

A pilot study of the weight of schoolbags carried by 10-year old children

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Summary

This study was carried out to determine the weights of schoolbags that 10-year-old children carry to school. The relationship between bag weight and body weight was established. Investigation was also made into the methods adopted by children to carry their bags, and the distances that they are expected to carry these loads. A questionnaire was used to gain some of this information, while measurements of bag weight and body weight were obtained using an electronic weighing scales.

The findings suggest that 10-year-old children are carrying an average load of 11.4 lbs or equivalent to 15.2% of total body weight. Sixty-two percent carried the bags on their backs. The mean distance that subjects carried their bags was 0.6 miles per day. In the absence of guidelines on acceptable loads to be carried by children it is difficult to assess the possible consequences of carrying such loads. There is a need for further research in this area.

Introduction

Throughout history men and women of all ages have carried goods, food, supplies and arms for the purpose of survival. Today, despite many technological advances, this basic form of man-powered transportation remains an indispensable resource for many occupational tasks and activities of daily life (Kinoshita, 1985).

In recent times parents have expressed concern about the weight of children's schoolbags, and the consequences of carrying such loads. Their concerns cannot be allayed because little has been documented on the carrying of loads by children. The authors are not aware of any published survey documenting the loads that are carried by children to and from school. Research on manual handling that has been documented has been carried out on adult populations, especially those whose work practices include frequent manual handling of loads (Winkelmolen et al 1994; Dehlin and Jaderberg 1982).

Several studies have been conducted to identify the physiological cost of manual handling and to determine the most effective way of carrying loads. The energy cost required for carrying loads depends on many factors such as walking speed, walking surface, distance, body weight, load weight, posture, and the method of carrying the load (Giovanni and Goldman, 1971; Haisman 1988; Pandolf et al, 1977; Soule and Goldman, 1969). Malhotra and Sengupta (1965) compared different methods of carrying schoolbags. The rucksack method proved to be the most economical, and hand carriage to be the least economical in terms of energy expenditure. They also found that hand carriage caused marked side bending of the trunk and poor posture. Datta and Ramanathan (1971) also investigated several methods of carrying loads. A double pack (i.e. front and backpack) was the most economical in energy cost and the least stressful to the cardiorespiratory system. Carrying the load with the hands by the side proved to be the worst in terms of physiological efficiency. Similar observations were made by Lind and McNicol (1968) investigating load carriage

by hand or by shoulder harness. They noted that in hand carriage the arm muscles involved were close to fatigue after 2.5 minutes, while with the same load the shoulder muscles had not fatigued until after 15 minutes.

To reduce the stress imposed on the body during load carriage the placement of the load needs to be comfortable for the carrier. Pierrynowski et al (1981) noted that there was increased energy expenditure when a load being carried on the back moved out of phase with the trunk. This was also reported to be uncomfortable by the carrier. Pierrynowski et al concluded that in the pursuit of comfort and reduced energy expenditure more attention should be paid to shoulder straps and hip and shoulder contact points to bring the trunk and load in phase with each other.

Carrying a load is stressful both physiologically and biomechanically. Although there is no conclusion as to the optimal load to be carried by a person, there are relevant guidelines that have been produced in response to research findings (NIOSH, 1981; Birnbaum et al, 1993). There is also legislation in place for the promotion of good work practices among adults (Safety, Health and Welfare at Work Act, 1989). There are no guidelines for loads to be carried by children. The effects these loads have on a growing child are not clearly understood. It is possible that the carrying of heavy loads in childhood could predispose to backpain. It is also likely that habits or methods of carrying that are learnt in childhood will continue through to adult life. Physiotherapists have been and are involved in the training and education of adults in approaches to manual handling (Girling & Goldman, 1988). However, the process of education in manual handling should commence at a much earlier stage. Given that there is so little indication of the extent of the loads that are carried by children or the methods by which they are carried, it was decided to investigate the weight of schoolbags carried by children.

The specific aims of the study were to:

- investigate the weights of schoolbags that 10-year-old children carry to school;
- establish the weight of child : weight of bag ratio;
- investigate the methods of carrying related to type of schoolbag;
- investigate the distances that these weights are carried.

Methodology

One hundred subjects, 50 boys and 50 girls, took part in the study, which was conducted in two schools. The subjects were all 10 years of age. The study was carried out by means of objective measurement and assisted questionnaire. The study took place each morning as soon as the subjects had arrived for class. The weight of any individual child's schoolbag could vary from day to day depending on the timetabled classes. Therefore, ten different subjects were measured each day in order to get a representative sample of the weight of schoolbags on different days over the course of two weeks. The procedure of the study was firstly to weigh each schoolbag on an electronic weighing scales (Yamato Scale Model ECS 600). Secondly, each subject was weighed and then measured for height (using a Harpenden Anthropometer). When all measurements were taken, a brief interview took place with each subject during which the questionnaire was completed. The questionnaire was used to gain information about the type of schoolbag used (this was also determined by observation); the method used by the subject to carry his/her schoolbag; means of transport to/from school; the distance the load is carried each day.

On completion of the questionnaire each subject was asked to carry his/her schoolbag in the normal way as he/she left the room so that carrying posture could be observed.

Weight of Schoolbags

The majority of subjects (83%) had schoolbags that weighed between 9 lbs and 13.9 lbs (see figure 1). The average weight of a schoolbag was 11.4 lbs. The results also show that there is a wide distribution in the

weights of the schoolbags, ranging from 6.4 lbs to 18 lbs (see figure 1).

The weight of the schoolbag compared to the child's body weight was measured. The average body weight was 75.9 lbs. Subjects carried between 8.8% and 24.5% of body weight to school (see figure 2). This was an average of 15% body weight.

Method of Load Carriage

The majority of subjects (74%) have rucksack type schoolbags (see figure 3). This is a favourable finding given that the rucksack has been found to be the best in terms of energy cost and posture (Malhotra and Sengupta, 1965). The next most popular schoolbag (19%) was the backpack/ satchel type, i.e. a bag that can be carried on the back or in one hand. The remainder of subjects carried a shoulder bag (5%) or a football bag (2%).

Distance of Load Carriage

The subjects taking part in this study lived a quarter of a mile to 10 miles from school, with two-thirds living within a one mile radius of school. They did not carry their bags over these distances as the majority had transportation to school (see figure 5). The mean distance that bags were carried was 0.6 miles per day, i.e. the distance to and from school. The distances ranged from 100 yards to three miles.

Discussion

The primary reason for carrying out this study was to determine the average weight that 10-year-old children are carrying to school, and the relationship between that weight and the child's own body weight. The average schoolbag weight was 11.4 lbs, with a range from 6.4 lbs to 18 lbs. Perhaps this wide range can be explained by the fact that some children carry every book to school each day, while others carry the bare minimum. It was also noted that schoolbags are made from a variety of materials, some from light synthetics and others from leather which is much heavier. This may account for some of the variation. However, in this study empty schoolbags were not weighed.

Robertson et al (1982) reported that there was a weight limit for carrying loads without causing an increase in oxygen consumption beyond that required to move the body alone. This limit falls between 7.5% and 15% of total body weight. All the subjects in this study are carrying weights above the minimum limit, therefore one could expect the carrying of these loads to have physiologic implications.

Research on adults reveals that loads which are greater than 20% body weight bring about adverse physical effects (Gary and Luckwill, 1985; Kinoshita, 1985). Seven percent of subjects in this study were carrying more than 20% body weight. It was found that 56% of subjects were carrying 15% or more of body weight – a load that would be considered excessive, particularly if carried in the hand (Lind and McNicol, 1968). It must be emphasised that the studies quoted above have been conducted on healthy young adults. The long and the short term effects that the carrying of loads may have on children have not been established.

When investigating the methods of carrying schoolbags it was found that only 62% of subjects carried their bags on their backs (see figure 4). This is a disappointing finding given that 93% of subjects had schoolbags (rucksack and backpack/satchel) that could have been carried in this preferred way. Furthermore, of the group who had rucksack type bags (74%), 34% of these carried their bags on one shoulder instead of on their backs, because it was the fashionable thing to do. This method of carrying should be discouraged because it leads to side bending of the body, which is a poor posture. Side bending may be further accentuated depending on the weight of the bag. Six percent of subjects carried their schoolbags in one hand. This method should be discouraged as it increases energy expenditure and places the cardiorespiratory system under stress. It also promotes poor body posture. Positions which require a relatively high energy consumption will cause early fatigue, while the faulty carriage of a load is likely to result in body

deformities especially in the formative stage of childhood (Malhotra and Sengupta, 1965) for greatest efficiency and stability, loads should be kept as close to the body as possible. Heavy loads handled incorrectly may lead to mechanical stress in the spine resulting in back pain in later life.

The findings on distance of load carriage would obviously have seasonal and geographical variations. The mean distance that bags were carried was 0.6 miles a day, i.e. the distance to and from school. The length of time that bags were carried for was not included. This could be an important factor given that a child standing or waiting for transport could still have the load applied to the spine.

Conclusion

The results showed that an average of 11.4 lbs, or equivalent to 15.2% of total body weight, was carried by subjects in this study. In the absence of research or guidelines on acceptable loads to be carried by children it is difficult to assess the possible consequences of carrying such loads. The study sample was small, but the results highlight a factor that is a cause for concern i.e. the method of carrying schoolbags. A large proportion of subjects in this study carried their schoolbags inefficiently which would lead to unnecessary energy expenditure and physiological strain. Carrying a bag on one shoulder, or in one hand, leads to posture that may predispose to back pain. Greater emphasis should be placed on back carriage as a means of transporting schoolbags.

There is a need for further research in this area to investigate the effect of carrying on children's posture and to guidelines for acceptable loads to be carried by children.

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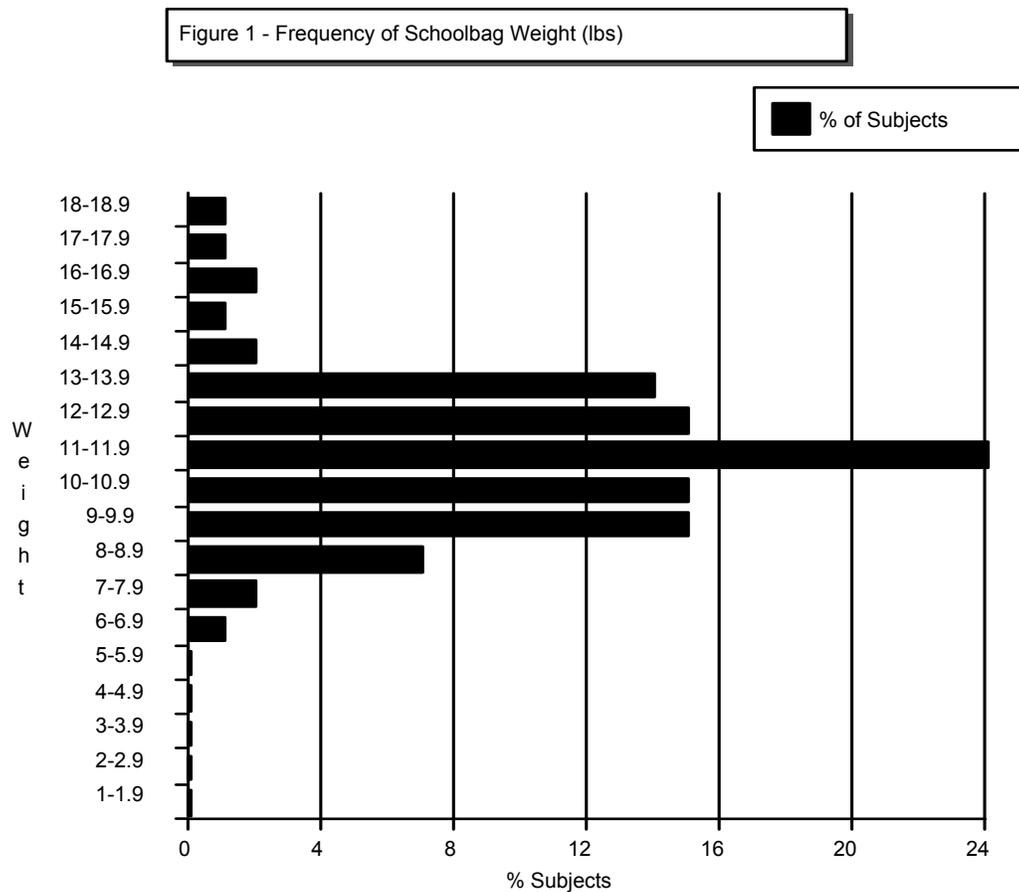


Figure 2 - Frequency of % Bodyweight Carried

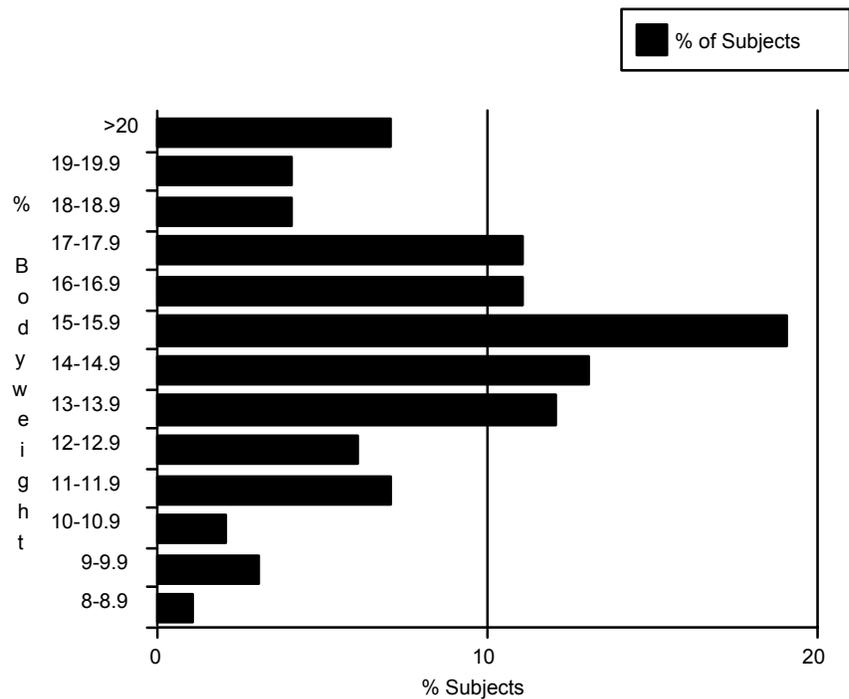


Figure 3 - Types of Schoolbags

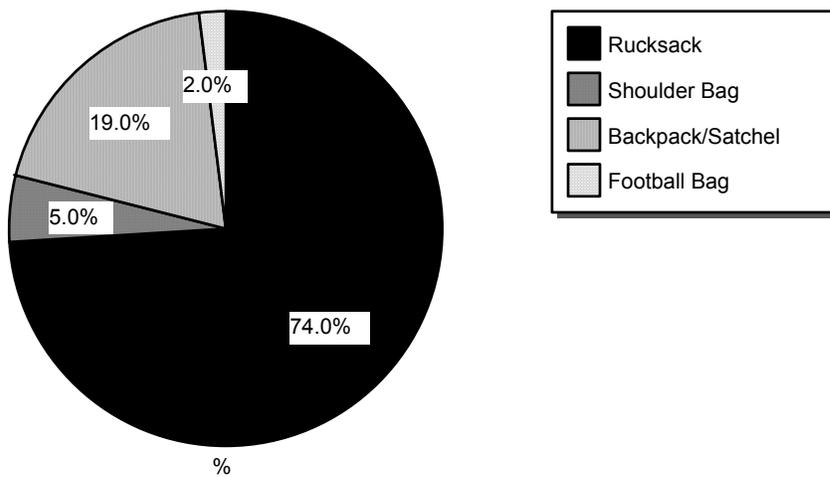


Figure 4 - Methods of Carrying Schoolbags

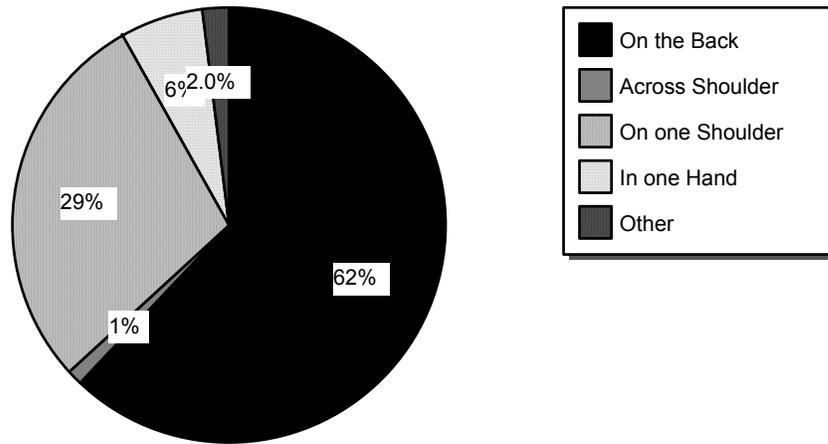


Figure 5 - Usual means of Transport

