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EFFECT OF BACKPACK LOADING ON POSTURAL ANGLES IN STANDING AND AFTER DYNAMIC ACTIVITY IN SECONDARY SCHOOL GOING CHILDREN – A COMPARATIVE STUDY

Physiotherapy

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ABSTRACT

Improper backpack loading can lead to significant postural deviations in school-going children. This study aimed to assess the effects of backpack weight on cervical, sagittal shoulder, and trunk posture in 169 secondary school students aged 10–11 years in a metropolitan city in India. Backpack weight averaged 5 kg, constituting 14% of the students' mean body weight (37 kg). Postural angles were measured using Kineova software under three conditions: without the bag, with the bag in static standing, and after dynamic activity. Statistical analysis revealed significant forward head, forward shoulder, and forward trunk postures in both static and dynamic conditions. These findings highlight the need for weight guidelines, posture education, and interventions to mitigate the impact of heavy backpacks on children's musculoskeletal health.

KEYWORDS

INTRODUCTION

Education is crucial, and students often carry books using backpacks, but excessive carrying can increase manual load and cause biomechanical and postural changes.[1,2]

School-going children face increased risk of overuse injuries and biomechanical adaptations due to incomplete cartilage and secondary ossification of vertebrae. Postural muscles support leaning forward or inclining the head.[1]

The American Physical Therapy Association recommends school bags should be 5-10% of body weight, and an Indian study has reported musculoskeletal pain in school-going children.[3]

This study investigates backpack loading's impact on cervical, shoulder, and trunk posture in secondary school-going children, assessing average weight, postural angles, and comparing angles without and with the bag.

MATERIAL AND METHODS

Methods - The study is a comparative study where a comparison is done on the effect of backpack loading in static and after dynamic activity in secondary school-going children. The study was conducted at a secondary school in a metropolitan city in INDIA. The sampling for the study was done using the convenience sampling method and the sample size was 159 calculated using open EPI software.

Participants- The participants were secondary school-going children 10-11 years of age. The inclusion criteria for the study were: the participants must be willing to participate, be school-aged children who carry backpacks over both their shoulders and fall within the age range of 10 to 11 years. Both genders are eligible to take part in the study. Exclusion criteria for the study were children with recent systemic illnesses, any musculoskeletal, cardiorespiratory, or neurological issues, congenital deformities, or those outside the specified age range of 10 to 11 years are excluded from the study.

Material Used – Pen, paper, camera[108mp], weighing machine

Procedure-
- Participant Selection and Consent
- Participants were secondary school-going children aged 10-11 years.
- Informed consent was obtained from their guardians.
- The study was conducted in two phases:

Phase 1: Measurement of backpack weight to provide baseline understanding.

Phase 2: Assessments involving photography and posture analysis.
- Key points were palpated and marked on participants.
- Sider view photographs were taken without and with the school bag on and with the school bag on after doing dynamic activity.

Posture Analysis
- Kineova software was used for posture analysis.
- Angles measured included Craniohorizontal Angle (CHA), Craniovertebral Angle (CVA), Sagittal Shoulder Posture (SSP), and Turn Forward Lean (TFL).

Data Analysis –
- Preliminary Analysis of Student Bag Weight
- Data entered into MS Excel for preliminary analysis.
- Average weight of school bags and students calculated.
- Percentage of body weight represented by backpack determined.

Postural Angle Analysis
- SPSS software used for postural angle measurement.
- Shapiro-Wilk test used for normality assessment.
- Comparisons made between postural angles recorded without bag and with bag, and after dynamic activity.
- Wilcoxon or paired t-tests used for comparisons

RESULTS

Statistical analysis was performed using statistical package for social science [SPSS20]. Normality of the variables was tested using Shapiro wilk normality test. To compare the without bag angles with bag and with bag after dynamic activity data which were normally distributed paired t test was done and the data which were not normally distributed Will coxan test was performed. The level of significance was set to less than or equal to 0.05.

Table 1: Mean, Standard Deviation And Normality Distribution Of The Craniohorizontal Angle

	Mean	Standard deviation	Normality testing
Craniohorizontal angle without bag	18	±3	Not normally distributed [p=0.001]
Craniohorizontal angle with bag	20	±3	Not normally distributed [p=0.044]
Craniohorizontal angle with bag after dynamic activity	20	±3	Not normally distributed [p=0.02]

Table 2 : Mean, Standard Deviation And Normality Distribution Of The Craniovertebral Angle

	Mean	Standard deviation	Test of normality
Craniovertebral angle without bag	49	±7	Normally distributed [p=0.062]
Craniovertebral angle with bag	42	±7	Not normally distributed [p=0.036]
Craniovertebral angle with bag and after dynamic activity	42	±7	Normally distributed [p=0.508]

Table 3: Mean, Standard Deviation And Normality Distribution

Of The Sagittal Shoulder Posture Angle

	Mean	Standard deviation	Normality test
Sagittal shoulder posture without bag	67	±9	Not normally distributed [p=0.01]
Sagittal shoulder posture with bag	75	±8	Normally distributed [p=0.09]
Sagittal shoulder posture with bag after dynamic activity	76	±8	Normally distributed [p=0.05]

Table 4: Mean, Standard Deviation And Normality Distribution Of The Trunk Forward Lean Angle

	Mean	Standard deviation	Normality distribution
Trunk forward without bag	3	±2	Not normally distributed [p<0.001]
Trunk forward lean with bag	6	±3	Not normally distributed [p=0.003]
Trunk forward lean with bag after dynamic activity	6	±2	Not normally distributed[p=0.04]

Table 5: Shows The Percentage Of Body Weight Carried By The Students

The average weight of the students	The average weight of the school bag carried by the students	Percentage of body weight carried by the students
37kg±10kg	5 kg±1kg	14%

Effect Of Static Loading And Dynamic Loading On Craniohorizontal Angle: There was a statistically significant change in Craniohorizontal angle with p value<0.001 in static loading and after dynamic loading of back pack from unloaded condition as shown in Table 5. There was no statistically significant changes seen in Craniohorizontal angle with p value- 0.379 in static and after dynamic loading as shown in table 5.

Table 5: Test for comparison of CHA

Test for comparison	Null Hypothesis	Test	Significance	Decision
Wilcoxon test to compare CHA without bag and with bag	The median of differences between CHA without bag and CHA with bag equals 0.	Related-Samples Wilcoxon Signed Rank Test	<.001	Reject the null hypothesis.
Wilcoxon test to compare CHA without bag and after dynamic activity	The median of differences between CHA without bag and CHA after dynamic equals 0.	Related-Samples Wilcoxon Signed Rank Test	<.001	Reject the null hypothesis.
Wilcoxon test to compare CHA in static and after dynamic loading	The median of differences between CHA with bag and CHA after dynamic equals 0.	Related-Samples Wilcoxon Signed Rank Test	.379	Retain the null hypothesis.

Effect Of Static Loading And Dynamic Loading On Craniovertebral Angle: There was a statistically significant change in Craniovertebral angle with p value<0.001 in static loading and dynamic loading of the backpack from the unloaded condition as shown in table 6. There was no statistically significant changes seen in CVA with p value 0.365 in static and after dynamic loading as shown in table 6.

Table 6 – Test for comparison of CVA

Test for comparison	Null hypothesis	Test	Significance	Decision
Wilcoxon test to compare CVA with bag and without bag	The median of differences between CVA without bag and CVA with bag equals 0.	Related-Samples Wilcoxon Signed Rank Test	<.001	Reject the null hypothesis.
Paired t-test to compare CVA without bag and after dynamic activity	The median of the difference between CVA without bag and after dynamic activity	Paired t-test	<.001	Reject the null hypothesis.
Wilcoxon test to compare CVA in static and after dynamic loading.	The median of differences between CVA with bag and CVA after dynamic equals 0.	Related-Samples Wilcoxon Signed Rank Test	.365	Retain the null hypothesis.

Effect Of Static Loading And Dynamic Loading On Sagittal Shoulder Posture Angle: There was a statistically significant change in sagittal shoulder posture angle with p value<0.001 in static loading and dynamic loading of the backpack from the unloaded condition as shown in Table 7. There was a statistically significant difference seen in SSP p value < 0.01 in static and after dynamic loading as shown in table 7.

Table 7 – Test For comparison of SSP

Test for comparison	Null hypothesis	Test	Significance	Decision
Wilcoxon test for SSP with bag and without bag	The median of differences between SSP without bag and SSP with bag equals 0.	Related-Samples Wilcoxon Signed Rank Test	<.001	Reject the null hypothesis.
Wilcoxon test for SSP without bag and after dynamic activity	The median of differences between SSP without bag and SSP after dynamic equals 0.	Related-Samples Wilcoxon Signed Rank Test	<.001	Reject the null hypothesis.
Paired t test to compare SSP in static and after dynamic loading.	The median of differences between SSP in static and after dynamic loading	Paired t-test	<0.01	Reject the null hypothesis.

Effect Of Static Loading And Dynamic Loading On Trunk Forward Lean Angle: There was a statistically significant change in Trunk forward lean angle with p value<0.001 in static loading and dynamic loading of the backpack from the unloaded condition as shown in table 8. There was statistically significant changes seen in TFL p value 0.02 in static and after dynamic activity as seen in table 8.

Table 8- Test for comparison of TFL

Test for comparison	Null hypothesis	Test	Significance	Decision
Wilcoxon test for TFL with bag and without bag	The median of differences between TFL without bag and TFL with a bag equals 0.	Related-Samples Wilcoxon Signed Rank Test	<.001	Reject the null hypothesis.
Wilcoxon test for TFL without bag and after dynamic activity.	The median of differences between TFL without bag and TFL after dynamic equals 0.	Related-Samples Wilcoxon Signed Rank Test	<.001	Reject the null hypothesis.
Wilcoxon test to compare TFL in static and dynamic loading.	The median of differences between TFL with bag and TFL after dynamic equals 0	Related-Samples Wilcoxon Signed Rank Test	<0.02	Reject the null hypothesis.

DISCUSSION

A study on 10-11-year-old secondary school children found that backpack weight significantly affects postural angles, including CHA (craniohorizontal angle), CVA (craniovertebral angle), SSP (sagittal shoulder posture angle), and TFL (trunk forward lean). The average weight of the students was 37 kg, with backpacks weighing 5 kg, equivalent to 14% of their average body weight. The findings suggest that backpack weight influences postural alignment in children of this age group. The study found that backpacks increased CHA, decreased CVA, increased SSP, and increased TFL, indicating more forward

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bending of the trunk as compensation for the posterior load. Similar studies have also found significant changes in cervical and shoulder posture with even 10% loading of the spine. Most students carried more than 15% of their body weight in the form of a backpack.

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