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The Relationship of Bag Load to Changes Vertebra Curves in Students (Study on Students Age 9-12 Years at SDIT Al Ikhlas, Magetan)

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ABSTRACT

In children aged 9-12, reduced bone density, length of schooling, duration of daily bag use and bag weight exceeding the recommended weight of 10-15% of body weight can affect changes in the vertebral curve either into kyphosis, lordosis or scoliosis. The purpose of this study was to determine the relationship between bag load and changes in the vertebral curve as measured by the plumb line and scoliometer. The load of the bag is seen from 2 things, namely the weight of the bag and the duration of use of the bag. The research method used a cross sectional study with a sample of 207 school children aged 9-12 years using 2 analytical tests. The results of the Kendall's tau-b analysis test showed p-value = 0.773 and 0.262 (>0.005) which showed that there was no relationship between the weight and duration of bag use and changes in the vertebral curve. The results of the Spearman Rho test analysis showed p-value = 0.448 and 0.407 (> 0.005) which showed no relationship between weight and duration of bag use with the degree of change in the vertebral curve (Angle of Trunk Rotation/ATR).

INTRODUCTION

School-age children as the first generation who play an important role in the future in nation-building, naturally have strong, well-built and healthy bodies from an early age. It is during this period of growth and development that the body's posture/straight posture is formed to the fullest. Causes of postural disorders include physical activity, habits, types of movement behavior, incorrect use of backpacks and sports as well as genetic factors that affect a child's posture (Naufal & Wahyuni, 2022). The habit of carrying this load 5 days a week throughout the school year can affect the condition of the backs of school children (Rai *et al*., 2013).

Back conditions due to the use of heavy backpacks can also damage the natural curve in the back, causing muscle tension and irritation of the ribs or joints of the spine. Most of these problems are caused by bad habits that start at a young age, including the habit of carrying a backpack that exceeds the recommended

capacity (Rai *et al*., 2013). The recommended ideal bag weight for children according to the American Chiropractic Association is at least 10%-15% of the child's body weight (Dumondor *et al*., 2015). The backpack should not weigh more than 15% of the child's total body weight. If left unchecked for years, this habituation causes vertebral deformities such as lordosis, kyphosis and scoliosis.

As quoted from Fitriyani *et al*. (2016) , scoliosis is a disorder caused by an abnormal lateral curvature of the vertebrae that occurs in one or more parts of the vertebrae. It is estimated that 4% of all children aged between 10-14 years suffer from 40-60% scoliosis, the majority is found in girls. Scoliosis with unknown causes (idiopathic) in Surabaya, shows that 2.93% of children with scoliosis show a male and female ratio of 1:4.7 in the age range of 9-16 years (Komang-Agung *et al*., 2017).

As per statement Wahyuddin & Anggita (2022), vertebral deviation in scoliosis occurs in three planes of motion, the form is in the form of lateral deviation, rotation, and also changes in the curve in the sagittal plane either in the form of a decrease in the kyphosis curve in the thoracic al and or the lordosis curve in the lumbar. Apart from causing an crooked posture, loading on the back can cause back pain and a feeling of fatigue in the spine in people with scoliosis (Fitriyani *et al*., 2016) . There is a decrease in quality of life and disability, lung problems, functional barriers, psychological disorders and the occurrence of progression as adults can become problems that arise as a result of scoliosis later in life (Nabila, 2020).

Vertebral curve abnormalities can be known by examining the scoliometer and plumb line. Plumb line is a tool for detecting the shape of a C or S scoliosis curve, by using a pendulum (pendulum) tied to a long string positioned on the midline of the body, useful to provide an overview of the vertical line of the body against the force of gravity in the sagittal plane (Białek, 2015) . Scoliometer is a tool to measure the degree of vertebral curve in scoliosis. Measurement of the asymmetrical pattern on the sides of the trunk seen from the degree of axial rotation by calculating the trunk rotation angle or Angle of Trunk Rotation/ATR (Coelho *et al*., 2013).

The study that was conducted by Dumondor *et al*. (2015) by conducting an adam forward bending test on 30 grade VIII students of SMP Negeri 2 Tombatu, it was concluded that there was no

relationship between the use of backpacks and vertebral abnormalities. While the study conducted by Dewi & Widyastuti (2016) of 282 students of SMPN 7 Denpasar class VII and VIII using a checklist The Adam Forward Bending Test concluded that there is an effect between changing body posture and wearing a bag. The two studies above have similarities in research objectives, the population used and the instruments used but have different numbers of samples used so that the conclusions obtained are also different.

The study conducted by Soesanti *et al.* (2013) concluded that there is a high prevalence of vitamin D deficiency in healthy children aged 7-12 years in Indonesia where girls have an increased risk compared to boys. Deficiency of vitamin D causes calcium absorption to be disrupted, which adversely affects bone density. Reduced bone density, length of schooling, duration of daily use of bags and the weight of bags carried by children in grades 4-6 are the basis for the authors to take samples of children aged 9-12 years.

In accordance with the information above, the author intends to learn more about the relationship between bag loads on changes in vertebral curves in school children aged 9-12 years. The load of the bag can be seen from the weight and duration of wearing the bag, while changes in the vertebral curve are seen from 2 areas of the body, namely the sagittal plane (left-sided) and the frontal plane (anterior - posterior) examined using a plumb line and measuring the degree of vertebral curve to determine the atr value with a scoliometer.

METHODS AND MATERIALS

This research was reviewed by the Research Ethics Committee for Hospital Tk II 04.05.01 dr. Soedjono with number 088/EC/XI/2022 and was declared ethically fit with an observational research design and a cross-sectional study approach. Activity begins with the collection of data including class schedules, types of bags, bag weight, duration and how to use the bag, the results of examination of vertebral curve abnormalities with a plumb line and the results of measuring the degree of vertebral curve with a scoliometer. The plumb line examination has a test-retest reliability value of r=0.98 and high inter-trial reliability r=0.99 and a validity value of r=79-83 while the scoliometer shows an intrarater reliability value of r=92 and an interrater reliability r=0.89 with a validity value of r=0.7.

The sample in this study were students aged 9-12 years who attended

SDIT Al Ikhlas. The research sample used probability sampling with the sampling technique that used quota sampling. Samples that met the inclusion criteria were 207 children, 112 boys and 95 girls, with the inclusion criteria include, a) student aged 9-12 years, b) total weight of bag used > 3 kg, c) total duration of bag usage >15 minutes (1/4 hour) and d) willing to be a respondent. The exclusion criteria were that the child had experienced a back injury or suffered from scoliosis since birth.

RESULTS AND DISCUSSION

Results

Table 1. Characteristics of Respondents Based on Spinal Abnormalities

Variable	Category	Spinal Deformities									
		Normal		Kyphosis		Lordosis		Scoliosis		Total	
		N	%	n	%	N	%	n	%	N	%
Age	9 years	17	8.2	3	1.4	4	1.9	7	3.4	31	15.0
	10 years	43	20.8	7	3.4	9	4.3	13	6.3	72	34.8
	11 years old	49	23.7	2	1.0	7	3.4	13	6.3	71	34.3
	12 years old	18	8.7	1	0.5	3	1.4	11	5.3	33	15.9
	Total	127	61.4	13	6.3	23	11.1	44	21.3	207	100.0
Gender	Man	87	42.0	2	1.0	9	4.3	14	6.8	112	54.1
	Woman	40	19.3	11	5.3	14	6.8	30	14.5	95	45.9
	Total	127	61.4	13	6.3	23	11.1	44	21.3	207	100.0
Weight	<30 kgs	41	19.8	5	2.4	9	4.3	14	6.8	69	33.3
	31-40 kg	36	17.4	5	2.4	11	5.3	19	9.2	71	34.3
	41-50Kg	22	10.6	2	1.0	2	1.0	6	2.9	32	15.5
	51-60kg	21	10.1	1	0.5	1	0.5	4	1.9	27	13.0
	>60 kgs	7	3.4	0	0.0	0	0.0	1	0.5	8	3.9
	Total	127	61.4	13	6.3	23	11.1	44	21.3	207	100.0
Height	<130	20	9.7	0	0.0	5	2.4	1	0.5	26	12.6
	131-140	45	21.7	7	3.4	10	4.8	22	10.6	84	40.6
	141-150	43	20.8	6	2.9	7	3.4	14	6.8	70	33.8
	>151	19	9.2	0	0.0	1	0.5	7	3.4	27	13.0
	Total	127	61.4	13	6.3	23	11.1	44	21.3	207	100.0
BMI	<18.5	64	30.9	7	3.4	17	8.2	30	14.5	118	57.0
	18.5-22.9	30	14.5	5	2.4	4	1.9	9	4.3	48	23.2
	23-24,9	15	7.2	0	0.0	1	0.5	2	1.0	18	8.7
	25-29.9	15	7.2	1	0.5	1	0.5	3	1.4	20	9.7
	>30	3	1.4	0	0.0	0	0.0	0	0.0	3	1.4
	Total	127	61.4	13	6.3	23	11.1	44	21.3	207	100.0
Total Bag Weight	3-3.9 kgs	105	50.7	13	6.3	20	9.7	35	16.9	173	83.6
	4-4.9 kg	17	8.2	0	0.0	2	1.0	7	3.4	26	12.6

	>5 kgs	5	2.4	0	0.0	1	0.5	2	1.0	8	3.9
	Total	127	61.4	13	6.3	23	11.1	44	21.3	207	100.0
Bag Usage Duration	<20 min	29	14.0	3	1.4	6	2.9	16	7.7	54	26.1
	21-40 min	63	30.4	7	3.4	13	6.3	18	8.7	101	48.8
	>40 min	35	16.9	3	1.4	4	1.9	10	4.8	52	25.1
	Total	127	61.4	13	6.3	23	11.1	44	21.3	207	100.0

Table 2. Characteristics of Respondents Based on Angle of Trunk Rotation (ATR)

Variable	Category	Angle of Trunk Rotation (ATR) Value							
		< 5 °		5 ° -9 °		≥ 10°		Total	
		n	%	n	%	N	%	n	%
Age	9 years	30	14.5	1	0.5	0	0.0	31	15.0
	10 years	64	30.9	8	3.9	0	0.0	72	34.8
	11 years old	59	28.5	12	5.8	0	0.0	71	34.3
	12 years old	25	12.1	7	3.4	1	0.5	33	15.9
	Total	178	86.0	28	13.5	1	0.5	207	100.0
Gender	Man	95	45.9	17	8.2	0	0.0	112	54.1
	Woman	83	40.1	11	5.3	1	0.5	95	45.9
	Total	178	86.0	28	13.5	1	0.5	207	100.0
Weight	<30 kgs	65	31.4	4	1.9	0	0.0	69	33.3
	31-40 kg	58	28.0	13	6.3	0	0.0	71	34.3
	41-50Kg	29	14.0	3	1.4	0	0.0	32	15.5
	51-60kg	22	10.6	5	2.4	0	0.0	27	13.0
	>60 kgs	4	1.9	3	1.4	1	0.5	8	3.9
	Total	178	86.0	28	13.5	1	0.5	207	100.0
Height	<130	26	12.6	8	3.9	0	0.0	34	16.4
	131-140	76	36.7	15	7.2	0	0.0	91	44.0
	141-150	55	26.6	5	2.4	0	0.0	60	29.0
	>151	21	10.1	0	0.0	1	0.5	22	10.6
	Total	178	86.0	28	13.5	1	0.5	207	100.0
BMI	<18.5	104	50.2	14	6.8	0	0.0	118	57.0
	18.5-22.9	41	19.8	7	3.4	0	0.0	48	23.2
	23-24,9	15	7.2	3	1.4	0	0.0	18	8.7
	25-29.9	15	7.2	4	1.9	1	0.5	20	9.7
	>30	3	1.4	0	0.0	0	0.0	3	1.4
	Total	178	86.0	28	13.5	1	0.5	207	100.0
Total Bag Weight	3-3.9 kgs	148	71.5	24	11.6	1	0.5	173	83.6
	4-4.9 kg	24	11.6	2	1.0	0	0.0	26	12.6
	>5 kgs	6	2.9	2	1.0	0	0.0	8	3.9
	Total	178	86.0	28	13.5	1	0.5	207	100.0
Bag Usage Duration	<20 minutes	46	22.2	8	3.9	0	0.0	54	26.1
	21-40 minutes	90	43.5	11	5.3	1	0.5	102	49.3
	>40 minutes	42	20.3	9	4.3	0	0.0	51	24.6
	Total	178	86.0	28	13.5	1	0.5	207	100.0

From the results of examination of vertebral curve abnormalities that have been carried out on 207 respondents it is known that 127 samples (61.4%) have normal vertebral curves and 80 respondents have vertebral curve abnormalities which are divided into 6.3% kyphosis, 11.1% lordosis and 21.3% scoliosis The majority of vertebra curve abnormalities occur in women (26.6 %), the age range is 10-11 years (24.6%) and a Body Mass Index (BMI) value of <18.5 (24%) means light weight/thin. The majority of abnormal vertebral curves were found in children with a total bag weight of 3-3.9 kg (85%) and a duration of wearing a bag of 20-40 minutes (47.5%).

Based on the characteristics in table 2, 86% ATR angle < 5°, 13.5% ATR angle 5°-9° and 0.5% ATR angle ≥10°. Scoliosis is an abnormal curvature of the vertebrae (angle of trunk rotation/ATR) laterally in the frontal plane which can also be accompanied by rotation of the vertebrae in the sagittal and axial planes with a curvature angle of >10°. In general, Angle of Trunk Rotation (ATR) <5º is not significant and does not require re-examination. If the examination results show an ATR value of 5°-9º, a re-examination is required in 6 months. If an ATR value of ≥10º is obtained, a radiological examination is needed to measure the cobb angle (Nabila, 2020) .

Table 3. Data Normality Test

	Kolmogorov-Smirnov[a]		
	Statistics	Df	Sig.
Bag Weight	0.145	207	0.000
Bag usage time	0.214	207	0.000
Vertebral curve shape	0.402	207	0.000
Vertebral curve degree	0.217	207	0.000

Table 3 shows the Kolmogorov-Smirnov test to see the normality of the data on the weight of the bag, the duration of use, the shape of the curve and the degree of the curve with the asymp value. Sig. (2-tailed) 0.000 or the data distribution is not normal (<0.001) so that it can be continued with the relationship test using Kendall's Tau_b and Spearman Rho Test.

Table 4. Vertebra Curve Shape Relationship Test

			Bag weight	Bag usage time	Vertebral curve shape
Kendall's tau_b	Bag weight	Correlation Coefficient	1.000	.020	.017

		Sig. (2-tailed)	.	.696	.773
		N	207	207	207
	Bag usage time	Correlation Coefficient	.020	1.000	-.067
		Sig. (2-tailed)	.696	.	.262
		N	0.206	207	207
	Vertebral curve shape	Correlation Coefficient	.017	-.067	1.000
		Sig. (2-tailed)	.773	.262	.
		N	207	207	207

Table 4 is the result of relationship analysis using Kendall's Tau-b test. The relationship between the weight and duration of bag use and changes in the shape of the curve shows a p-value of 0.773 (> 0.05) and 0.262 (> 0.05), it can be concluded that Ho is accepted and Ha is rejected, meaning there is no relationship between the weight and duration of bag use and changes vertebral curve.

Table 5. Angle Of Trunk Rotation (ATR) Relationship Test

			Bag weight	Bag usage time	Vertebral curve degree
Spearman's rho	Bag weight	Correlation Coefficient	1.000	.026	053
		Sig. (2-tailed)	.	.705	.448
		N	207	207	207
	Bag usage time	Correlation Coefficient	.026	1,000	058
		Sig. (2-tailed)	.705	.	.407
		N	207	207	207
	Vertebral curve degrees	Correlation Coefficient	053	058	1.000
		Sig. (2-tailed)	.448	.407	.
		N	207	207	207

Table 5 is the result of the relationship analysis using the Spearman Rho test. The relationship between the weight and duration of wearing a bag and the degree of change in the vertebral curve showed a p-value of 0.448 (> 0.05) and 0.407 (> 0.05), it could be concluded that Ho was accepted and Ha was rejected, meaning that there was no relationship between the weight and duration of

wearing a bag and the degree of change in the curve vertebrae (angle of trunk rotation /ATR).

Discussion

a. Vertebral curve abnormalities due to bag load

The results showed that the incidence of scoliosis was 21.3%, this can be seen from the asymmetrical shoulder posture. The majority of respondents use backpacks (98.5%) so that respondents with asymmetrical shoulder postures have a habit of using heavy backpacks on one side and some others use sling bags. Backpacks are recommended to carry loads so that they can be supported by both shoulders in a balanced way. Using a backpack that is too low can increase the load on the bag itself so that the shoulder muscles are even more stressed and cause when walking, the child's posture leans forward so it is recommended that the bag should not hang too much (Ardiono & Yuantari, 2014) .

b. Vertebral curve abnormalities seen from Body Mass Index (BMI), gender and age.

More female students have asymmetrical body postures (26.6%) than male students because they carry a heavier load. Female students more often use handbags (tote bags) if the books they carry exceed their body capacity so that the burden does not only rest on them (Dewi & Widyastuti, 2016) . Adolescents aged 10-12 years have a tendency for spinal curve abnormalities (24.6%), this may be due to the development and growth phase there will be several physical changes and psychosocial adaptations including other changes including increasing body size. Musculoskeletal complaints in school-age children can be caused by bone growth that is not age-appropriate, this is due to bad habits such as a sitting position that is not upright can affect growth and result in disruption of the vertebrae (Afifah *et al*., 2022) .

Students who are thin (BMI <18.5) are 24%, in general biomechanically the shape of thin bones affects compressive loads and flexion movements (bending) so that it has a widespread impact on skeletal muscle disorders and vertebral curve abnormalities. Changes in the forward head position and the trunk position to the anterior lean are the kinematic effects of wearing a backpack. Heavy loads on the back will shift the center of gravity of the body so that a person can compensate by moving the head and body forward. If it continues continuously, changes in body shape can occur in the head and neck in the form of a decrease in angle of craniovertebral and increased head and neck relative to the body indicating

forward head posture (Ardiono & Yuantari, 2014).

c. The relationship between the shape of the vertebral curve with the weight and duration of wearing the bag

The results of the relationship test show that there is no relationship between the shape of the vertebral curve and the weight and duration of wearing the bag, this is because it is still within the recommended limits between the ratio of bag weight to body weight. In addition, there are other factors that can affect the shape of the vertebral curve such as nutrition, physical activity, pathological disorders, psychological, sitting habits and pain (Dumondor *et al*., 2015). Problems that occur in the spine can be affected by sitting position. The student's sitting position that can cause spinal disorders is the reading position in an upright, bent and tilted position and sitting while writing (Pristianto *et al*., 2019).

d. The relationship between the degree of spinal curve with the weight of the bag and the duration of use

The results of the relationship test concluded that there was no relationship between the degree of the vertebral curve/ angle of trunk (ATR) with the weight and duration of wearing the bag. However, an interesting thing is found where there are children with a scoliosis curve but the ATR value is 0° and vice versa the vertebral curve is normal but the ATR value is > 5°, because there is a need for a comparative diagnosis through x-ray results. Many factors influence the results of this examination, including the position of the respondent, the accuracy of the eyes looking at the angle of the scoliometer, the presence of back muscle spasms, and the respondent's embarrassment because he has to take off his clothes. Early detection of measurements with a scoliometer is very easy, efficient and fast, but it takes a physiotherapist who has been trained to palpate the vertebral curves or the tools used to measure the degree of scoliosis are used properly so that the measurement results are precise (Nabila, 2020).

The degree of scoliosis curve is categorized into 3 including mild category (10°-20°), moderate category (21°-35°), moderate to severe category (36°-40°), severe category (41°-50°), moderate category severe to very severe (51°-55°), very severe category (> 55°). The mild category of scoliosis requires the assistance of a physiotherapist, the moderate category of scoliosis is treated using a brace and physiotherapy assistance, the severe category is treated with surgical procedures (Negrini *et al*., 2019) . The results showed that there was 1 child whose ATR value was ≥10°, so that the results of comparison

with x-rays were needed before getting physiotherapist treatment.

Of the 207 samples, 2 children with vertebral curve abnormalities were found, 8 children with scoliosis-lordosis and 1 child with scoliosis-kyphosis. About 30% of a child's time at school is spent in a sitting position. Non-ergonomic seating and sitting positions between 4-7 hours can cause changes in posture and muscle tension in the spine. Many studies have identified postural patterns in school children, and the results show a high prevalence of antero-posterior and lateral changes in the vertebral column (Afifah *et al.*, 2022).

CONCLUSIONSAND SUGGESTIONS

From the results of the study, it was concluded that there was no relationship between bag load and changes in the vertebral curve seen from the shape of the vertebral curves both in the sagittal and frontal planes and the degree of change in the vertebral curves. Researchers found interesting things in this study, where there is a difference in shoulder and back height, not only due to vertebral deformities but can be caused by spasm of the paravertebral muscles on one side. From these results it can be suggested, for future researchers it is necessary to pay attention to other factors that can affect the subject such as other physical activities, for physiotherapists it is necessary to carry out better management of scoliosis and for schools it is necessary to work together with health workers to detect vertebral abnormalities in school children as well as for parents of children with scoliosis are expected to do an x-ray examination and consult a doctor.

BIBLIOGRAPHY

Afifah, A.N., Sugiono, S., Sukadarwanto, S., & Noerjanah, N. (2022). Pengaruh Klapp Method Terhadap Penurunan Derajat Kurva Skoliosis Idiopatik Tipe C Lumbal Pada Adolescent *Jurnal Fisioterapi Dan Rehabilitasi*, *6*(2), 161–166.

Ardiono, F., & Yuantari, C. (2014). Keluhan Muskuloskeletal pada Siswa Sekolah Dasar di Wilayah Kecamatan Semarang Selatan 2014. *Jurnal Kesehatan Fakultas Kesehatan Universitas Dian Nuswantoro*, *1*(4), 214–222.

Białek, M. (2015). Mild Angle Early Onset Idiopathic Scoliosis Children Avoid Progression under FITS Method (Functional Individual Therapy of Scoliosis). *Medicine (United States)*, *94*(20), 1–14. https://doi.org/10.1097/MD.0000000000000863

Coelho, D.M., Bonagamba, G.H., & Oliveira, A.S. (2013). Scoliometer measurements of Patients with Idiopathic Scoliosis. *Brazilian Journal of Physical Therapy*, *17*(2), 179–184. https://doi.org/10.1590/S1413-35552012005000081

Dewi, I.G.A.P.A., & Widyastuti, I.A.P. (2016). Gambaran Perubahan Postur

Tubuh pada Siswa Sekolah Menengah Pertama (SMP) Akibat Penggunaan Tas Punggung Berat. *Community of Publishoing in Nursing(COPING)NER*, *295*(April), 35.

Dumondor, S. V., Angliadi, E., & Sengkey, L. (2015). Hubungan Penggunaan Ransel dengan Nyeri Punggung dan Kelainan Bentuk Tulang Belakang pada Siswa di SMP Negeri 2 Tombatu. *E-CliniC*, *3*(1), 1–5. https://doi.org/10.35790/ecl.3.1.2015.6824

Fitriyani, A., Hartati, H., & Handoyo, H. (2016). Perubahan Kualitas Hidup Dan Kenyamanan Sehari-Hari Dengan Swiss Ball Exercise pada Skoliosis Sedang. *Jurnal Ilmiah Kesehatan Keperawatan*, *12*(2), 63–73. https://doi.org/10.26753/jikk.v12i2.152

Komang-Agung, I.S., Dwi-Purnomo, S.B., & Susilowati, A. (2017). Prevalence Rate of Adolescent Idiopathic Scoliosis: Results of School-based Screening in Surabaya, Indonesia. *Malaysian Orthopaedic Journal*, *11*(3), 17–22. https://doi.org/10.5704/MOJ.1711.011

Nabila, E. (2020). Efektivitas Skoliometer Sebagai Alat Deteksi Dini Skoliosis. *Health And Medical Journal*, *2*(1), 58–61.

Naufal, A. F., & Wahyuni, N. I. (2022). Postur Abnormal dan Keseimbangan Pada Anak: Literature Study. *FISIO MU: Physiotherapy Evidences*, *3*(2), 113–119. https://doi.org/10.23917/fisiomu.v3i2.18040

Negrini, A., Vanossi, M., Donzelli, S., Zaina, F., Romano, M., & Negrini, S. (2019). 584 Healthy Individuals During Growth : Normal Plumb Line Values. *American Physical Therapy Association*, *99*(12), 1712–1718.

Pristianto, A., Damayanti, A., Suryani, N., Rahman, F., & Setiyaningsih, R. (2019). Upaya Pencegahan dan Edukasi Gangguan Postur pada Siswa SDN 03 Pabelan Sukoharjo. *The 9th University Research Colloqium (Urecol)*, *9*(1). https://scholar.google.com/citations?view_op=view_citation&hl=id&user=CJMh47UAAAAJ&pagesize=80&sortby=pubdate&citation_for_view=CJMh47UAAAAJ:_kc_bZDykSQC

Rai, A., Agarwal, S., & Bharti, S. (2013). Postural Effect of Back Packs on School Children: Its Consequences on Their Body Posture. *International Journal of Health Sciences and Research*, *3*(10), 109–116. https://www.ijhsr.org/IJHSR_Vol.3_Issue.10_Oct2013/18.pdf

Soesanti, F., Pulungan, A., Tridjaja, B., & Batubara, J. R. (2013). Vitamin D Profile in Healthy Children Aged 7-12 years old in Indonesia. *International Journal of Pediatric Endocrinology*, *2013*(S1), 9856. https://doi.org/10.1186/1687-9856-2013-s1-p167

Wahyuddin, W., & Anggita, M.Y. (2021). Hubungan Beban Tas dengan Resiko Skoliosis pada Remaja. *Jurnal Ilmiah Fisioterapi*, *21*, 58–62. https://digilib.esaunggul.ac.id/public/UEU-Journal-20947-11_1766.pdf