COMPARATIVE EFFECT OF BACK PACK AND MESSENGER BAG ON THE CRANIOVERTEBRAL ANGLE OF SECONDARY SCHOOL STUDENTS

COMPARAREA EFECTULUI PURTĂRII GHOZDANULUI ȘI GENȚII POȘTAȘ ASUPRA MODIFICĂRII UNGHIULUI CRANIOVERTEBRAL, LA ELEVII DIN CICLUL SECUNDAR ȘCOLAR

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Keywords: craniovertebral angle, backpack, messenger bag, secondary school student

Abstract

Introduction: There is a growing concern that overloaded children's backpack and messenger bag may lead to the development of musculoskeletal injuries. Forward head posture and protracted shoulder are two most common deformities causing postural deviations resulting from frequent carrying of heavy backpacks and messenger bags by children and adolescents.

Aim. This study is therefore aimed to compare the effect of backpack and messenger bag on the Craniovertebral angle (CVA) of secondary school students in selected local government's areas in Lagos State, Nigeria.

Methods: Two hundred (110(55%) females and 90(45%) males) secondary students participated in this study. They were within the age range of 10-18 years. Participants were randomly assigned into 2 groups: (group1-Back pack and group2-messenger bag) using computer generated number sequence. The CVA was obtained and was recorded photographically under several load-carrying conditions.

Result: There was statistically significant difference (p=0.000) in the CVA when the backpack or the messenger bag was careried with 15% of their body weight for both type of bags. There was also statistically significant difference (p=0.000) in CVA when the backpack or the messenger bag was carried and the participants were placed on a form of brisk walking for 5minutes with the backpack/ messenger bag and the additional 15% weight.

Conclusions: This study concluded that both the backpack and the messenger bag caused a significant change in the CVA of the participants when carried. Carrying schoolbags weighing ≥ 15% of body weight appeared to be too heavy to maintain normal standing posture for school students.

Cuvinte cheie: unghi craniovertebral, rucsac, gentă de umăr, elevi de gimnaziu

Rezumat

Introducere: Există o îngrjorare generală privid influența greutății prea mari a ghiozdanului sau a genții poștaș asupra apariției lezinunilor musculoscheletale. Capul proiectat înaite și umerii în protracție sunt două dintre cele mai frecvente tulburări posturale apărute ca urmare a căratului unui ghiozdan prea greu, de către copii și adolescenți.

Scop. Studiul de față compară efectele cărării ghiozdanului și a genții postaș asupra unghiului craniovertebral (CVA), la școlarii din ciclul secundar, din zonele guvernamentale ale statului Lagos, Nigeria.

Metode: Două sute de participanți, 110 (55%) fete și 90 (45%) băieți, elevi din al doilea ciclu școlar, au participat la acest studiu. Vărstele sunt între 10-18 ani. Participanții au fost distribuiți aleatoriu în 2 grupuri: (grup 1- ghiozdan și grup 2- geantă poștaș), folosind distibuția numerică computerizată. CVA s-a măsurat și înregistrat fotografic, în diverse condiții de încărcare.

Rezultate: Există diferențe semnificative statistic (p=0.000) între CVA la purtarea ghiozdanului având 15% din greutatea corporală și CVA la purtarea genții poștaș în aceleași condiții. Există de asemenea o diferență semnificativă statistic (p=0.000) a CVA când ghiozdanul sau geanta poștaș au fost purtate în mers timp de 5 minute, încărcat cu 15% din greutatea corpului.

Concluzii: Acest studiu stabilește că purtarea atât a ghiozdanului, cât și a genții poștaș, determină o modificare semnificativă a CVA la participanții luați în studiu. Ghiozdanului care cântărește ≥ 15% din greutatea corporală, pare să fie prea greu pentru a permite menținerea unei posturi corecte în ortostatism, de către elevii din al doilea ciclu școlar.

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INTRODUCTION

Backpacks are commonly used by students of all ages with more than 90% of school children carrying backpacks worldwide [1] and roughly 40 million students in the United States using them on a regular basis [2]. The term "backpack" is a broad term in its definition. Backpacks come in various sizes, shapes and brands. They also come with various types of straps. Single straps bag are typically known as messenger bags or brief cases [3].

However, there is a growing public concern that overloaded children's and adolescent's backpack may lead to the development of back pain and other musculoskeletal injuries [4].Children are introduced to the concept of carrying a backpack as early as 2 years due to decreased availability of school lockers, increased homework, larger textbooks and other objects being carried to school [5]. These have prompted the increase use of bags by school children which has led to both an increase in weight and duration of backpack carriage [5]. This is very applicable to children in secondary schools in Nigeria [6].

Mohan *et al.* [7] reported that external forces such as load carrying in the form of heavy bags may influence the normal growth, development of children and adolescents and also maintenance of alignment of their bodies. Probably, for this reason school children experience a period of accelerated growth and development of skeletal and soft tissues problems. Therefore, load carrying along with irregular spinal growth pattern can affect the adolescent posture and make the adolescent more susceptible to injury [7]. Carrying of heavy messenger bags has shown its adverse effect on the trunk angle of students on the side of carriage [3]. Overtime the continuous carriage of these heavy messenger bags could cause overuse injuries to the hip which will lead to pain and discomfort while walking [3].

Forward Head Posture (FHP) is one of the most common cervical abnormalities that predispose individuals to pathological conditions such as headaches, neck pain, vertebral bodies' disorders, soft-tissue length and strength alteration [8].

Craniovertebral angle (CVA) is one of the common objective methods in assessing head posture [9, 10]. Wilmarth *et al.* [11] and Yip *et al.* [9] defined it as the angle formed by a horizontal line drawn through the spinous process of the seventh cervical (C7) vertebrae and a line joining the spinous process of C7 vertebrae with tragus of the ear. A smaller CVA indicates a greater forward head posture [8].

The average normal value of the CVA in a pain free population is about 50°. Any value below 50° leads to a form of cervical disorders [12, 13, 10]. Past research shows numerous attempts to study the effect of backpack weight on children and the appropriate weight to be carried [14]. A limit of 10-15% of body weight has been suggested as a reasonable limit for adolescents so that backpacks should not exceed 10-20% of a child's body weight [15,16]. Olubusola *et al.* [14], reported that children in Nigeria carry an average of about 10-15% of their body weight as their backpacks. Epidemiological studies, van Niekerk *et al*, [17]; Silva *et al*, [18] have shown a high prevalence of postural deviations in children and adolescents with forward head posture (FHP) and protracted shoulder (PS) posture being two of the most common postural deviations. This is due to the frequent carrying of heavy backpacks by children and adolescents.

These studies were only concentrated on a particular type of backpack which is the popular 2-strapped backpack. Other types of bags like the messenger bags which are also used by some students also in schools have not been put into consideration.

Purpose

This study is therefore designed to compare the effect of backpack and messenger bag on the Craniovertebral angle of secondary school students in Lagos State.

Materials and Methods

Subject

A total number of 200 participants both, male and female students participated in this study. They were recruited from selected secondary schools in four selected Local Government Council Areas of Lagos State. Prior to the commencement of the study, approval was sought from the Health Research and Ethics Committee of Lagos University Teaching Hospital, Idi-araba, Lagos with approval no: ADM/DCST/HREC/APP/765, and from District offices of the Lagos State Ministry of Education. The purpose, relevance and significance of the study were explained to the participants and their school authorities. Purposive sampling technique was used to select the local governments' areas. A simple random sampling technique (Fish and Bowl method) was employed to allocate the participants into either group1 or 2. Group 1 carried the backpacks while Group 2 carried the messenger bags. An informed written consent was obtained from the school's authority and the students before their participation in the study. Any student with obvious musculoskeletal disorders of the neck, scoliosis, recent orthopaedic trauma and deformities, cardio respiratory and neurological problems were excluded from the study.

Assessment

Participants were instructed to maintain a comfortable anatomical standing position. Adhesive markers were placed on the 7th cervical vertebrae (C7) and the tragus of the ear for the measurement of the Craniovertebral angle. Participants from each group were told to stand in the anatomical position with the head erect. The plumb line was set 2 metres away from the participant while a tripod stand and camera were set just behind it. The lateral landmarks marked clearly by the adhesive markers were well exposed. The plumb line was expected to fall in front or through the tragus of the ear and in front of the acromion process. Participant's photographs were taken with the digital camera.

The research procedure was divided into 3 phases: **Phase A**: Without backpack/ Messenger bag. The Craniovertebral angle of the participants were measured without any of the two types of bags. **Phase B**: with backpack/ messenger bag + 15% bodyweight.

Group1: participants were instructed to carry the backpack over their shoulders with an additional 15% of their body weight using the sandbags as weights.

Group 2: participants were told to carry the messenger bag over one shoulder with an additional 15% of their body weight using sandbags as weights. Participants who carried the messenger bags carried the bags over their right shoulder which was their dominant side. The Craniovertebral angle of the participants was measured. **Phase C**: with backpack/ messenger bag + 15% body's weight + 5minutes walk. The participants from each group were placed on a form of brisk walking for 5minutes with the backpack/ messenger bag and the additional 15% weight [19]. After the walk, the Craniovertebral angle of the participants was measured.

The participant's pictures taken were imported into Corel draw X7 software version using the Toshiba laptop to measure the Craniovertebral angle. To measure the Craniovertebral angle, a horizontal line starting from the spinous process of the 7th cervical vertebrae was drawn using the angular dimension of the Corel draw X7 software. Also a diagonal line was drawn through the tragus of the ear to the spinous process of the 7th cervical vertebrae. The angle at the point where these two lines met (spinous process of the 7th cervical vertebrae) was measured and recorded [20, 21, 22, 23, 19, and 10].

Data Analysis/Means

Data was analysed using Statistical Package for Social Science SPSS version 22. Descriptive statistics of mean, standard deviations (SD) and normal distribution of age, weight, height and the Craniovertebral angle were used to summarize the results. Inferential statistics of paired t-test was used to compare the difference between the two types of backpack on the Craniovertebral angle. The level of significance was set at $p < 0.05$.

Result

A total of 200 secondary school students participated in this study. One hundred and ten (55%) of the participants were females while ninety (45%) were males with age ranging from 10 to 18 years. The mean value of the age, height, weight and body mass index (BMI), were 14.13±1.908 years, 1.57±0.91m, 46.50±9.83kg and 18.63±2.81kg/m² respectively.

Table 1: Demographic characteristics of the participants

Variables	Backpack (n=100) X±SD	Messenger Bag (n=100) X±SD	t-value	p-value
Age (years)	14.23±1.752	14.03±2.057	0.740	0.460
Height (m)	1.58±0.09	1.57±0.10	0.794	0.428
Weight (kg)	46.94±9.19	46.05±10.46	0.639	0.523
BMI (kg/m²)	18.67±2.63	18.59±2.99	0.223	0.824

Significant at p-value < 0.05

KEY

X= Mean

SD= Standard deviation

BMI= Body Mass Index

Effects of Backpack bag on the Craniovertebral angle (CVA) of the Participants

Table 2 shows the values of the Craniovertebral angle of the participants that carried the backpack.

Paired t-tested showed that there was a significant difference (p=0.000) between the CVA of the participants without the backpack and when the backpack was carried with 15% load of their body weight.

Paired t-tested showed that there was a significant difference (p=0.000) between the CVA of the participants before carrying the backpack and when the backpack was carried with an additional load of 15% body weight with 5minutes walk.

Paired t-test showed that there was a significant difference (p=0.001) between the CVA of the participants when the backpack was carried with the additional 15% loading and when the backpack was carried with the 15% load of body weight with 5minutes walk.

Table 2: Effects of Backpack on the Craniovertebral angle (CVA) of the Participants

Variable	X±SD	t-value	p-value
CVA wt B	55.18±6.07	6.225	0.000*
CVA+15%BW	52.91±5.90		
CVA wt B	55.18±6.07	7.498	0.000*
CVA+15%BW+5mins walk	51.84±5.64		
CVA+15%BW	52.91±5.90	3.516	0.001*
CVA+15%BW+5mins walk	51.84±5.64		

*= Significant at p < 0.05

KEY

X= Mean

SD= Standard Deviation

CVA wt B= Craniovertebral angle without the Backpack

CVA+15%BW= Craniovertebral angle with Backpack plus an additional 15% bodyweight loading.

CVA+15%BW+5mins walk= Craniovertebral angle with Backpack with the 15% bodyweight loading and an additional 5minutes walk.

Effects of Messenger bag on the Craniovertebral angle (CVA) of the Participants

Table 4 showed the values of the Craniovertebral angle of the participants that carried the messenger bag.

Paired t-tested showed that there was a significant difference (p=0.000) between the CVA of the participants without the messenger bag and when the messenger bag was carried with 15% loading of their body weight.

Paired t-tested showed that there was a significant difference (p=0.000) between the CVA of the participants before carrying the messenger bag and when the messenger bag was carried with an additional load of 15% body weight with 5minutes walk.

Paired t-test showed that there was a significant difference (p=0.004) between the CVA of the participants when the messenger bag was carried with the additional 15% loading and when the messenger bag was carried with the 15% load of the body weight with 5minutes walk.

Table 4: Effects of Messenger bag on the Craniovertebral angle (CVA) of the Participants

Variable	X±SD	t-value	p-value
CVA wt M	55.96±5.47	4.457	0.000*
CVA+15%BW	54.51±5.49		
CVA wt M	55.96±5.47	5.308	0.000*
CVA+15%BW+5mins walk	53.36±5.47		
CVA+15%BW	54.51±5.49	2.924	0.004*
CV+15%BW+5mins walk	53.36±5.47		

*= Significant at p < 0.05

KEY

X= Mean

SD= Standard Deviation

CVA wt M= Craniovertebral angle without the Messenger Bag

CVA+15%BW= Craniovertebral angle with Messenger Bag plus an additional 15% bodyweight loading.

CVA+15%BW+5mins walk= Craniovertebral angle with Messenger Bag with the 15% bodyweight loading and an additional 5minutes walk

Comparison of the effect of Backpack and Messenger bag on the Craniovertebral angle of the Participants

The comparison between the effect of backpack and messenger bag on the Craniovertebral angle of the participants (Table 5 and Figure 22).

Paired t-test showed that there was no significant difference (p=0.336) between the CVA of the participants without carrying any of the two types of bags.

Paired t-test showed that there was a significant difference (p=0.048) between the CVA of the participants when they carried the two types of bags with an additional 15% of their body weights.

Paired t-test showed that there was a significant difference (p=0.054) between the CVA of the participants when they carried the two types of bags with an additional 15% of their body weights coupled with a five minutes' walk.

Table 5: Comparison of the effect of Backpack and Messenger bag on the Craniovertebral angle of the Participants

Variable	Backpack (n=100) X±SD	Messenger bag (n=100) X±SD	t-value	p-value
CVA wt B/M	55.18±6.07	55.96±5.47	-.965	0.336
CVA+15%BW	52.91±5.90	54.51±5.49	-1.991	0.048*
CVA+15%BW+5mins walk	51.84±5.64	53.36±5.47	-1.937	0.054*

*= Significant at $p \leq 0.05$

KEY

X= Mean

SD= Standard Deviation

CVA wt B/M = Craniovertebral angle without the Backpack/Messenger Bag

CVA+15%BW= Craniovertebral angle with Backpack/Messenger Bag plus an additional 15% bodyweight loading.

CVA+15%BW+5mins walk= Craniovertebral angle with Backpack/Messenger Bag with the 15% bodyweight loading and an additional 5minutes walk

Discussion

The main aim of this study is to compare the effect of backpack and messenger bag on the Craniovertebral angle of secondary school students in Lagos State.

The mean values for the age of the participants in this study fell among the average values for the adolescence age group which is from 10-19 years [24]. The BMI of the participants fell within the normal body weight. This may be because the age group that participated are students and they are young and active. This finding corroborates the result of the study by Odebiyi *et al*. [6] and Olubusola *et al*. [14] who carried out researches on secondary school students with similar age group. The result of this study revealed a range of 51.84˚- 55.96˚ of the Craniovertebral angle among the participants, and this corroborate the findings of the studies of Spechpt. [12] Rodrigo *et al*. [13] and Akodu *et al*. [10] who in their own studies reported a range of about 50˚ and above for a pain free Craniovertebral angle.

The findings from this study revealed that there was a significant difference in the CVA of the participants when the backpack was carried initially with 15% of their body weight and after five minutes' walk with the load, compared to when the angle was measured without any load. This finding agrees with the study carried out by Shivanda *et al. [19]* (2013), which states that carrying of heavy backpacks had a significant effect on the Craniovertebral angle. There was also a decrease in the CVA which causes more forward head protrusion causing a forward head posture. This finding is supported by several other researchers (Ramprasad *et al*, [23]; Hundekari *et al* [25]; Shivanda *et al* [19], Akodu *et al*, [10] who reported in their own studies that reduction in the CVA leads to a forward head posture.

The result of this study showed that there was a significant difference in the CVA of the participants when the messenger bag was carried initially with 15% of their body weight and after five minutes' walk with the load when compared to when the CVA angle was measured without any load. This also shows reduction in the CVA which predisposes adolescents to great risk of musculoskeletal disorders. This finding is supported by the result of the study of Akodu *et al*.[10] who reported that greater head protrusion leads to greater risk of neck musculoskeletal disorders.

The reason being that when this bags are carried with weight, collectively there is flexion of lower cervical spine, extension of upper cervical spine and increased thoracic kyphosis when compared without carrying these bags. [25]

When the CVA of the participants that carried the backpack and the messenger bags were compared, it showed slight significant difference when it was initially carried with 15% of their body weight, and after the five minutes' walk with the load. The CVA of the participants without

either of the backpack or messenger bag load showed no significant difference. This shows that the CVA of the participants before carrying the bags was normal but the loads caused significant changes in CVA leading to forward head protrusion and increased risk of musculoskeletal disorders. This agrees with the study of Odebiyi *et al.* [6] who reported that there was high prevalence of back pain among students due to the weights of their school bags. The reason being that when students carry their school bags, their center of gravity moves posteriorly due to the posterior load. The students body then tries to keep center of mass between the feet, so with a school bag load, the trunk is in more forward position which then causes a compensatory movement in the neck causing a forward head position and protraction of the shoulders which causes the students to look down. The students are then forced to extend the occiput to keep the eyes horizontal and look straight leading to the forward head posture [25]. It also agrees with the result of the study by Akodu *et al*. [10] who reported that greater head protrusion leads to greater risk of neck musculoskeletal disorders.

Findings from this study showed, that there was a significant difference between the participants when either of the backpack or messenger bag was carried and when the participant walked for 5minutes as well as when the participants were in an unloaded position. The CVA reduced after the participants carried the backpack or the messenger bag with 15% of their body weight for 5minutes, indicating that time carrying a load influences neck posture on upper trunk position. This result agrees with the result of the study by Shivanda *et al.* [19], who reported that loading the shoulder with backpack load changes adolescents' normal postural alignment.

Ramprasad *et al.* [23], reported that carrying bag loads of 15% of the body weight do not only affect the neck posture but also the head, trunk, and lower limb and affect overall posture. Also, carrying loads as low as 5% of the body weight causes significant changes in trunk and lower limb angles. These predispose students to loads of musculoskeletal deformities and conditions.

The results of this study shows that the participants still fall within the normal range of pain free CVA which is about 50° and above ([12, 13, 10]. However constant loading of the body with backpacks and messenger bag can cause adverse effects in the future if these children continually carry heavy loads to school regularly. Ramprasad *et al.* [23] reported that persistent forward head posture was found to be the major cause of many musculoskeletal disorders around neck and shoulder region in adults.

Also, when both bags were carried with 15% body weight there was a significant decrease in the CVA, this therefore implies that no matter the type of bags being carried by students, carrying bags weighing 15% of their body weight would be too heavy for secondary school students to maintain their normal postural alignment, in other words, carrying a bag of less than 15% of body weight could be recommended. This finding agrees with the result of the study by Mohamed *et al*, [16] who reported that a schoolbag should not be more than 5% of body weight among the female students and 10% of body weight among male students.

Conclusion

Based on the results from this study, the following conclusions and recommendations were made: The Craniovertebral angles of the participants were normal when neither the backpack nor the messenger bag load was carried. The Craniovertebral angle reduced significantly when the participants carried either the backpack or the messenger bag with an additional 15% of their body's weight. The Craniovertebral angle reduced significantly when the participants carried either the backpack or the messenger bag plus an additional 15% of their body's weight with a five minutes' walk. Both the loaded backpack and the messenger bag caused a significant change in the CVA of the participants when carried. No matter the type of school bags carried by students, heavy bags greater or equal to 15% of their body weight predispose them to lots of musculoskeletal deformities and conditions. It is therefore

recommended that school lockers should be made to store student's school books rather than carrying heavy bags filled with books to school daily.

Parents and guardians should restrict the amount of load carried by their wards to school. Students should be educated on the effects of carrying heavy school bags on their musculoskeletal system. Students should be educated on the appropriate way of carrying their school bags. Parents and guardians should be educated on the exact or correct weight to be carried by students or their wards to school which should be less than 15% of their body weight.

Limitations

The study was not allowed to be carried out in some schools because of the use of camera which was one of instrument used in this study.

Acknowledgements

The authors appreciate and acknowledge the assistance of Lagos State government education district VI, Ikeja, Mushin, and Oshodi/ Isolo Local government areas for kindly mobilizing their students to participate in this study.

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