Review Article

The Effects of Schoolbags on the Health of Students

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Abstract

Schoolbags used by students has become the most popular means of carrying belongings to and from school all over the world. The aim of this study is to review the literature and to ascertain the recommended average weight of schoolbags in comparison to child Body Weight (BW), to describe the correct way of schoolbag carrying and to determine risk factors related to carriage of schoolbags in an attempt to suggest the alternatives to avoid or at least to reduce these drawbacks. The majority of reports indicated that schoolbag greater than the recommended weight (10% of student BW) for long period of time might affect the musculoskeletal alignment which will cause back pain, neck pain, and shoulder pain in addition to deformities in the stature.

Recent literature focused on schoolbag weight, the manner and duration of carriage, the age and gender of the student which could affect the shoulders, cervical and thoraco-lumber spines of students. A general guideline of 10% BW was initially proposed by a Germans (Voll and Klimt) in 1977. Many of studies later on continued to recommend and emphasize that the schoolbag load should not exceed this limit. The best way to carry schoolbag is on both shoulders with well-padded straps and hip belts for proper distribution of the load. The duration of carriage is also an important factor influencing cervical and shoulder posture and could contribute to and maintain musculoskeletal symptoms. Student age was found to be significantly associated with developing musculoskeletal disorders, especially among adolescent children (11-14 years). Gender was another significant predictor with girls showing more symptoms than boys of similar age. Back pain is the most frequent musculoskeletal problem and shoulder pain was the second most common symptom among children.

Preventive measures such as limiting carrying load and correcting way of carrying are multi-faceted and need to be implemented in cooperation between different authorities including the students and their parents, the Ministry of Education and media in order to achieve these goals.

Keywords: School age children, schoolbags, the way of carrying.

Introduction

The term schoolbag refers only to student bag, regardless of its weight, shape, size, or colour. The most common method used by students for carrying their belongings to and from school all over the world is the schoolbags [1-4]. Studies indicate the incidence of schoolbag use by school children in the developed countries is at least 90% [5]. Schoolbags carriage are thought to be the predictors of many musculoskeletal discomforts (MSD) [6-8].

In recent years, non-specific back pain, neck pain, shoulder pain and poor posture among school children are topics of growing importance in the literature and these conditions were mostly related to

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overloaded caused by heavy schoolbags [2, 8-10]. Factors affecting schoolbags weight are direct or indirect. Direct factors include the number, the size and weight of textbooks, and the weight of additional belongings such as the lunch, bottles, heavy pencil cases, sport equipment and jackets. More recently laptops are among the items that might be carried by the students. Important additional factors other than schoolbag weight are design and carriage adjustment of the bag. Indirect factors include storage facilities, study curriculum, lack of awareness about the potential health hazards resulting from carrying heavy schoolbag, the physical build and capability of the student, the duration and frequency of carriage, the need to bring homework back to the school and the lifting and carrying techniques of the bag [8, 9, 11-13].

Although few researchers denied schoolbags association with MSD [13], the majority of reports indicated the significant positive association. Heavy loads carried by the students (greater than the recommended bag weight of 10% of BW) for long period of time might affect the musculoskeletal alignment which contributes to the development of pain in the neck, shoulder and back which might be followed by irreversible deformities in the back [2, 5, 10, 14]. Although prevalence of back pain among children and adolescents is less than adults, but it is a strong predictor for back pain in adulthood (15, 16) . A study (in New York) found that about one third (30%) of children and adolescents investigated reported back pain but only a minority visited doctors [17, 18].

The most common reported causes of back pain and MSDs in children are those occurring due to trauma during playing or after a fall in addition to carrying a heavy schoolbags. Less common causes include abnormalities or disease in the spine [17, 19]. The pain may be sharp and shooting, burning, or aching and may be felt anywhere in the neck, shoulder and back [17].

An early published study of schoolbag carriage drawbacks was the study by Malhotra & Sengupta in 1965 who compared the different methods of carrying schoolbags and found that hand carriage caused marked lateral bending of the trunk and poor posture. [20, 21]. Recent literature focus on schoolbag weight, the manner and duration of carriage, the age and gender of student which can affect the shoulder, cervical and back posture of students [8]. The differences between the results of different studies could be related to the differences in the culture, school curriculums, and number of books and accessories, quality of books and quality of the schoolbags in addition to differences of physical capabilities of the students.

Method

The study is conducted a literature review of ninety three references from different locations all over the world. Locally, we found one study from Babylon governorate in Iraq by Farhood, H. We focused on the important risk factors which related with schoolbag carriage including schoolbag weight, the manner and duration of carriage, in addition to the age of the students of both genders in both primary and secondary schools.

The aim of this study is to determine the recommended average weight of schoolbags in comparison to child Body Weight (BW), to describe the correct way of schoolbag carrying and to determine the risk factors related to carriage of schoolbags aiming to reach suggestions about the alternatives to avoid or at least to reduce these drawbacks.

Pathophysiology

The spinal column is composed of 33 vertebrae. When viewed from the side, spinal column has a natural S-shaped curve. The cervical and lumbar regions have a slight concave curve, and the thoracic and sacral regions have a gentle

convex curve. The first cervical vertebra articulates with the skull and the last vertebrae (the sacrum) form the posterior wall of the pelvis. There are cartilaginous disks between the vertebrae for cushioning with supporting ligaments along the whole length of the spinal column for support. Openings between vertebrae called foramina, allow the nerve roots to exit the spinal canal.

The erector spinae and erector abdominalis, have been identified as the major trunk muscles responsible for stabilizing the backpack weight, while the shoulder protractors – serratus anterior, pectoralis major and pectoralis minor, and elevators – upper trapezius, levator scapulae and rhomboids have been identified as the muscles that resist the shoulder strap forces [8].

The concept of ideal posture is referred to as "neutral spine". From a sagittal plane (side) view, the line of gravity passes from external auditory meatus, posterior to the cervical and lumbar vertebrae, anterior to the thoracic vertebrae, through the shoulder joints, posterior to the hip joints and anterior to the knee and ankle joints. From a frontal view, bilateral structures (e.g., iliac crests, acromion processes) are at the same horizontal level (figure 1) [13, 22].

Loading the students with heavy weight leads to significant changes in cervical and shoulder posture as compared with unloaded. These changes could be estimated by measuring the changes in the postural angles. The Cranio-Horizontal Angle (CHA) the angle formed at the intersection of horizontal line through the tragus of the ear and the line joining the tragus of the ear and external canthus of the eye. It is believed to provide an estimation of head and neck angle or position of upper cervical spine. The Cranio-vertebral Angle (CVA): is the angle formed at the intersection of a horizontal line through the spinous process of C7 and line of the tragus of the ear. This is believed to provide an estimation of the angle between the neck and the upper trunk. A small angle indicates forward head posture. The Sagittal Shoulder Posture (SSP) is the angle formed by intersection of a horizontal line through C7and line between the mid- point of the greater tuberosity of the humerus and posterior aspect of the acromian process. This provides measurement of forward shoulder position (figure 2) [5].

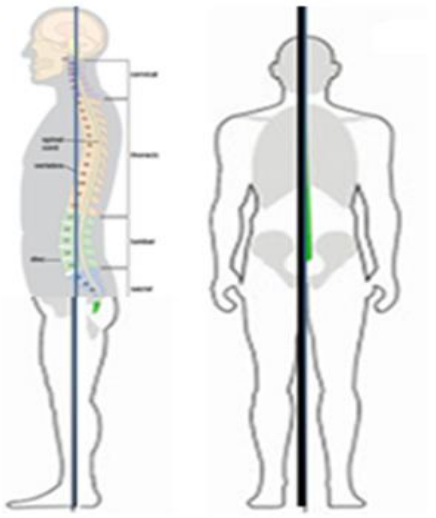

Figure 1. Posture profiling in the Sagittal and Frontal planes

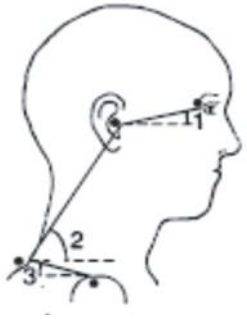

Figure 2. Important Postural Angles are: (1) The cranio-horizontal angle, (2) The carnio-vertebral angle, (3) The sagittal shoulder posture.

It is essential to remember that the school children are facing a period of accelerated growth and development of skeletal and soft tissue. In addition, the growth of the spinal structures extends over a longer period than other skeletal tissues. Furthermore, spinal ligament and muscles are not fully developed until after 16th year of life [23]. Consequently postural integrity in adolescents can be affected by both internal and external influences and this might threat the postural integrity in adulthood [5, 13].

Repeated carrying, lifting and manipulating a heavy weight applied to the body like backpack is commonly associated with simple muscle and ligament strain in the necks, shoulders and the back and might extend to deformities in the postural abnormalities leading to deviation from proper alignment with the gravitational axis like kyphosis, lordosis or scoliosis [13, 24]. Asymmetric weight carrying (i.e. by one shoulder, or one hand) leads to asymmetry in muscle activity and encourage lateral spinal bending and shoulder abnormality such as changes in the shoulders level) [13]. Any heavy weight positioned posterior to the body in between the shoulder blades will shift the center of gravity backward, so the body will lean forward to keep the center of gravity between feet, exerting excessive abnormal forces on the spine (figure 3). This is accomplished by leaning forward at the ankle or hip or through inclining the head forward. Additionally, the rigidity of postural muscles controlling these adjustments is proportional to the carried weight [5, 8, 13, 14, 24, 25].

To correct the bend back and elevating the head from downward posture can lead to compressive forces on the posterior region of the cervical and thoracolumbar spines and this will increase level of muscular contraction, the risk of muscle spasm, fatigue and stiffness [26]. The weight can also pull on the neck muscles, contributing to neck pain and headache [13].

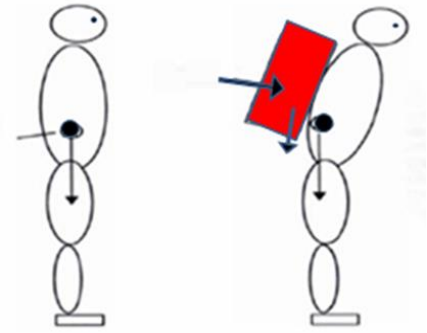

Figure 3. Children carrying the backpack lean forward to keep the center of gravity between feet

The natural curves in the middle and lower back will be distorted, which can cause irritation to the spine joints and the rib cage and with time may increase the normal curvatures present in the spine [27]. Lifestyle may be associated with postural alterations [28]. Additional effects might be related to of schoolbag uses are injuries due to the fall on up or down stairs, or buses [13]

Schoolbag weight

In both scientific and popular media, schoolbag weight appears to attract more attention than other schoolbag carriage factors. Several authors from different countries reported positive significant association between musculoskeletal pain and schoolbag weight [29-33]. The weight of the schoolbag carried by the students varies considerably from one area to another, from day to day according to curriculum and even among students within one classroom. The schoolbag weight is usually measured as percentage of BW. Literature review showed that the average loads of schoolbags carried by the students vary greatly and ranged from 8.84% to 27.5% of the child BW [1, 5, 6, 9, 23, 34]. For example a study in Babylon governorate in Iraq by Farhood, H. in 2013, reported the mean schoolbag weight of primary school children at 18.9 % of their BWs [14].

It is worth to mention that there is no clear cut limit for maximum load below which no adverse effects are seen. A general guideline of 10% BW was initially proposed by German scientists, Voll and Klimt, in 1977 and several studies later on continued to recommend and emphasize that the schoolbag load should not exceed this limit. A significant correlation was reported between the extra load weight and the clinical problems. An increase of schoolbag weight to 15% to 20% appeared to be too heavy for the child to maintain normal cervical and shoulder posture alignment and may lead to a long list of consequences including increased risk of musculature imbalance which predispose to the development of neck pain, shoulder pain, back pain, restrictive effect on lung volumes, heart rate change, lower limb dynamic changes while walking and posture changes [6-9, 13, 35-39]. Ramprasad and his colleagues (2010, in India) concluded that carrying a backpack weighing 15% of BW changes all the postural angles (CHA, CVA and SSA) [40] They recommend that adolescents should carry backpack of less than 10% of BW to maintain good postural alignment. Similarly, Mayank and his colleagues (2007) found that school bag weighing 10% of BW would be too heavy for the Indian school children aged 10-15 to maintain their normal cervical and shoulder posture alignment [5].

Schoolbag placement and the way of carriage

The second important factor that may cause MSDs relates to schoolbag carrying way where the load is not distributed equally on both body sides and this is related to the placement of the bag. Stuempfle KJ and his colleagues (2004, in Gettysburg College) found that the load placement is an important factor in the physiological and perceptual responses to load carriage [13, 41]. Some authors reported a significant correlation between backache complaint and the way in which the schoolbag was carried [29].

All around the world, the most usual ways of schoolbag carrying include: carrying by one hand, slung over one shoulder (one-strap bags), carrying on both shoulders (two straps bag) and rolling schoolbag (wheeled schoolbag). The carrying manner of a schoolbag is determined by its design and is related to its style, cost and availability. Choice of schoolbag placement by children is most often based on personal comfort, ease in donning and doffing backpack, or peer acceptance. Some authors suggested that asymmetric

schoolbag carrying (on one shoulder, or by one hand) causes asymmetry in muscle activity and encourages lateral spinal bending and might lead to changes in shoulder level (figure 4) and development of shoulder, neck and lower back pain (LBP) even if the bag weight constitutes 10% of the child's weight [6, 13, 14, 21, 42-44]. Skoffer in his Study (2007, in Denmark) found that carrying the schoolbag in an asymmetric manner may play a role with LBP [45]. On the contrary, other researchers found no significant relationship between the method of carrying schoolbag, both symmetrical and asymmetrical, and the prevalence of back pain [10, 23, 31] which may be attributable to the differences in school curriculum or the type of books required in each of the different countries. Chansirinukor and his colleagues (2001, in South Australia) found that carrying a backpack over both shoulders has no significant or minor effect on the postural angles [36].

It is worth mentioning that the most common way of schoolbag carriage reported by researchers carrying the backpacks using both shoulder straps [6, 9, 13, 46-48]. Usually shoulder straps and are used to secure the backpack on the person's back. If a hip-belt is also worn, much of the shoulder strain can be reduced as the weight of the bag is largely being transferred to the hip (figure 5) and improved postural stability [8, 49]. However, it is important to mention that this hip-belt when tightened might induce a compressive force on the lower abdomen.

Figure 4. Changes in the level of shoulders caused by faulty schoolbag carriage

Figure 5. Straps transfer the weight of the bag along the lower backpack on the lumbar region.

Grimmer and his colleagues (2002, in South Australian) found that carrying backpack centered at the level of the third lumbar vertebra (low on the back) was associated with least postural displacement [24]. Recent study (2015, in Korea) which suggested that carrying a backpack in higher position, with fastening of the shoulder strap, may be more favorable for normalizing the foot weight distribution [50]. In another study involving school students, they found that postural adjustment of the backpack load leads to greater harm when it was carried high on the back [24]. The best schoolbags are those especially designed and shaped for lumbar areas, so that some of the load is carried to the top of the buttocks (figure 6) [51]

Mackie and his colleagues, (2005, in New Zealand) showed that shoulder strap tension and shoulder pressure is affected strongly by the manipulation of backpack weight, hip-belt use, and length of the strap [6, 51]. On the other hand, the tightness of fit of a backpack might restrict a person's ability to breathe, which may in turn affect respiratory performance [8]. But unfortunately few students reported using hip belt [13]. Additionally, Hong and his colleagues (2003, in Hong Kong) concluded that the two straps backpack found to be safer than the one strap bag for children stair walking [38].

Choosing a schoolbag with many separated compartments will help to ensure correct packing, organizes load distribution - where the largest and heaviest items in the backpack fitted closest to the back and the smallest sharp contents away. This will prevent items movement within the bag and so load movement can be controlled [13, 51].

The rolling or wheeled schoolbags have been recommended by most professionals in the United Kingdom, but might face other challenges such as difficult manipulation on stairs, storage within school and passage through crowded hallways and buses. However, researchers have found that wheeled backpacks were significantly heavier than the regular backpack [7, 13, 29, 52]. For all types of carrying, special precautions need to be taken by children and adolescents with spine deformities caused by scoliosis, kyphosis, cerebral palsy and other musculo-skeletal deformities.

Dieter Kanabah (a member of the German Technical Commission for Quality Control in the city of Leipzig) pointed out that school bag should be of bright orange or yellow color. These colors make the child visible during the day. Additional reflective safety tape or strips should be added to children bags to prevent traffic injuries at night or on dim light conditions. He also recommended the parents to select lightweight bag. Low weight bag is that weighing when empty (without any content) between 1- 1.3 kg. A lighter bag may then lacks the necessary tough structure, so a proper bag need good durability and stiffness, particularly in the back area [53].

Figure 6. The right way of Backpack carrying.

Duration of carriage

A considerable variation in the length of time of bag carriage by school children is expected. Some students, especially those in the city, are usually taken to their school by their parents' cars so they might carry their bags for only few minutes while others may carry their bags for longer period (20 to 30 minutes or more). The duration of carriage depend on the distance between the student's house and their school which is usually longer in rural than urban areas.

Results of many studies revealed that carrying time of schoolbag influences cervical, shoulder and lumbar posture and could contribute to the pathogenesis of MSDs both in initiation and maintenance [5, 6, 8, 10, 13, 22, 36, 54-56]. It was found that children reporting fatigue while carrying the pack for longer periods of time experienced significantly more back pain [9, 13, 48]. Studies by Haselgrove and his colleagues, (2008, in western Australia) found that about one half of participants carried their school bag for more than 30 minutes per day with 85% carrying their bag over both shoulders and felt to be heavy by 54% and cause fatigue by 51% of the participants. Carrying a school bag for more than 30 minutes daily and taking an inactive form of transport to school (car or bus) increased the odds of having both back and neck pain [13, 34].

Student age

Children's skeletons are still growing so carrying heavy bags and other external forces might influence the growth, development and maintenance of posture of children and can act as a predictor of lasting MSDs. The results of one study (2001, in South Australia) suggested that carrying school bag weighing 10% of BW would be too heavy for students aged 6-7 years to be able to maintain their normal postural alignment [36].

It was shown that student age has a significant negative association with developing MSDs especially among adolescent children aged 11-14 years (junior students in secondary schools) as their spine is at critical stage of the growth spurt of puberty. Some researchers reported that some adolescent students are still quite young to carry heavy bag weight in proportion to their BW [8, 9, 13, 57-60]. In addition, in some educational premises such as the high schools, the students need to move between classrooms or halls with their schoolbags in order to attend different lessons which will increase the carriage load. However, this differs from primary schools where all lessons are usually given in specific classrooms for each group of students [8].

Gender

Several studies showed that gender is a significant factor for development back pain among school children. Girls were more likely to report such symptoms and diability than boys of the same age [6, 8, 10, 29, 34, 51, 59, 61-63] . This might be related to physiological differences between the two genders. However, few studies revealed that girls carried heavier school bags than boys, (both in term of raw school bag weight and BW proportion) [10, 64, 65]. Navuluri et al, (2006, in New Mexico) found that the correlation between pain and backpack weight per body mass index among girls was positive and significant, but negative and non-significant among boys [6, 13, 66]. On the other hand, some other researchers found no significant difference between boys and girls in this aspect [10].

Additionally, the duration of schoolbag carriage might also be related to gender. A study by Smith and his colleagues among female undergraduate students.in Wichita State University in the US in 2006 suggested that long term shoulder bag carriage could cause permanent postural deviation due to altered pelvic rotation

during walking [14, 67]. The results of another study among female undergraduate students in King Saud University in Saudi Arabia in 2011concluded that carrying backpack that is 10% of BW caused higher rates of complain of shoulder, neck and back pain and induced more postural changes and negatively affected their dynamic balance. The researchers recommended reduction of the backpack weight percentile to 5% BW among females [13]. It well documented that adolescent idiopathic scoliosis is more common in girls than in boys and as many researchers showed that schoolbag weight was higher among females, so one conclude that schoolbag weight might exaggerate the condition, but this finding needs more studies to be proved.

Complaints

The causes of musculoskeletal symptoms among students are believed to be of multifactorial origin, and the carriage of heavy schoolbags is suspected to be the main 'contributory factor' which is usually overlooked [9, 35, 68]. These MSD symptoms might be of somatic or psychological origin. Many researchers concluded that most musculoskeletal complaints relate to childhood somatic symptoms [29, 69, 70]. On the contrary, other researchers found that the psychological and emotional factors appeared to be more important in neck, shoulder, and back complaints occurring in young population [9, 71-73].

(1) Back pain is the most frequent musculoskeletal problem among school students found in the literature review [13, 14, 47, 74-77]. Siambanes and his colleagues (2004, in California) found that back pain of 87% of students reported was "bad" or "very bad" and almost all of them reported feeling relief on taking off their backpack [59].

(2) Shoulder pain was the second most common musculoskeletal compliant in school children. Dochrell and his colleagues found that pain was mostly reported in the shoulder region, followed by discomfort in the back among school age children in Dublin in 2006.[9, 13, 33]. Yanto and his colleagues (2008, in Indonesia) reported most of the 2nd grade (11 – 12 years) school children reported that the highest musculoskeletal pain was shoulder area (16.4%) followed by neck (14.5%) and leg (12.7%) pain [69].

(3) Some mechanical musculoskeletal injuries such as fall on stairs or buses due to wearing of backpack or being hit by the backpack [78-80].

(4) Fatigability sensation due to schoolbag carrying is also a common complaint [76]. Fatigue may prevent student participation in some school activities or even missing school, abstaining from playing or participating in sport activities [76, 81-83]

(5) Postural effects are also common complaints resulting from schoolbag position on the back during its carrying. Repeated carrying backpack is commonly associated with musculoskeletal misalignment which might extend to postural asymmetry like kyphosis, lordosis or scoliosis. Pascoe and his colleagues in 1997, found that the daily physical stresses which was associated with carrying the bag on one shoulder significantly altered the posture and gait of youths aged 11-13 years [84]. Asymmetric weight carrying might cause asymmetric muscular activity which may contributes to or exaggerates lateral spinal bending and changes shoulder level. Another similar finding was reported in a study among undergraduate students in Hong Kong in 2003. The authors concluded that walking with a backpack of greater than 10% body mass induced significant changes in trunk posture and negative deviation of respiratory parameters [9, 85].

(6) Headache is another complaint: Mikkelsson and his colleagues (1997, in Finland) showed that about one third of school children in their study (30.5%) reported headache at least once a week

compared with 54% who reported musculoskeletal pain [86].

(7) Pressure sores underneath shoulder straps are also common complaints in some students. Backpack weight had the greatest influence on shoulder strap tension and shoulder pressure as the increased weight of backpack increase the strap tension. While if the shoulder strap was loose, the tension and pressure under the shoulder strap was decreased [8, 13, 51, 87]. The result of one study revealed that the prevalence of contact pressure beneath the shoulder straps and the resulting perceived pain were significantly correlated with increasing schoolbag weight over the range from 10%, 20% to 30% BW while contact pressures were zero with an empty backpack [13, 88]. Another study in Britain in 2005 found that the pressure underneath the shoulder will not decrease or get relieved by wearing multiple garments, even in layers, when carrying a backpack [13, 89]. Mackie and his colleagues (2005, in New Zealand) showed that the manipulation of backpack weight, using hip-belt and shoulder strap length had a significant effect on shoulder strap tension and shoulder pressure sores [13, 87].

(8) Considerable physiological changes might result from backpack carriage. There is a positive relationship between the weight of backpack and the changes in the vital signs (such as the respiratory rate). Significant increase in forward bending and limited movement range of the trunk appears to affect negatively the movement of the thorax and reduce the volume of the abdomen. The abdominal muscles are contracted in order to gain trunk stability and this will prevent abdominal breathing. Thus, the only way that the subject could increase oxygen uptake to support the increased metabolic cost might be through the use of costal breathing and rapid breathing [13, 85]. Additionally, some researchers found that loads greater than 10% BW have a restrictive effect on lung volume, similar to kyphotic postural effect [13, 26, 90, 91]. This restrictive effects were more pronounced for the schoolbag with a mono shoulder strap [92]. Others reported no significant change in heart rate and blood pressure, however the study reported significantly prolonged blood pressure recovery time at 15% load [13, 93].

Conclusions

Carrying a backpack weighing more than 10% of BW is associated with increased incidence of neck pain, back pain, shoulder pain and other MSD. The best way to carry schoolbag is multiple compartment backpack using two shoulder straps with hip belts; well-padded to ensure best distribution of the load. The results of the reviewed studies revealed that the time of schoolbag carriage is an important factor influencing cervical and shoulder posture and could contribute to the appearance and continuation of musculoskeletal symptoms. It was shown that the student age was significantly associated with developing MSDs, especially among adolescent children aged 11-14 years and females were more likely to report such symptoms than males of the same age.

Recommendations

The preventive measures for limiting the carrying load to less than 10% of child's body weight and the correct way of carrying and these measures are multi-faceted and should be implemented in cooperation between different related authorities. The Ministry of Education and the parents should work together to achieve these goals. Suggestions to solve the problems of carrying more than 10% BW:

(A) The role of the Ministry of Education

(1) The Ministry of Education has a role in educating the community including the students and teachers and the general community about the possible health

hazards induced by carrying heavy schoolbags. The Directorate of Education needs to circulate educational materials such as folders, posters and information booklets to the students, and teachers to educate them about these hazards.

(2) The role of the Ministry of Education is to implement these steps mentioned in the recommendations to reduce the schoolbag weight. The Ministry of Education should put forward guidelines for publishers responsible of books printing aiming to reduce the size and weight of textbooks. This could be accomplished through dividing large books into two or more parts (up to 12 parts or more, each part 16 pages) to reduce the weight of the books carried daily by the students. The Iraqi Ministry of Education had recently introduced a new educational system depending on dividing the study year into two separate courses and this might reduce the need for heavy serial textbooks and may reduce the weight of school backpacks

(3) At the primary school level, one of the most important suggestions is to focus on school activities more than home activities. Here the student do almost all their school duties within the school and leave their books in their schools.

(4) At the secondary school level, the needed actions include the provision storage facilities in the schools such as cabinet or lockers for the students to keep their schoolbag.

(5) The provision of free meals and water or proper food shops as substitute for carried food and water bottle in the students' bags.

(B) The parents must keep an eye on children's schoolbags and insist on:

(1) Selection of light bags, keeping in mind that lighter bag may lacks the necessary tough structure, so a proper bag need good durability and stiffness, particularly in the back area and should permit balanced bag weight.

In addition, the parent help in the selection of light notebooks with small number of papers and light covers and proper additional tools such as bottle of water and cans of pens and all must be well designed and have light weight and small size.

(2) The use of well fitted bag and correct lifting and carrying habits through:

a. The backpack should fit properly and comfortably to the child's back rather than hang off their shoulders.

b. Adjusting two shoulders straps and pelvic belt so that the bag is resting in the middle of their back and the bottom of the backpack is just above the child’s waist.

c. Making sure that school children understand that carrying the school bag on one shoulder will cause back pain and potential injury.

(3) The use of computers as a substitute for books is costly and need long time and might not be applicable even in developed countries and the use of paper- book will remain as an essential element in education. The problem of using both laptops and books with the potential extra weight loads needs to be investigated in future studies.

(4) Regular cleaning of the schoolbag is also important parents’ responsibility as the child may store non-essential items in his bag.

(5) The parents need to ask their children regularly about fatigue feeling or pain. If so, lighten the load and adjust the fittings.

(6) It is very important for parents to consult the doctor if the child complains of neck pain, back pain, or see any spinal or postural deviations.

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