Investigation of Musculoskeletal Symptoms (MSS) and Manual Handling Risk Factors (MHRFS) among Students at School

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Abstract

The study aims to investigate musculoskeletal symptoms (MSS) among primary and secondary school students using the Body Symptoms Survey (BSS), assess manual handling risk factors (MHRFs) with the Manual Handling Assessment Charts (MAC), and recommend improvements for student manual handling practices, focusing on heavy school bags, improper carrying techniques, and ergonomic deficiencies.The study employed a mixed-methods approach with 130 volunteer primary and secondary school students in Parit Raja. focusing on musculoskeletal symptoms. Quantitative data, including mean, mode, median, and standard deviation, were analyzed using descriptive statistics. The Body Symptoms Survey and Manual Handling Risk Assessment were integrated to assess and correlate manual handling risk factors impacting student health. The manual handling risk assessment of 130 students identified varying risk levels from carrying heavy school bags. Most students scored low (0-4), indicating no immediate action required. However, a notable portion scored moderate to high (5-16), highlighting the need for prompt interventions to mitigate risks and ensure student safety, particularly for those nearing higher risk levels. The study underscores the need for immediate interventions to improve how students carry heavy school bags, especially for those experiencing ongoing musculoskeletal pain. Future research should focus on long-term impacts, ergonomic interventions, and student perspectives to enhance school safety and health effectively across diverse student populations.

1. Introduction

Musculoskeletal pain (MSS) in primary and secondary school students refers to discomfort affecting muscles, bones, joints, tendons, ligaments, and nerves, often manifesting as back, neck, shoulder, or limb pain due to inadequate body ergonomics or repetitive motions [1][2][3]. This pain is prevalent during the school year, with over 80% of technical school students and more than 55% of general school students experiencing symptoms, especially in the neck, shoulders, and lower back [4][5]. Contributing factors include heavy backpacks, inadequate school settings, prolonged sitting, and the lack of lockers, with symptoms commonly occurring in classrooms and playgrounds [5][6]. Notably, carrying bags exceeding 10% of body weight, using bags with multiple compartments, and improper bag carrying techniques significantly contribute to musculoskeletal pain among students [5].

Manual handling risk factors among students, such as lifting, carrying, and handling heavy school bags, lead to musculoskeletal issues like back, shoulder, and neck pain [7]. This problem affects primary and secondary school students who regularly carry heavy backpacks or move school-related materials [8]. The risks are most pronounced during the school year when students handle heavy loads daily, especially in schools lacking lockers or ergonomic facilities [9]. Primary causes include the excessive weight of school bags, improper carrying techniques, and transporting supplies over long distances or up and down stairs [10]. Additional factors contributing to these risks are pre-existing conditions, poor handling techniques, inadequate training, inappropriate furniture, and tasks in classrooms and during transportation [6][11]. These activities result in discomfort, pain, and long-term musculoskeletal disorders (MSDs), exacerbated by expanding curriculums, limited locker facilities, mismatched body dimensions and school furniture, and uncomfortable sitting postures [11]. This situation has raised concerns among educators, parents, and healthcare professionals [3].

This study aims to investigate musculoskeletal symptoms (MSS) among primary and secondary school students and assess manual handling risk factors (MHRFs) related to carrying heavy school bags. Using the Body Symptoms Survey (BSS), we will identify the prevalence and nature of MSS, such as back, neck, shoulder, and limb pain, caused by factors like heavy backpacks [1][2][3]. The Manual Handling Assessment Charts (MAC) method will help evaluate risks associated with lifting, carrying, and transporting school materials [7]. The study will particularly focus on the impact of excessive bag weight, improper carrying techniques, and lack of ergonomic facilities [8][10]. Based on these assessments, we will provide recommendations to improve manual handling practices, aiming to reduce MSS and enhance the overall safety and well-being of students [6][11].

2. Methodology

The study methodology involved a sample size of 108 students, determined through a calculated sample size estimation. A total of 130 participants from various schools in Parit Raja, Batu Pahat, were selected on a volunteer basis, specifically those experiencing discomfort in a particular body area. The participants included both primary and secondary school students, all of whom potentially had musculoskeletal symptoms. The study utilized a combination of quantitative and qualitative data collection methods. Data analysis included calculating the mean, mode, median, and standard deviation, and presenting findings through bar charts, pie charts, and percentages. Additionally, the study aimed to correlate the results of the Body Symptoms Survey (BSS) with the Manual Handling Risk Assessment (MAC) to identify and address the manual handling risk factors among the students.

The questionnaire survey consists of four parts to gather information from participants. Part A collects basic details like name, age, gender, height, race, education level, and body weight. Part B, the Body Symptoms Survey (BSS), asks about musculoskeletal symptoms such as back, neck, and shoulder pain to assess their frequency and severity among students. Parts C1 and C2 are Manual Handling Risk Assessments. C1 evaluates risks related to lifting tasks, considering how often and how difficult these tasks are, and factors like physical strain or ergonomic setup that could lead to injuries. C2 focuses on carrying tasks, examining similar factors to understand their potential risks. These parts aim to comprehensively evaluate musculoskeletal health and manual handling risks among participants.

Data collection began with interviews to gather participants' demographic details and medical histories. Participants reported musculoskeletal symptoms, pain frequency, and locations. Researchers used a goniometer to measure body posture angles. They also administered the Body Symptoms Survey (BSS) to categorize musculoskeletal disorders into three severity levels based on pain duration and impact on daily life. Observations in classrooms included monitoring students carrying heavy bags. The Manual Handling Risk Assessment (MAC) was employed through direct observations and video recordings to evaluate tasks' physical demands and risks.

3. Result and Findings

The data provided includes the weight, height, and age of 130 students from four schools in Batu Pahat, Johor's Parit Raja neighborhood. Table 1 shows majority of students are aged 12 to 13, with a mean age of 12.81 years, a median of 13 years, and a mode of 12 years. Most students are approximately 150 cm tall, with a mean height of 150.07 cm, a median of 150 cm, and a mode of 147 cm. The majority of students weigh between 40 and 41 kg, with a mean weight of 46.77 kg, a median of 41 kg, and a mode of 40 kg. The standard deviations for age, height, and weight are 0.93, 7.09, and 17.27, respectively, indicating the variability in the data. The schools involved in the data collection include SK Jelotong, SK Pintas Puding, SMK Seri Gading, and SMK Tun Ismail, representing a mix of primary and secondary schools. The gender distribution shows that 83 students (63.8%) are female, and 48 students (36.9%) are male, indicating a higher proportion of female students in the sample. The data refer to Table 2 also details the distribution of body weight and suggested weight limits for the respondents. The "Beg Weight" has a mean of 3.93 kg, a median of 3.82 kg, and a mode of 2.33 kg, with a standard deviation of 2.01. The suggested weight limits (10% and 15% of body weight) have means of 4.63 kg and 6.79 kg, medians of 4.1 kg and 6 kg, and modes of 4 kg and 6 kg, with standard deviations of 1.92 and 2.74, respectively. This comprehensive data provides a detailed picture of the students' demographics, body weight, and suggested weight ranges.

Table 1 *Demographics Characteristics of Respondent Age, Height(cm) and Weight(kg)*

	Age	Height (cm)	Weight (kg)
Mean	12.81	150.07	46.77
Median	13	150	41
Mode	12	147	40
Standard Deviation	0.93	7.09	17.27

Table 2 *Demographic Data of Beg Weight(kg), Minimum - Recommended Weight Limit (kg) and Maximum - Recommended Weight Limit (kg)*

	Beg Weight (kg)	Minimum - Recommended Weight Limit (kg) (10% x Body Weight)	Maximum - Recommended Weight Limit (kg) (15% x Body Weight)
Mean	3.93	4.63	6.79
Median	3.82	4.1	6
Mode	2.33	4	6
Standard Deviation	2.01	1.92	2.74

The results of the Body Symptoms Survey (BSS) Forms (Part B), which included 130 respondents from primary and secondary schools, provide valuable insights into the frequency and intensity of pain or discomfort in various body parts. Most respondents, 94 people (72.30%), reported light neck discomfort or body tiredness (C-1) that resolves within 14 days. A smaller group (10%) experienced persistent pain (C-2) lasting more than 14 days but less than three months, potentially impairing daily activities and work performance. None reported neck pain lasting more than three months (C-3). A high rate of mild shoulder discomfort was noted, with 86 respondents (66.15%) reporting C-1 level pain, while 25 respondents (19.23%) reported C-2 level pain, indicating ongoing discomfort that affects daily functioning and job performance. Additionally, 2 respondents (1.54%) reported

persistent shoulder pain (C-3), requiring more frequent and extended medical certifications. For upper back pain, 81 respondents (62.31%) reported C-1 level pain, and 20 respondents (15.38%) reported C-2 level pain, with no reports of C-3 level pain. Various body areas, including the lower back, thigh, knee, calf, ankle, feet, upper arm, elbow, lower arm, wrist, and hand, also showed different degrees of discomfort. Most respondents (61.54% to 67.69%) had C-1 level discomfort in these areas. Although less frequent, persistent discomfort (C-2) was significant, especially in the lower back (20%) and shoulder (19.23%). Reports of chronic pain (C-3) were rare, mainly affecting the feet, lower back, and wrist. These findings indicate that most students experience mild discomfort, with a smaller but significant percentage reporting more severe pain that may interfere with daily activities and academic performance. Refers to Table 3.

Table 3 *Body Symptoms Survey (BSS)*

Body Part affected	Experience of Pain / Discomfort					
	C-1		C-2		C-3	
	Generally healthy, Body fatigue or mild discomfort in the localized area only during work or subsides within 14 days.		Persistent pain lasting more than 14 days, but less than 3 months. May start to affect work performance and daily activities.		Pain at all times lasting for more than 3 months. Required frequent and longer Medical Certificates (MC). Affect work performance and daily activities	
	Total	Percentage %	Total	Percentage %	Total	Percentage %
Neck	94	72.30	13	10	-	-
Shoulder	86	66.15	25	19.23	2	1.54
Upper Back	81	62.31	20	15.38	-	-
Upper Arm	85	65.38	9	6.92	-	-
Elbow	82	63.08	4	3.08	-	-
Lower Arm	81	62.31	10	7.69	-	-
Wrist	87	66.92	17	13.08	1	0.77
Hand	84	64.62	9	6.92	-	-
Lower Back	80	61.54	26	20	1	0.77
Thigh	84	64.62	8	6.15	-	-
Knee	85	65.38	9	6.92	-	-
Calf	85	65.38	14	10.77	-	-
Ankle	82	63.08	12	9.23	-	-
Feet	88	67.69	10	7.69	1	0.77

Figure 1 shows manual handling risk assessment for carrying heavy school bags evaluated 130 students from elementary and secondary schools, using eight criteria to calculate total scores. Four risk categories with corresponding action levels were identified. Thirteen students (10%) scored 0, and fifteen (11.5%) scored 1, indicating no action needed. Similarly, 25 students (19.2%) scored 2, 15 (11.5%) scored 3, and 9 (6.9%) scored 4, all of which also required no action, suggesting that most students aren't at significant risk from carrying heavy bags. However, 2 students (1.5%) scored 8, 5 (3.8%) scored 9, and 10 (7.7%) scored 10, indicating action needed soon. Four students (3.1%) scored 5, 10 (7.7%) scored 6, 7 (5.4%) scored 7, and 2 (1.5%) scored 8, requiring immediate attention due to moderate risk. Higher scores were also noted: 2 students (1.5%) and 1 student (0.8%) scored 12, indicating moderate but nearing high risk, while 6 students (4.6%) scored 13, 3 (2.3%) scored 14, 2

(1.5%) scored 15, and 1 (0.8%) scored 16, all needing urgent action. Overall, while most students are at low risk, a notable number need prompt measures to ensure their safety when carrying heavy school bags.
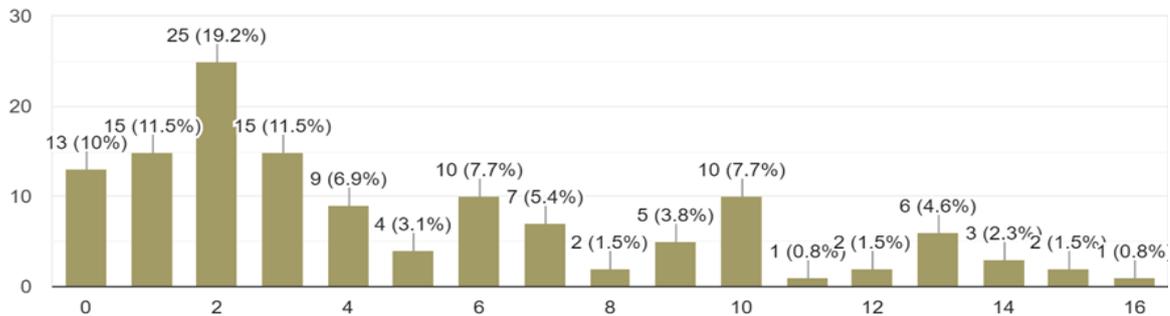

Fig 1 *Total numerical score Manual Handling Risk Assessment score, Risk Level and Action Level (Lifting)*

A survey of 130 primary and secondary school students assessed the risk of lifting heavy school bags, dividing the risk into color bands indicating danger levels and necessary actions. The results show that 59.2% of the students are in the low-risk green band, meaning no immediate action is needed, suggesting most students are not at risk when lifting heavy bags. However, 32.3% are in the amber band, indicating a moderate risk that requires prompt attention. These students might face issues that could lead to harm if not addressed. Additionally, 8.5% are in the red band, indicating a high risk that needs immediate action to prevent serious injuries. No students were in the highest risk purple band. This distribution highlights the need for targeted interventions, especially for students in the red and amber bands, to ensure their safety when lifting heavy items. Refer to figure 2.
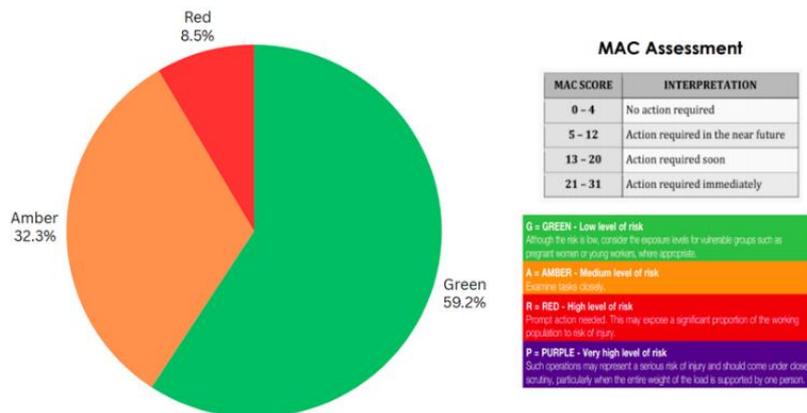

Fig 2 *Total colour band Manual Handling Risk Assessment score, Risk Level and Action Level (Lifting)*

Figure 3 shows manual handling risk assessment for carrying large school bags was conducted with 130 primary and secondary school students. The assessment evaluated the total scores from nine elements (A + B + C + D + E + F + G + H + I) to determine risk levels and necessary actions. Out of 131 responses, five students (3.8%) scored zero, twenty-seven (20.8%) scored one, twelve (9.2%) scored two, seven (5.4%) scored three, and eight (6.2%) scored four. These scores, ranging from 0 to 4, fall into the "no action required" category, indicating low risk for these students. However, the "action required in the near future" group included 10 students (7.7%), 24 (18.5%), 6 (4.6%), 12 (9.2%), and 7 (5.4%), showing a moderate risk that needs prompt attention to prevent harm. Additionally, 3 students (2.3%) scored 10, 1 (0.8%) scored 11, and 1 (0.8%) scored 12, indicating they are nearing a higher risk level. The "action necessary soon" category included 4 students (3.1%), 1 (0.8%), and 2 (1.5%) with higher scores, indicating serious issues that need immediate attention. There were no students in the "action required immediately" group (scores 21–31), suggesting no significant immediate danger. This

distribution emphasizes the need for targeted interventions to enhance student safety and well-being, particularly for those in the moderate and higher risk categories.
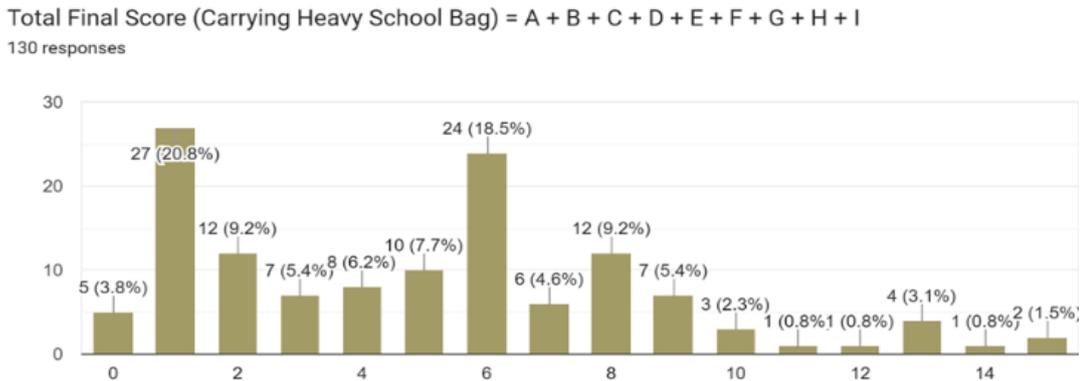

Fig 3 *Total numerical score Manual Handling Risk Assessment score, Risk Level and Action Level (Carrying)*

A manual handling risk assessment for carrying heavy school bags was done with 130 primary and secondary school students, categorizing risk levels into four color bands with specific instructions. Figure 4 shows that 45.4% of students are in the green band, indicating a low-risk level where no immediate action is needed, suggesting that nearly half of the students are in safe conditions for carrying their school bags. However, 49.2% are in the amber band, indicating a moderate risk that needs prompt action to prevent potential problems. Additionally, 5.4% are in the red band, indicating a high risk that requires immediate attention to prevent harm. None of the students are in the purple band, which would indicate an urgent risk level needing immediate action. This distribution highlights the need for targeted interventions, especially for students in the red and amber bands, to ensure their safety and well-being when carrying heavy school bags.
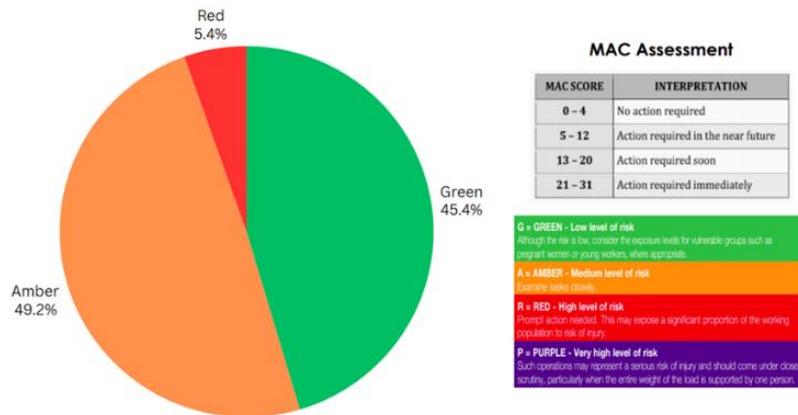

Fig 4 *Total colour band Manual Handling Risk Assessment score, Risk Level and Action Level (Carrying)*

4. Conclusion

The study looked at 130 students from primary and secondary schools in Parit Raja, Batu Pahat, Johor. It examined their age, height, weight, and problems like muscle pain. Most students were between 12 and 13 years old, with average heights and weights for kids their age. The survey found that many students felt slight discomfort in their neck, shoulders, and upper back, but some had ongoing pain that could affect how they do things every day and how well they do in school. When it came to carrying heavy school bags, most students stuck to safe weight limits. However, how they held their bags, the way they balanced them, and other things like that made a difference. Some students needed help right away to make things safer. Overall, the study shows that it's important to make changes so students can carry their bags safely and stay healthy, especially those who are at higher risk.

The research effectively meets its purpose of assessment by comprehensively exploring musculoskeletal symptoms (MSS) among primary and secondary school students and conducting thorough manual handling risk

assessments related to carrying heavy school bags. Through detailed surveys and assessments involving 130 respondents, the study provides valuable insights into the prevalence, severity, and impact of neck, shoulder, upper back, and other bodily discomforts associated with carrying school bags. It identifies varying levels of discomfort and risk among students, from mild to severe, highlighting areas where immediate or near-future interventions are necessary. By emphasizing the need for targeted interventions, such as ergonomic improvements or behavioral changes, the research aims to mitigate musculoskeletal issues effectively, thereby enhancing student well-being and academic performance in school settings.

5. Recommendations

Future research should explore different paths to build on what we learned about muscle and bone pain and the risks of handling heavy school bags among students. First, long-term studies can show how these problems change over time and how they affect grades and overall health. Studying how well ergonomic changes, like different types of school bags or desks that move, work can help lower the chances of muscle and bone pain. Also, looking at how exercise and teaching about good posture can stop muscle and bone pain in students can give schools ways to prevent it. It would help to study more kinds of students in different places, so we know these ideas can work for everyone. Lastly, talking to students about what they think and feel about muscle and bone pain and handling heavy school bags can give us more ideas to help. By looking at these things, future research can make schools safer and healthier places for students.

Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The author confirms sole responsibility for the following: study conception and design, data collection, analysis and interpation of results, and manuscript preparation

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References

[1] Prajapati, S.P.; Purohit, A. Prevalence of musculoskeletal disorder among college students in times of COVID-19 pandemic-an observational study. Int. J. Health Sci. Res. 2021, 11, 214–219. https://www.ijhsr.org/IJHSR_Vol.11_Issue.10_Oct2021/IJHSR028.pdf

[2] Mohsin, M. K., Nayyef, O. H., & Salman, A. B. (2021). Effect of Heavy School Bag on Musculoskeletal System of the Students. Iraqi Medical Journal, 67(2), 90-97. https://imj.edu.iq/wp-content/uploads/2023/03/09-Effect-of-heavy-school-bag-on-musculoskeletal-system-of-the-students-2.pdf

[3] Guessogo, W. R. (2020). Effect of Schoolbag Weight on Musculoskeletal Pain among Primary School Children in Yaounde, Cameroon: A Cross-sectional Study. https://www.semanticscholar.org/paper/Effect-of-Schoolbag-Weight-on-Musculoskeletal-Pain-Guessogo-Assomo-Ndemba/95b95d99600e36e6a1e769b44da83786309547cc

[4] Doaa Tammam Atia, Nader Ibrahim Elsayed, Abdelmonem, A. F., Mohamed, S., Mahmoud, M., Mohamed, Khalid, Rashad, U. M., & Abdel, E. (2023). Prevalence of Musculoskeletal Disorders among General and Technical Secondary School Students in Egypt. International Journal of Environmental Research and Public Health, 20(2), 1465–1465. https://doi.org/10.3390/ijerph20021465

[5] Dubey, M., Choudhary, Y., Bhatia, P., & Kumar, M. (2022). Prevalence and determinants of musculoskeletal pain among school-going children carrying schoolbags: A cross-sectional study from Central India. Journal of Family Medicine and Primary Care, 11(6), 3045. https://doi.org/10.4103/jfmpc.jfmpc_2363_21

[6] Delele, M., Janakiraman, B., Abebe, A. B., Tafese, A., & Van De Water, A. T. (2018). Musculoskeletal pain and associated factors among Ethiopian elementary school children. BMC Musculoskeletal Disorders, 19(1). https://doi.org/10.1186/s12891-018-2192-6

[7] Ziaei, M., Choobineh, A., Abdoli-Eramaki, M., & Ghaem, H. (2018). Individual, physical, and organizational risk factors for musculoskeletal disorders among municipality solid waste collectors in Shiraz, Iran. Industrial health, 56(4), 308-319. https://www.jstage.jst.go.jp/article/indhealth/56/4/56_2018-0011/_article/-char/ja/

[8] Alghamdi, R. S., Nafee, H. M., El-Sayed, A., & Alsaadi, S. M. (2018). A study of school bag weight and back pain among intermediate female students in Dammam City, Kingdom of Saudi Arabia. J Nurs Educ Pract, 8(12), 105-109. https://shorturl.at/dkWOP

[9] Hussain, S. G., Rehman, A. U., & Siraj, M. (2022). IMPACT OF HEAVY SCHOOL BAGS ON PHYSICAL HEALTH OF SCHOOL GOING CHILDREN: A CASE STUDY OF PRIMARY LEVEL SCHOOLS OF DISTRICT LASBELA, PAKISTAN. Pakistan Journal of Educational Research, 5(2). https://www.pjer.org/index.php/pjer/article/view/533

[10] Rizaldy, N., Alvin, A., Lingga, W., Goeij, E B., & Ferryanto, F. (2022, November 15). Backpack Effects on Two-Dimensional Gait Spatiotemporal and Kinematic Parameters. https://scite.ai/reports/10.17977/um016v6i22022p057

[11] Nazari, M., Beigi, R., Salesi, M., Cousins, R., & Mokarami, H. (2020). Development and validation of the tool for the evaluation of the behavioral factors affecting the prevalence of musculoskeletal disorders in Iranian students. BMC pediatrics, 20, 1-9. https://link.springer.com/article/10.1186/s12887-020-02452-8

[12] Zaheer, M., Fatima, N., Riaz, U., & Haseeb, N. (2022). Association of heavy bag lifting time with postural pain in secondary school students. Pakistan BioMedical Journal, 64-67. http://pakistanbmj.com/journal/index.php/pbmj/article/view/232

[13] Zhou, N., Chen, W., Zhou, J., & Yang, L. (2018). Influence of the increasing weight of the backpack on the balance of movement to primary school students. Leather and Footwear Journal, 18(2), 123–130. https://doi.org/10.24264/lfj.18.2.7

[14] Dadashi Tonkaboni, N., Tavafian, S. S., & Gholamnia Shirvani, Z. (2020). Effectiveness of a Back Care Intervention on Spine-related Behavior among Female students: a schoolbased randomized controlled trial. International Journal of Musculoskeletal Pain Prevention, 5(4), 425-430. https://ijmpp.modares.ac.ir/browse.php?a_id=48598&sid=32&slc_lang=fa

[15] Gheysvandi, E., Dianat, I., Heidarimoghadam, R., Tapak, L., Karimi-Shahanjarini, A., & Rezapur-Shahkolai, F. (2019). Neck and shoulder pain among elementary school students: prevalence and its risk factors. BMC Public Health, 19(1). https://doi.org/10.1186/s12889-019-7706-0

[16] Meenakshi, Saini, S. K., Bharti, B., Gopinathan, N. R., & Kavita. (2023). Impact of Educational Intervention in Reducing the Weight of School Bags in Selected School Children. Indian Journal of Community Medicine, 48(4), 533. https://doi.org/10.4103/ijcm.ijcm_80_22

[17] Mandrekar, S., Chavhan, D., Shyam, A. K., & Sancheti, P. K. (2022). Effects of carrying school bags on cervical and shoulder posture in static and dynamic conditions in adolescent students. International Journal of Adolescent Medicine and Health, 34(1), 20190073. https://www.degruyter.com/document/doi/10.1515/ijamh-2019-0073/html

[18] National Institute of Arthritis and Musculoskeletal and Skin Diseases. (2019, April 23). Back Pain. National Institute of Arthritis and Musculoskeletal and Skin Diseases. https://www.niams.nih.gov/health-topics/back-pain

[19] Information, N. C. for B., Pike, U. S. N. L. of M. 8600 R., MD, B., & Usa, 20894. (2020). Shoulder pain: Overview. In www.ncbi.nlm.nih.gov. Institute for Quality and Efficiency in Health Care (IQWiG). https://www.ncbi.nlm.nih.gov/books/NBK554693/

[20] Health and Safety Executive. (2019). Manual Handling at Work: A Brief Guide. Retrieved from https://www.hse.gov.uk/pubns/indg143.htm