Fisiomu.2024,Vol 5(2): 154-161
DOI: https://10.23917/fisiomu.v5i2.2107

The Relationship Between Leg Length Discrepancy and Scoliosis in Children Aged 4-6 Years

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Submition : 2023-07-07; Accepted : 2024-05-29; Published : 2024-06-01

ABSTRACT

Background: Scoliosis is defined as the lateral curvature of the spine reaching an angle of 10 degrees or more on coronal radiographs when an individual is standing. According to data from the World Health Organization (WHO), around 3% of the global population is at risk of experiencing scoliosis, while in Indonesia, the prevalence of scoliosis ranges between 3% and 5%. Leg length discrepancy is a situation where the length of both lower extremities is unbalanced. Leg length discrepancy can lead to various issues in body posture, such as scoliosis. **Objective:** This study aims to investigate the relationship between scoliosis and leg length discrepancy in children aged 4-6 years. The degree of scoliosis was measured using a scoliometer, and leg length examination was conducted using a measuring tape. **Method:** This study is a quantitative research with a cross-sectional research design. The sample size was 567, selected through purposive sampling based on inclusion, exclusion, and dropout criteria. **Research Results:** The results, obtained using the Nonparametric Correlation Test with the Spearman Rank Test, indicate the absence of a relationship between leg length discrepancy and scoliosis, with a p-value of 0.189 (p>0.05) and a correlation strength level of 0.055, meaning the correlation is very weak, and the direction of the relationship is positive or in the same direction. **Conclusion:** There is no relationship between leg length discrepancy and scoliosis in children aged 4-6 years.

***Keywords**:* Leg Length Discrepancy, Scoliosis, Scoliometer, Metline

ISSN 2722 – 9610
E –ISSN 2722 - 9629

INTRODUCTION

In life, Allah SWT has created humans in the most perfect form, as mentioned in the Quran, "Indeed, We have created man in the best of stature." QS. At-Tin Ayat 4

Children are a gift from the Almighty and as future heirs of the nation, they have many potentials that need to be optimized. Therefore, ensuring that children receive high-quality education from an early age is crucial to ensure that they reach their full potential (Siregar & Lis, 2017). Kindergarten (TK) is one part of the formal education system that focuses on young children who are ready to continue their education to the Elementary School (SD) level. TK has been integrated into the Early Childhood Education (PAUD) system as part of the formal pathway, with two different age groups, Group A for children aged 4-5 years and Group B for children aged 5-6 years (Watini, 2020). This child education is essentially an organized form of teaching to provide comprehensive support for children's growth and development. Its main focus is on developing all aspects of a child's personality and potential optimally (Salsabila & Nurmaniah, 2021).

Along with their physical development, some children face challenges that can affect their body shape, one of which is a medical condition known as scoliosis. Scoliosis is defined as a lateral curvature of the spine that

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reaches an angle of 10 degrees or more on coronal radiographs when the individual is standing (Naufal et al., 2023). This condition in young children refers to abnormal curvature in the spine that occurs before the child reaches the age of 10, which can be caused by various factors (Pristianto et al., 2023). This is a serious concern, especially when scoliosis occurs in children, who are in a very important growth stage in their lives.

According to information from The National Scoliosis Foundation in the United States, scoliosis is found in about 2% to 3% of the general population, and most of those who have scoliosis are female. According to data from the World Health Organization (WHO), about 3% of the global population is at risk of having scoliosis, while in Indonesia, the prevalence rate of scoliosis ranges from 3% to 5%. Nugroho (2021) revealed that scoliosis in children aged 10-12 years ranges from 0.5-3%. Based on findings from a study conducted in primary schools in Johannesburg, it was revealed that in private schools, there was an incidence rate of potential scoliosis of 2.5%, while in public schools, it was only about 0.5% (Parera et al., 2016). Idiopathic scoliosis in Surabaya occurs in about 2.93% of individuals, with a male-to-female ratio of about 1:4.7, especially occurring in the age group of 9-16 years (Komang-Agung et al., 2017).

Scoliosis can be congenital, and arise due to abnormalities in the spine or ribs, problems in the overall body system, neuromuscular problems, or idiopathic (Winata, 2014). In idiopathic scoliosis, there are four groups based on age range: infantile (0-3 years), juvenile (4-9 years), adolescent (10 years until growth stops), and adult (>19 years). Juvenile Idiopathic Scoliosis (JIS) is observed in 8% to 21% of all types of idiopathic scoliosis cases. The male-to-female ratio of JIS varies throughout the age of manifestation and ranges from 1:1.6 to 1:4.4 (Babaee et al., 2020). The natural history of juvenile idiopathic scoliosis usually progresses slowly to moderately. Because these curves occur at a very young age, the risk of severe deformity is higher for these patients than for patients with adolescent idiopathic scoliosis (Min Seok Kang et al., 2016).

Scoliosis diagnosis is established if there is a curvature of the spine of more than 10 degrees, which affects about 2-3% of children and is most common in teenagers, with 90% of cases in females. Scoliosis can be divided based on the Cobb angle into three levels: mild (10-25 degrees), moderate (25-40 degrees), and severe (>40 degrees), each with different characteristics. Mild scoliosis is characterized by an imbalance in neck, shoulder, and waist height, as well as disrupted symmetry in clothing. In moderate scoliosis, one shoulder may protrude more than the other, often accompanied by a rib hump and fatigue after physical activity. Severe scoliosis can cause easy fatigue, especially when sitting or standing for long periods and sometimes accompanied by coughing and shortness of breath (Razan & Wijianto, 2021).

Clinical presentation of scoliosis includes deviation from the normal appearance of the spine, resulting in a curved shape that appears to descend from the shoulders to the buttocks. Other observable characteristics include protrusion of the ribs on the convex side, uneven height of the iliac crest, which can result in one leg being longer than the other, asymmetrical chest cavities, and misalignment of the spine that becomes apparent when bending over (Rachmat & Fauzi, 2019).

Leg length discrepancy is a condition in which the lengths of both lower extremities are imbalanced (Applebaum et al., 2021). Leg length discrepancy can lead to various problems in body posture (Mahendrakrisna, 2019). This issue can be measured by placing a measuring tape between two points, namely the anterior superior iliac spine (ASIS) and the medial malleolus in the lying position (Khamis & Carmeli, 2017). In a study conducted by Sekiya et al. (2018), it was found that in individuals with idiopathic scoliosis, there is a functional leg length discrepancy that correlates or is associated with the Cobb angle in the lumbar.

Leg length discrepancy is a common condition and can lead to scoliosis, with severity

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occurring if the leg length discrepancy reaches ≥30 mm (Kobayashi et al., 2020). Previous research consistently highlights measurement methods using radiography to determine the correlation between leg length discrepancy and scoliosis. Additionally, previous research was conducted on ages 10 and up, while research starting from age 5 also used radiographic measurements and a sample size of only 23 children. In this study, to determine the correlation between the two using screening methods, namely with a scoliometer for scoliosis and metline to measure leg length, with 567 children aged 4-6 years as respondents.

Therefore, one of the factors contributing to scoliosis is leg length discrepancy, which can manifest through protrusions on one hip or asymmetry in the height of the iliac crest, which then results in deformities in the spine. The causes of scoliosis can vary, such as trauma or unknown origin. Structural factors can be caused by intrinsic spinal shape abnormalities, while non-structural factors can arise from improper body posture or muscle tension that leads to scoliosis development.

METHODS

Study Design

This research applies an analytical observational quantitative approach with a cross-sectional method. In the cross-sectional approach, measurements or observations of independent and dependent variables are conducted only once at a particular time simultaneously. This study has been approved by the Research Ethics Committee of the Faculty of Health Sciences, Muhammadiyah University of Surakarta, with the number 066/KEPK-FIK/XI/2023.

Study Variables

The difference in leg length is the independent variable and scoliosis in children aged 4-6 years is the dependent variable on that variable. The population in this study consists of children distributed in the Kartasura District with samples taken from 11 kindergartens, namely TK Aisyiyah Makam Haji 1, Makam Haji 2, Gonilan, Pabelan, Ngadirejo 2, Ngadirejo 3, Gumpang, Khoirul Ummah, Makarimah, Pucangan 1, and Pucangan 2. With a total of 582, and respondents numbering 567 samples due to dropouts. The dropout criteria are due to respondents having hypersensitivity in the ASIS area and fear during measurement, making them uncooperative and resulting in invalid data. Therefore, these dropout criteria are due to respondents being uncooperative during the study, leading to their exclusion from inclusion.

Research Instruments

Leg Length Discrepancy

The leg length discrepancy is measured using the Medline method, which is considered a valid and reliable tool for measuring leg length discrepancy (LLD) in individuals with normal and healthy body weight (Farahmand et al., 2019). This measurement is performed by placing the midline between the anterior superior iliac spine (ASIS) and medial malleolus in a supine position (Khamis & Carmeli, 2017).

Scoliosis

Examinations that can be performed to determine the degree of spinal curvature in scoliosis can utilize a kilometre, with the Theratools brand being an example. A kilometre is a tool used to assess the angle of trunk rotation, with a validity value of r=0.7 and interrater reliability of r=0.92, while interrater reliability is r=0.89, indicating a good relationship (Coelho et al., 2013).

Data Analysis

The method of data analysis involves normality testing and correlation analysis. Normality testing is conducted using the Kolmogorov-Smirnov Test, chosen because the number of respondents is more than 50, thus meeting the criteria for its use. Data is considered normally distributed if the significance value is greater than 0.05. There is said to be a relationship between two variables if ($p>0.05$). If the normality test results indicate non-normal data, then the Spearman Rank Test is used. There is said to be a relationship between two variables if ($p<0.05$)

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RESULTS
Descriptive Statistical Test

Gender	Frequency	Percentage (%)
Male	276	48,7%
Female	291	51,3%
Total	**567**	**100%**

Age	Frequency	Percentage (%)
4	136	24%
5	249	43,9%
6	182	32,1%
Total	**567**	**100%**

Variable	Range	Mean ± STDEV
Scoliosis	0-8	1,57±1,320
Leg Length Discrepancy	0-3	0,7±0,826

Scoliosis			Leg Length Discrepancy		
Value	**Frequency**	**Percentage**	**Value**	**Frequency**	**Percentage**
0-0,9	147	26%	0	274	48,3%
1-1,9	195	34,3%	1	215	37,9%
2-2,9	100	17,6%	2	50	8,8%
3-3,9	63	11,1%	3	28	5%
4-4,9	51	9%			
5-5,9	9	1,6%			
6-6,9	1	0,2%			
7-7,9	0	0%			
8	1	0,2%			
Total	**567**	**100%**		**567**	**100%**

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Based on the research results, the total number of respondents was 567, consisting of 276 boys (48.7%) and 291 girls (51.3%), with an age range between 4 and 6 years. Then, in terms of age percentage, it can be observed that the age of 5 years had the highest percentage, with 249 children (43.9%), this is because during the research, the respondents' average age was 5 years. Out of 567 respondents, it was found that the Scoliosis Range had a value of 8, with a minimum value (Min) of 0, a maximum value (Max) of 8, and a mean value (Mean) of 1.57, and a Standard Deviation (Std. Deviation) of 1.320. Meanwhile, the leg length discrepancy had a Range of 3, with a minimum value of 0, a maximum value of 3, a mean value of 0.7, and a Standard Deviation of 0.826. Based on the number of respondents studied, there were children with scoliosis curvature ranging from 0-8° and leg length discrepancies ranging from 0-3cm. For scoliosis itself, within the range of 0-0.9° there were 147 children (26%), 1-1.9° there were 195 children (34.3%), 2-2.9° there were 100 children (17.6%), 3-3.9° there were 63 children (11.1%), 4-4.9° there were 51 children (9%), 5-5.9° there were 9 children (1.6%), 6-6.9° there was 1 child (0.2%), 7-7.9° there were 0 children (0%), and 8° there was 1 child (0.2%). Meanwhile, for leg length discrepancies, with a value of 0 cm, there were 274 children (48.3%), 1 cm there were 215 children (37.9%), 2 cm there were 50 children (8.8%), and 3 cm there were 28 children (5%).

Normality Test Analysis

The normality test used in this examination is the Kolmogorov-Smirnov test because the sample taken is >50 individuals.

Table 3.2 Results of the Kolmogorov-Smirnov Normality Test

Variable	Sig. (2-tailed)	Description
Scoliosis	0,000	Abnormal
Leg Length Discrepancy	0,000	Abnormal

Based on the calculations from the Kolmogorov-Smirnov Test, both variables have a significance value (Sig.) of 0.000, indicating that the data is not normally distributed because the significance value is less than 0.05. The data's non-normality occurs because the Standard Deviation is below the mean value and close to the mean, which can be interpreted as having values that are less varied or closer to the average value as shown in Table 3.1.

Correlation Test

In this test, the correlation test used is Spearman's Rank because the result of the normality test is not normally distributed. To determine the results of the correlation test between the two variables, the level of correlation strength and significance criteria are examined.

Table 3.3 Results of Spearman Rank Test

			Scoliosis	Leg Length Discrepancy
Spearman's rho	**Scoliosis**	*Correlation Coefficient*	1.000	0.055
		Sig. (2-tailed)	.	0.189
		N	567	567
	Leg Length Discrepancy	*Correlation Coefficient*	0.055	1.000
		Sig. (2-tailed)	0.187	.
		N	567	565

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DOI: https://10.23917/fisiomu.v5i2.2107

Based on the correlation test above, the result obtained is a p-value of 0.189 (p>0.05). This indicates that there is no relationship because the correlation between variables is not significant.

DISCUSSION

Discussion of Respondents Based on Leg Length Discrepancy

From the leg length measurements, it can be seen that on average, there is a difference with a value of 0, totalling 274 children or 48.3%. Meanwhile, for the highest leg length discrepancy, it was found to be 3, with a total of 28 children or 5%.

Discussion of Respondents Based on Scoliosis

From the results of scoliosis measurements using a scoliometer, it was found that among children aged 4-6 years, who fall into the Juvenile category, out of a total of 567 respondents, 11 respondents had measurements with values greater than or equal to 5 degrees, or about 2% of the respondents suspected of having scoliosis. Syabariyah et al. (2022) revealed that the group at risk of scoliosis is in the age range of 10-15 years and it is recommended that screening examinations be conducted for girls aged 10-12 years and for boys aged 13-14 years. Thus, the curvature of scoliosis can increase with age, especially during the growth period (Syabariyah et al., 2022). Scoliosis can be observed from physical conditions such as one shoulder being higher, one scapula protruding, and hips being more prominent (Nadhir & Norlinta, 2022). The development of scoliosis can also be caused by leg length discrepancies affecting pelvic tilt in the frontal plane, leading to structural scoliosis (Sekiya et al., 2018). The factors that can worsen scoliosis in children include growth stage, gender, spinal problems since birth, location, and age.

The Relationship Between Leg Length Discrepancy and Scoliosis

Leg length discrepancy about scoliosis in children aged 4-6 years, based on the results of the Spearman Rank test, yielded a result of ρ-value = 0.189. Thus, H0 is accepted and Ha is rejected, indicating no relationship. Spinal deformities resulting in scoliosis occur during the adolescent growth spurt. Growth spurts that occur in juveniles and incorrect sitting posture habits also affect spinal abnormalities. During this period, high growth rates have side effects on bone strength, making bones more prone to abnormalities. This becomes a factor in the occurrence of spinal deformities besides leg length discrepancies. In a study conducted by Buyukaslan et al. (2022), the relationship between scoliosis test results with a scoliometer was strongly associated with leg length discrepancies measured using a midline in 47 scoliosis respondents with an average LLD age of 10-18 years. However, this study is consistent with the results of research conducted by Pinto et al. (2019), which stated that small LLDs <1cm have no significant correlation with scoliosis curvature with a p-value of 0.052 (p>0.05).

CONCLUSIONS

The conclusion is that there is no relationship between leg length discrepancy and scoliosis in children aged 4-6 years. The next research is expected to further investigate the relationship between leg length discrepancy and factors such as activity patterns, especially when sitting in improper positions, such as tilting and lifting heavy loads, which can cause partial nerve weakening. If these habits persist, the nerves can even suffer fatal damage. Consequently, an imbalance in the pulling forces on the spinal segment can occur, leading to scoliosis, making it important to pay attention to this so that parents can use it as a source for prevention through early education or evaluation of issues related to children's posture.

ACKNOWLEDGMENTS

The Physiotherapy Study Program at Universitas Muhammadiyah Surakarta has provided wellness and sports laboratory facilities throughout the course of this research. Additionally, our gratitude goes to the Research and Innovation Institute (LRI) UMS for funding this research from beginning to end. We also extend our thanks to the research respondents who were willing to participate in the study until the final evaluation. We are grateful to the editor who participated in the overall editing process, ensuring compliance with all guidelines,

conducting plagiarism checks, and evaluating the quality of the article. All authors have read and approved the final manuscript.

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