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A Study to Evaluate the Effect of Back Pack Load on Weight Bearing, Among School Children, Using Digital Weighing Machine

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ABSTRACT

Background and objective: The impact of musculoskeletal diseases is widespread among student population and may affect any age group. Some conditions often last from adolescence into adulthood. Notably, most of the studies assessed the weight distribution over the foot using force plates and other posturography units. To identify the effect of backpack loads and the carrying patterns by the students on the weight-bearing of the children using Digital weighing machines.

Methodology: A cross-sectional study was done on 150 school going children aged 10 to 14 years.The asymmetric weight distribution of foot was checked using a digital weighing machine in 3 patterns; backpack weight on the right shoulder, backpack weight on the left shoulder and backpack weight on both the shoulders.

Results: Statistically significant differences were noted between the weight bearing of the normal standing when compared to the standing either with shoulder bag on the right side or on the left side. Also significant differences were noted between the weight bearing of normal standing weight and standing with shoulder bag on both sides. ($P< 0.001$)

Conclusion: When carrying a load bilaterally or unilaterally, the result shows a statistical variation when compared to vertical standing with no weight. Musculoskeletal changes may be suspected in the future if proper awareness programs are not implemented in schools and at home. Additionally, the relevant authority's lack of awareness about ideal bag weight was a noted disadvantage. Backpacks with additional horizontal straps can reduce these stresses; modification of bag weight, as well as activities such as core muscle strengthening, can be some of the precautionary measures that can be incorporated into the school curriculum beginning from primary school itself.

Keywords: backpack load, asymmetrical weight distribution, school children, musculoskeletal disorders

INTRODUCTION

A child's dream of going to school begins with a new backpack, books, box, and colour pencils etc. It's an age-old tradition to carry loaded bags and walk to school. A school bag is frequently loaded with books in accordance with their time table. Children have a habit of taking books and other items that aren't usually needed. In addition to this, few kids carry their lunch boxes and water bottles in their school bags.[1] surprisingly; loaded bags are a common topic of conversation among parents, teachers, health professionals, and school-aged children. Loaded school bags affect between 40% and 70% of

children in developed countries,[2,3] and we could anticipate that this figure may be much higher in a developing country like India. Over half of parents were unaware of the recommended weight limit for a school bag and two-thirds were unaware of the correct size and how their child should carry his/her school bag.[4] There are few studies to back up incorrect schoolbag use, which can lead to poor posture. Carrying an asymmetric loads and walking on uneven terrain will put more strain on the lower back and legs.[5]

To prevent the upper trunk from leaning forward, a child should carry a bag weighing between 10 to 15% of the child's body weight.[6] Any disparities in these percentages can cause musculoskeletal issues; any symptoms like headaches, fatigue, neck and back pain associated with carrying a backpack have been referred to as "Backpack Syndrome" if these symptoms persist, it can lead to the development of abnormal body posture.[7,8]

The impact of musculoskeletal diseases is widespread and may affect the student population at any age group. Some conditions often last from adolescence into adulthood. It was notable that in research done among children and adolescents around, 10- 67% of the study population had reported some form of MSD.[9] Posturogenesis is defined as the adaptation of new posture maybe, due to growth spurt, improper static body positions, shoulder strap size adjustment and the method of putting on and taking off the backpack.

The average school bag of adolescents across countries ranges from 2.8 kg to 6.6 kg.[10] Heavy school bags put strain on the spine, back, and shoulders, causing muscular pain, fatigue, and strain. [11] Backpack load causes changes in posture that, if not addressed promptly, can lead to postural abnormalities. A recent systematic review discovered no evidence as simply carrying a schoolbag increased the risk of back pain in children and adolescents.[11] Student's bag styles, as well as the length and width of their straps, varies from one another. Some students prefer to wear their backpacks on one shoulder while others prefer to wear them on both. External forces, such as the weight of a bag, influence the child's posture and walking pattern during the growth phase, increasing the child's vulnerability to low back pain.[12]

Some countries like Australia, Poland have brought regulations regarding maximum backpack load but children lack awareness of their health. Notably, most studies assessed the weight distribution over the foot using force plates and other Posturography units. Caldwell and colleagues[13] in a study had made use of digital weighing scales to evaluate the symmetry of weight distribution. Bohannon and Larkin[14] had also used such a scale to measure lower limb weight bearing in hemi paretic patients. These studies found the use of digital scale to be an easy method to assess standing weight distribution in stroke patient as well as in people with unilateral distribution of lower limb weight bearing. This study intends to identify the effect of backpack loads, on the way the bags are worn by the students, on the weight-bearing using digital weighing machine.

METHODOLOGY

Study design and Setting: A Cross sectional study among 10 – 14 years school going children from Apartments and Housing Colony after taking permission from the concerned authorities, study was carried out over a period of 12 months from August 2020 to August 2021.

Study participants and Sampling: Convenience Sampling, based on the study by Kim K[15] distribution of the mean weight among normal healthy population was found to be for right and left 49.1 ± 2.77 and 50.6 ± 2.76 respectively. The sample size is estimated to be N = 150.

One hundred and fifty (150) healthy children were randomly selected for this study. The mean age of the children was 12.43±1.33 years, their mean height was152.21±9Cms, and their mean weight was 41.13±10.47Kg. Only the subjects who fulfilled the following criteria were included in this study: no orthopaedic, neurological, or cognitive impairments that could have influenced the study procedure or results; no discrepancy in leg length; and no regular daily exercise.

Data collection tools and techniques:.

Digital Weighing Machine (Beurer),Measuring Tape, Paper and Pen.

Foot weight distribution during standing was recorded using two digital weighing scales (Beurer standard name)Digital Weighing Scale A and Digital Weighing Scale B (DWS A and DWS B), with 0.01 kg precision and a maximum loading capacity of 150 kg each was used.In both weighing scale centre was marked for standing for equal distribution of weight on the foot.

Beurer weighing scale

The equipment evaluates the back pack load on weight bearing, the symmetrical weight distribution of the foot on each weighing machine and analyzes the load distribution while carrying school backpack in three different patterns.

Method

The loading protocol was performed with the subject standing still on the glass plate, with their feet shoulder length apart and their arms at sides, while looking at a round target attached to wall located 2 m in front of them. A single investigator placed the backpack in the same location relative to the posterior aspect of the scapula. After zero-point calibration, measurement was performed for 1 min and data were averaged over three trials separated by 1 min rest intervals. Order of the carrying patterns was randomly given. All assessment was done by the principal investigator.

Backpack Description

Three types of backpack carrying patterns Kim K [15] were assessed with the mean value of Bag length (BTL): 17.89±0.63cms, Bag Weight (WT-B): 6.14±1.49cms, Strap Length (STL): 23±2.19cms, Acromion –Strap (AC-SL): 6.67±0.82cms respectively.

The weight of each backpack was adjusted to 15% of the subject's bodyweight (average backpack weight of the subjects: 6.14±1.49cms). In our study, the school backpacks were filled with books weighed according to the mentioned percentage.

Ethical Consideration: The study participants were provided with a patient information sheet containing details about the study, and informed consent was obtained from each participant prior to their involvement in the study and Ethical clearance was obtained from the Institutional ethics committee of Yenepoya Ethics committee 2, Mangalore on 3.10.2020.DCGI Registration Number.: ECR/1337/Inst/KA/2020.

Statistical Analysis: SPSS 20.0 was used to analyze all data. Data are presented as mean ± standard deviation (SD). Statistical significance was noted for values of **P<0.001**. When statistical significance was identified, the differences in the pair wise comparison were examined using the **Paired-t-test** adjustment.

RESULTS

The demographic data obtained from all the 150 children were analysed for descriptive information ,the foot pressure results of each patterns compared with Normal Standing Foot Pressure. The initial evaluation in a bipedal position with no load showed equal Pressure Distribution on the right and left foot (20.79±4.97). When the bag loads were added to both shoulders, the pressure on the right and left foot, respectively, were 23.52±5.81 and 23.36±5.78 with a 15% load. When the bag loads were added to the right shoulder, the pressure on the right and left foot, respectively, were 24.79±5.81and 22.29±5.96, with a 15% load; When the bag loads were added to the left shoulder, the pressure on the right and left foot, respectively, were 22.17±5.85 and 24.63±5.75 with a 15% load. Statistically significant differences in foot pressure were noted in all the three backpack carrying Patterns when compared with foot pressure of Normal Standing without backpack load ($P<0.001$) using Paired-t-test.

DISCUSSION

Backpacks are one method of transporting school supplies. Scapular attachment is the most common method of attaching them to the back. Excess backpack weight can cause asymmetrical weight bearing of the foot, eliciting upper trunk leaning to a more weighted side to adapt postural agitation and maintain postural balance. The current study's main goal was to use a digital weighing machine to assess the effect of backpack load on weight-bearing in school-aged children.

A cross-sectional study was done on 150 school going students aged between 10 to 14 years. All the participants were asked to stand still on the digital weighing scale and their weight in Normal standing without backpack ,weight with backpack on both shoulders, weight with backpack on right side ,weight with backpack on left side were assessed. This was consistent with the objective of the current study. The literature reveals a debate about the load limit for backpacks, which is between 10% and 15% of the body weight. The present study, however, found statistical significance when standing normally without a backpack was compared to standing normally with the backpack on the shoulders using 15% of the bodyweight of the pupil. In static standing with 15% of backpack load on both shoulders caused an increased forward head tilt and rounded shoulders compared to backpack unloaded posture. The trunk also assumed a forward lean posture to counterbalance the load, limiting co-contraction of abdominal and back muscles and pelvic movement.

Static standing with 15% bag load on unilateral sides showed shoulder elevation and lateral spinal deviation away from the weight. Considering the fact that musculoskeletal disorders are one of the reasons for postural alteration among the student population, finding asymmetries in foot pressure distribution caused by the backpack overload and improper backpack carrying methods are necessary aspects to be considered within public health.

According to a study conducted by Macias BR and colleagues, carrying a heavy backpack load increased contact pressure beneath the shoulder straps by more than 20%. If the contact pressure on the right or left shoulder is higher than the pressure thresholds (30 mm Hg), it can cause changes in local skin and muscle blood flow.[16]. The centre of gravity shifted when a bag weighing 15% of the load carried on the shoulders, with fewer changes observed when compared to a bag load weighing 5% only. When the weight of the backpack exceeds the support capacity of the muscle groups, the vertebral column becomes overloaded, which can result in postural changes, pain, and dysfunction.[17]

When the school backpack weight was higher (15 percent), a decrease in the lumbar lordosis and a sligh-

tly smaller variation in sacral inclination were recorded, indicating a reduction in the natural curvature of the lumbar spine and asymmetry.[18] The current study found no link between excessive backpack weight and postural changes, and the findings was consistent with the current study. A similar result was obtained by Minghelli and colleagues, [19] Grimmer et al.[20] who found no difference in postural response with a bag weighing up to 10% of body weight compared to a lighter weight backpack and could not support the rule of establishing a limit load of 10% of body weight.

The current study's main objective was to evaluate the effect of backpack load (15% body weight) on weight-bearing among school-aged children, using the digital weighing machine in three different carrying patterns that showed a positive tendency towards the weighted side. This tendency was noted when the load is added either to the right or to the left shoulder. But if this posture is maintained even after the load is removed can cause postural changes in future that was consistent with a study done by Walicka K. and colleagues.[18]Notably, another study done by Motman et., al.[21] suggested that during shoulder bag carriage, asymmetry in muscle activity may indicate an inability to stabilize the trunk leading to development of back pain. Asymmetrical activity in back musculature was observed via electromyography (EMG) while carrying a shoulder bag with the weight on the right side of the body (right shoulder to right hip).Physical stress in the sagittal plane was found more with backpacks than single strap shoulder bag loading, although backpacks worn on both shoulders are thought to improve symmetry.

Caldwell and colleagues in a study had made use of digital weighing scales to evaluate the symmetry of weight distribution. Bohannon and Larkin had also used such a scale to measure lower limb weight bearing in hemi paretic patients. These studies found the use of digital scale to be an easy method to assess standing weight distribution in stroke patient as well as in people with unilateral distribution of lower limb weight bearing.[13,14] Further research is needed to investigate The effect of backpack carriage in dynamic conditions on cervical and shoulder postural changes. Moreover, the subjects were assessed in their homes, which may not reflect a realistic environment for children during day-time backpack carriage.

LIMITATION:

The small size of the participants couldn't be generalised that school-going children carrying 15% of load can end up with musculoskeletal problems.

The measurements are taken in a standing position as well as in a confined residential setting.

Participants stood motionless on the digital weighing machines, so subtle changes in posture could not be assessed as fast as they could on a force plate.

CONCLUSION:

When carrying a load bilaterally or unilaterally, the result shows a statistical variation when compared to vertical standing with no weight. Musculoskeletal changes may be suspected in the future if proper awareness programs are not implemented in schools and at homes. Furthermore, the effect of carriage on the shoulder and cervical postural changes need to be examined in dynamic conditions.

Backpacks with additional horizontal straps can reduce these stresses; modification of bag weight, as well as activities such as abdominal and back muscle strengthening, can be some of the precautionary measures that can be incorporated into the school

Pair wise comparison of back pack load						
		N	**Mean ± SD**	**Mean difference ± SD**	**t**	**P value**
Pair 1	NORMAL STANDING(KGS) RIGHT	150	20.79±4.97	-2.73±1.92	-17.39	**<0.001***
	RIGHT BACK PACK ON BOTH SIDE	150	23.52±5.81			
Pair 2	NORMAL STANDING(KGS) RIGHT	150	20.79±4.97	-4±2.17	-22.59	**<0.001***
	RIGHT BACK PACK ON RIGHT SIDE	150	24.79±5.81			
Pair 3	NORMAL STANDING(KGS) RIGHT	150	20.79±4.97	-1.5±2.01	-9.15	**<0.001***
	RIGHT BACK PACK ON LEFT SIDE	150	22.29±5.96			
Pair 4	NORMAL STANDING (KGS) LEFT	150	20.79±4.97	-2.57±1.91	-16.49	**<0.001***
	LEFT BACK PACK ON BOTH SIDE	150	23.36±5.78			
Pair 5	NORMAL STANDING (KGS) LEFT	150	20.79±4.97	-1.38±1.9	-8.86	**<0.001***
	LEFT BACK PACK ON RIGHT SIDE	150	22.17±5.85			
Pair 6	NORMAL STANDING(KGS) LEFT	150	20.79±4.97	-3.84±2.17	-21.68	**<0.001***
	LEFT BACK PACK ON LEFT SIDE	150	24.63±5.75			

Data are mean ± SD: Standard Deviation

*p < 0.001; P – value according to paired t test

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