Applied Ergonomics 45 (2014) 437–442

Contents lists available at SciVerse ScienceDirect

Applied Ergonomics

journal homepage: www.elsevier.com/locate/apergo

# Neck, shoulder and low back pain in secondary schoolchildren in relation to schoolbag carriage: Should the recommended weight limits be gender-specific?

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ARTICLE INFO

*Article history:*
Received 16 May 2012
Accepted 6 June 2013

*Keywords:*
Musculoskeletal pain
Adolescents
Backpack

ABSTRACT

The occurrence of neck, shoulder and low back complaints in relation to schoolbag carriage and other potential risk factors were investigated in a cross-sectional study of 586 Iranian schoolchildren aged 12–14 years. The average load carried by schoolchildren was 2.8 kg. Neck, shoulder and low back complaints during the preceding month were reported by 35.3%, 26.1% and 33% of the students, respectively. Gender was an independent factor predicting musculoskeletal symptoms in schoolchildren. Girls were more likely than boys to suffer from neck, shoulder and low back complaints, although there was no significant difference between genders in terms of schoolbag carriage variables. The findings suggest that the recommended weight limit for schoolbag carriage may need to differ between boys and girls. The associations between schoolbag variables and reported symptoms are also discussed. The results provide evidence that the current weight limit should consider a broader combination of factors that influence the use of schoolbags.



## 1. Introduction

Evidence suggests that back pain is frequent among children and adolescents (Harreby et al., 1999; Hakala et al., 2002; Watson et al., 2002; Jones et al., 2003; Murphy et al., 2007). According to the literature, the occurrence of back pain in children and adolescents has varied between 7% and 74% (Balagué et al., 1995; Jeffries et al., 2007). Similarly, neck or shoulder complaints are also fairly common among schoolchildren (Ehrmann-Feldman et al., 2002; Hakala et al., 2002; Auvinen et al., 2009). There is evidence that musculoskeletal pain in childhood and adolescence is a significant risk factor for experiencing such symptoms in adulthood (Hakala et al., 2002; Siivola et al., 2004; Hestbaek et al., 2006). Therefore, to prevent musculoskeletal pain, we need to improve our understanding of the risk factors associated with such complaints among children and adolescents (Trevelyan and Legg, 2006).

Loads carried by schoolchildren and their role in the development of musculoskeletal pain among this age group has been the subject of recent attention (Grimmer and Williams, 2000; Negrini and Carabalona, 2002; Sheir-Neiss et al., 2003; Mackie et al., 2005; Murphy et al., 2007; Javadivala et al., 2012). There is evidence that schoolbags may be a factor contributing to musculoskeletal complaints in schoolchildren. Several studies have reported an association between carrying heavily loaded schoolbags and musculoskeletal pain or discomfort (Grimmer and Williams, 2000; Negrini and Carabalona, 2002; Sheir-Neiss et al., 2003; Dianat et al., 2013). As a consequence, a weight limit of 10%–15% of body weight (BW) has been recommended recently as a maximum load for schoolchildren based on epidemiologic, physiologic, and biomechanical approaches (Brackley and Stevenson, 2004; Devroey et al., 2007; Bauer and Freivalds, 2009). However, there are still inadequacies in the recommended schoolbag weight limit due to limited research in this area. To the authors' knowledge, there are several key issues that are still unresolved, making the applicability of this generic weight limit questionable. One is that the recommendations are mostly based on studies conducted in the developed countries, and therefore giving no evidence that the results are generalizable to less developed countries. It is also not clear

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http://dx.doi.org/10.1016/j.apergo.2013.06.003

whether or not the limit set should be the same for both boys and girls. Furthermore, most previous research has focused on low back pain, whereas much less attention has been given to the effects of load carriage on the other body regions such as neck and shoulders, areas which might also be affected by carrying schoolbags. Thus, understanding the epidemiology of this phenomenon is a valuable tool to develop guidelines and recommendations with regard to safe load carriage for schoolchildren around the world.

This cross-sectional study was therefore conducted to investigate the occurrence of neck, shoulder and low back complaints in relation to the use of schoolbags and other potential risk factors among Iranian schoolchildren. One of the aims of the study was to evaluate whether or not the recommended weight limit for carrying schoolbags should be gender-specific. In addition, as the literature is somewhat limited and the findings are varied, this study adds more evidence to the debate and identifies broader issues (e.g. different educational philosophies, sociocultural contexts, etc.) and also widens the discussion to more countries. It is also of particular interest as it considers the effect of schoolbag carriage on several body regions.

## 2. Materials and methods

This cross-sectional study was performed between February and June 2011, in the city of Tabriz (population about 1.58 million), the fourth largest city in Iran and the capital of East Azerbaijan province in Northwest Iran. A sample of 586 students aged 12–14 years (who were in grades six through eight) participated in the study. A three stage sampling procedure was used to obtain a representative sample of schoolchildren in the study area. In the first stage, five educational districts were chosen (as strata), and then in the second stage, a total of 20 schools were selected randomly from the districts (including two boy's schools and two girl's schools from each district). Finally, the study participants were chosen randomly from each school. Permission to approach schools in the study area was obtained from the Tabriz Department of Education and the school authorities involved. The study protocol was approved by the ethical review committee of Tabriz University of Medical Sciences. The students were given a letter asking for parental consent for them to take part in the study. The data were collected by two trained investigators (authors of this paper).

The weights (body weight and schoolbag weight including any additional items carried separately) and standing height were measured using a digital electronic scale (accurate to 0.01 kg) and portable stadiometer, respectively. The data were collected on an unannounced day so that children could not alter their schoolbag weight. The scale was calibrated over a range of known weights prior to data collection. Body mass index (BMI as weight/height$^2$) was derived from measurements of height and weight.

The questionnaire used in the study was developed based on data in the literature. The first item on the questionnaire was to record demographic details (including age, gender and grade level) of each student. The occurrence of neck, shoulder and low back complaints during the preceding month was recorded according to a modification of the standardised Nordic Musculoskeletal Disorders Questionnaire (Kuorinka et al., 1987). The validity and reliability of the Nordic questionnaire have been established previously (Kuorinka et al., 1987; Dickinson et al., 1992). The English version of Nordic questionnaire has already been translated and revised into Persian language (Ghaffari et al., 2006). The questions about neck, shoulder and low back pain were as follows: "Have you, at any time during the past month, had trouble (such as ache, pain, discomfort or numbness) in the following areas of your body?" 1) Neck, 2) shoulders, and 3) low back area. The location of these anatomic areas was demonstrated by a drawing in the questionnaire. The response alternatives were "no" and "yes". The questions regarding the use of schoolbags were based on the relevant literature (Grimmer and Williams, 2000; Goodgold et al., 2002; Negrini and Carabalona, 2002; van Gent et al., 2003; Dianat et al., 2013) and included information about the type of schoolbag, time spent carrying a schoolbag to and from school each day, preferred method of carrying a schoolbag and mode of transportation to and from the school. The amount of time spent on sport and physical activities, watching television and using a computer was also recorded. The questionnaire was evaluated in a pilot study on a sample of 50 school students and minor revisions related to clarity and wording were made based on the pilot testing feedback. Also, the test-retest reliability (stability) of the items of the questionnaire was acceptable (phi coefficients ranged from 0.72 to 0.91). The whole questionnaire, administered by interviewing the children, took approximately 10 min to complete.

Statistical analysis of the data was performed with SPSS software version 11.5 (SPSS Inc., Chicago, IL, USA). Statistical analyses were performed for the whole sample and for the subgroups of students (e.g. by gender and educational grade level). Two-way Analysis of Variance (ANOVA) was used for evaluation of the main effects of gender and grade level on the schoolbag weight (both absolute weight and % BW) and time spent carrying a schoolbag. This analysis was followed by Tukey's post hoc tests for pairwise comparisons. Similarly, multinomial logistic regression was applied to evaluate the effects of gender and grade level on the method of carrying and type of schoolbag as well as the mode of transportation to and from the school. The relationship between prevalence rates and study variables was assessed using binary logistic regression analysis. In addition, multiple logistic regression analysis was carried out using backward stepwise procedure to estimate the association between independent variables and self-reported neck, shoulder and low back pain in the multivariate context. The odds ratios (ORs) and 95% confidence intervals (CIs) were calculated from the relevant multiple logistic regression models. The assumptions of the model (including the presence of outliers and collinearity) were checked and were not in violation. There was no sign of collinearity (e.g. the confidence intervals were not wide). The fit of the logistic regression models was confirmed by the Hosmer–Lemeshow goodness-of-fit test. $P$ values $< 0.05$ were considered statistically significant.

## 3. Results

The questionnaire was completed by all 586 schoolchildren (257 boys and 329 girls; age, 12.8 $\pm$ 1.27 years; weight, 50.7 $\pm$ 14.3 kg; height, 155.6 $\pm$ 8.93 cm; body mass index, 20.7 $\pm$ 4.6 kg/m$^2$). The mean schoolbag weight (absolute weight) for all of the children was 2.8 $\pm$ 0.94 kg (range, 0.86–6.5 kg), and the percent this represented of student body weight (% BW) for the whole sample was 7.1 $\pm$ 2.81% BW (range, 1.6–18.4% BW). The ANOVA revealed significant differences in the amounts of loads carried by the children (in terms of both absolute mean schoolbag weight and % BW) by grade level, but not by gender. Post hoc tests showed that Grade 8 students carried significantly heavier schoolbags (2.9 $\pm$ 0.94 kg, $p < 0.01$) than Grade 6 (2.5 $\pm$ 0.91 kg) students. In contrast, Grade 6 students (7.2 $\pm$ 2.47% BW, $p < 0.01$) carried a significantly greater proportion of body weight than Grade 8 (6.1 $\pm$ 1.73% BW) students (Table 1).

The majority of children used a backpack to transport items to and from school (72.6% overall, 68.3% boys, 75.1% girls). The remainder of children carried a brief case (13.9%) or satchel (13.5%). The most popular method of carrying a schoolbag was on both shoulders (46.1% overall, 49.7% boys, 43.4% girls), followed by on one shoulder (39.3%) and by hands (14.6%). The mean carrying time