43,480	5
Scoliometer Score	565	1,50 ± 1,326	5	1,27	1,758	1

Characteristics	Frequency		Percentage	
Age				
4 years	139		24,6 %	
5 years	246		43,5 %	
6 years	180		31,9 %	
Total	**565**		**100%**	
Gender				
Male	279		49,4%	
Female	286		50,6%	
Total	**565**		**100%**	
Arcus Pedis	**Kanan**	**Kiri**	**Kanan**	**Kiri**
Low arcus	419	434	74,2 %	76,8 %
Normal arcus	130	113	23 %	20 %
High arcus	16	18	2,8 %	3,2 %
Total	**565**	**565**	**100%**	**100%**
Difference between right and left arcus pedis values				
0°-5°	335		59,1 %	
6°-10°	117		20,7%	
11°-15°	53		9,4 %	
16°-20°	34		6,0 %	
21°-25°	19		3,4 %	
26°-30°	6		1,1 %	
31°-35°	2		0,4 %	
Total	**565**		**100%**	
Scoliometer Score				
0º	143		25,3 %	
1º	198		35 %	
2º	97		17,2 %	
3º	66		11,7 %	
4º	50		8,8 %	
5º	11		1,9 %	
Total	**565**		**100%**	

Data Normality Test Analysis

The data normality test carried out in this study was the Kolmogorov-Smirnov Test because the sample collected was > 50 people.

Based on the calculation of the Kolmogorov-Smirnov test, it was found that the p-value <0.05 on both variables with a value of <0.001, which means that it is not normally distributed (table 1).

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Table 2. Data Normality test results

Variable	ρ-value	α =0,05	Description
Scoliometer Score	< 0,001	0,05	Abnormal
Arcus Pedis Difference	< 0,001	0,05	Abnormal

Non-normal data is also seen from the standard deficiency value where the greater the standard deficiency value indicates the distribution of data is not uniform. Judging from the average value of the arcus pedis difference value of 6.92 with a Standard Deviation value of 6.594, it shows that the standard deviation is close to the average value which will produce abnormal data. Likewise, the average value of the scoliometer value of 1.50 with a Standard Deviation value of 1.326 shows that the standard deviation is close to the average value which will produce abnormal data (table 2).

Correlation Test Analysis

The correlation test in this study used the Nonparametric Correlation Test with the Spearman Rank Test because the normality test was not normal.

Based on the statistical test above, the p-value is 0.228 (p>0.05). This shows that there is no relationship between the degree of Arcus pedis to the vertebral curve in children aged 4-6 years in the kart-asura area with a relationship strength level of 0.051 which means the correlation level is very weak and the direction of the relationship is positive or unidirectional. So it can be said that Ho is accepted and Ha is rejected (table 3).

Table 3. Correlation Test Results

			Scoliometer Score	**Arcus Pedis Difference**
Spearman's rho	**Scoliometer Score**	*Correlation Coefficient*	1.000	0.051
		Sig. (2-tailed)	.	0.228
		N	565	565
	Arcus Pedis Difference	*Correlation Coefficient*	0.051	1.000
		Sig. (2-tailed)	0.228	.
		N	565	565

DISCUSSION

Characteristics of Respondents Based on Arcus Pedis

Judging from the results of measuring the degree of arcus pedis, around 74.2% of children still have low arcus on the right foot as well as the arcus pedis on the left with a presentation of 76.8% of children still having low arcus. This is normal among his age because according to Munawarah (2021), the critical period for the formation of the arcus pedis is at the age of 6 years, but indeed the arch of the pedis in some children is not fully developed due to the occurrence of valgus in the calcaneus, as well as the abduction of the front of the pedis and the collapse of the longitudinal arcus. The Arcus pedis development period is also discussed in Karandagh's research (2015) which explains that children at the age of the first five years are still in the process of forming the Arcus pedis precisely at the age of 2-6 years. So the Arcus pedis in this study cannot be used as a reference or causative factor of changes in vertebral curves or postural abnormalities in children 4-6 years.

Characteristics of Respondents Based on Vertebral Curve (Scoliosis)

From the results of measuring the vertebral curve using a scoliometer, it was found that in children aged 4-6 years or in scoliosis included in the Juvenile type with 565 respondents, only 11 respondents had a measurement value of 5 degrees or only 1.9% of respondents experienced a shift in the vertebral curve. These measurements are in line with previous research by Baswara (2019) which states that of the 62 students suspected of having scoliosis, most were from the adolescent age range (>10 years) totalling 39 students (81.3%) while the juvenile age range (4-9 years) only about 23 students (18.7%). This is reinforced according to Peng (2020) About 85% of scoliosis cases are Adolescent Idiopathic Scoliosis (AIS) where the population at risk of scoliosis is at the age of 10-15 years. In other words, increasing age will have a major effect on increasing the degree of vertebral curve towards scoliosis. According to the results of the Decree of the Minister of Health of the Republic of Indonesia (2021), it is stated that adolescents in the peak of puberty often progress the angle of the vertebral curve. So in this study, the shift in the vertebral curve of children aged 4-6 years cannot be used as a reference because it is of low value.

Relationship between Arcus pedis degree and vertebral curve (Scoliosis)

The results of data processing of the degree of Arcus pedis on the vertebral curve of children aged 4-6 years based on the results of the Spearman Rank Test showed no relationship. This is by research conducted by Zaharieva (2014) where her research states that there is no direct correlation between flat feet and postural abnormalities. This is also reinforced by research conducted by Paolucci (2020) which states that the posture of 6-year-old children during growth is not affected by flat feet. According to the results of the Decree of the Indonesian Minister of Health (2021), the aetiology of scoliosis is multifactorial and the main cause is not fully known. The causative factor for this shift in the vertebral curve is still a conjecture such as the influence of genetic factors, aspects of growth disorders, changes in the biomechanical structure of discs and back muscles, changes in the central nervous system, or lifestyle (Syabariyah et al., 2022). In addition, other factors that affect children's posture can be due to the use of the wrong backpack, various types of movement behaviour, physical activity and sports (Naufal et al., 2022).

CONCLUSIONS

From the research that has been done, it can be concluded that there is no relationship between the degree of Arcus pedis to the degree of vertebral curve in children aged 4-6 years in the kart-asura area with a p-value = 0.228. The hypothesis result Ho is accepted and Ha is rejected. Based on this, the researcher realizes that there are still limitations to the study where this study only measures the arcus pedis and vertebral curve and does not measure other parts, it is difficult for researchers to see other factors related to variables, plus there are not many previous researchers whose discussions are the same as this study.

ADVICE

Future research is expected to discuss more deeply the relationship of the Arcus pedis and other factors to the degree of vertebral curves so that everyone, especially parents, can make this a source of prevention in the form of education or early evaluation of vertebral curves and scoliosis.

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