

Weight of Backpacks and Musculoskeletal Pain among Iranian Elementary School Students

¹Kim Geok Soh, ²Zeinab Ghiami, ³Karim Khallaghi and ⁴Kim Lam Soh

^{1,2}Faculty of Educational Studies, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia

¹Sports Academy, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia

³Department of Physical Education, Islamic Azad University, Quchan, Iran

⁴Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia

DOI: 10.6007/IJARBSS/v7-i14/3757 URL: <http://dx.doi.org/10.6007/IJARBSS/v7-i14/3757>

Abstract

The study aims to investigate the relationship between the weight of backpacks and musculoskeletal pain among Iranian elementary school students. In addition, this study also aims to identify the common pain areas reported among Iranian elementary school students as the result of carrying heavy backpacks. The subjects of the study consisted of 1118 females and 5474 males' students from elementary school at all different grades. They represented 36 schools which were selected based on stratified random sampling out of all elementary schools in Quchan, Iran. Students as well as their bags and backpacks were separately weighed using a calibrated weight scale. The mean weights of students and their bags and backpacks were also calculated for each grade. Musculoskeletal questionnaire was administered to 23% of female and 9% of male students through an interview procedure to find the difference between males and females musculoskeletal pain. The results showed that the male first and third-graders carried backpacks which were respectively 9.9% and 9.0% of their body weight. While the female first and third-graders' backpacks and second-graders' were reported to be heavier with the backpacks weight of 10.2% and 10.4% of their body weights, respectively. It was concluded that elementary students considering their average weight, carry heavy bags to school (higher than the standard bag weight, i.e., 3-5% of body weight). In addition, the findings showed the existence of different musculoskeletal problems among female and male students. The commonest pain areas among males were neck (24.9%) and backbone (24.6%) and among females were knees (51.9%) and shoulders (34.5%).

Keywords: Backpacks, Ergonomic, Musculoskeletal Pains, School Begg, And Elementary Schools

Introduction

Children play an important role in the population dynamics of a country. They will be the future adults and parents of tomorrow. Hence, protecting the children's well-being especially during their vital age is a fundamental act because being unhealthy and frequently sick will cause a poor learning process at school. This act will ensure that the children will receive an enjoyable life, health, identity, education and other fundamental goods as planned without

jeopardise their health (Gillam, Yates, & Badrinath, 2012). In order to achieve this goal, investigating the health problems of the children is very important and it requires action at the individual, family, school, society's level and demands cross-disciplinary and intersectional collaboration. Among the global concern arise is regarding musculoskeletal health of school going children (Gillam et al., 2012). Back pain is regarded as one of the top general health problems among college students; however, the risk factors for back pain in this age group have been investigated by few studies. A survey study examined the relationship between the self-reported annual low back pains and the usual backpack weight among college students. Result indicated that carrying heavier backpack weight since they were young was among the factor contributed to this pains (Heuscher, Gilkey, Peel, & Kennedy, 2010).

Prevalence of musculoskeletal pain in schoolchildren, as young as 7 years of age, has been reported. A study in Iran particularly looked at the prevalence of musculoskeletal pain among 307 primary school children. It was alarming to find that 86% of the children reported presence of musculoskeletal symptoms at the younger ages between 7 to 12 years (Dianat, Javadi, & Allahverdi, 2011). Carrying heavy backpacks can lead to a wide range of pain-related musculoskeletal disorders and postural dysfunctions in children. For two reasons children are more vulnerable to the risk of overuse injuries. First, great amounts of cartilage in a child's skeleton, especially in growth areas, as it is predecessors to bone ossification (L. Micheli, 1983; L. J. Micheli & Fehlandt Jr, 1992). Second, the decline in soft tissue flexibility or muscle imbalances can also cause injury. Soft tissue elongation that happens as a response to longitudinal bone growth, leads to a period during growth when muscles and tendons become taut and lose flexibility as a result (L. Micheli, 1983). Therefore, the spine may be at the risk of injury for a longer period of time.

Musculoskeletal disorders are consistently a major cause of disability and lost work time. Understanding their reasons provides the key to primary prevention. Contemporary ergonomics emphasizes the significance of a participatory approach for prevention and to find solution, and evidence in support of this is presented. However, it has been seen that knowledge sharing in the form of ergonomic training could prove useful in prevention of musculoskeletal pain related to bad postures (Jacobs et al., 2013). Using a backpack is an appropriate way for carrying loads on the spine, due to its closeness and symmetry, while one can maintain his stability as well (Voll & Klimt, 1977). Students usually carry their school loads in backpacks, lacking the workplace standards developed for adults. (Grimmer, Dansie, Milanese, Pirunsan, & Trott, 2002). The consistent physical stresses due to carrying backpacks lead to significant forward lean of the head and trunk (Mohan, Singh, & Qudus, 2007). Daily intermittent abnormal postural adaptations are assumed to be the cause of pain and disability in children of school going age (Voll & Klimt, 1977). A recent study at Houston, USA International School, in the age group of 11.1 to 14.5 years found that about 60% of the students had chronic musculoskeletal pain as a result of carrying backpacks to school (Dianat et al., 2011).

Recent studies have focused on the role of backpacks in the development non-specific low back pain among adolescents. Researchers have attempted to determine whether there is a critical backpack weight to body ratio that can affect health if exceeded. Research shows that backpacks are used by at least 90% of school children in the developed countries (Goodgold et al., 2002; Grimmer & Williams, 2000; Negrini & Carabalona, 2002; Sheir-Neiss, Kruse, Rahman, Jacobson, & Pelli, 2003; JK Whittfield, Legg, & Hedderley, 2001). Talbott et al. (2009) assessed the backpack features, the self-perceived backpack weight, duration and posture as well as any backpack-related pain among 871 students. Results of the survey showed that 99% of the students carried backpacks, 83% carried their backpacks over both shoulders, and the most common feature of the backpacks was that all of them had adjustable shoulder straps. Also, 50% of the students perceived their backpack as heavy, and 46% reported that they carry the backpack 10–20 minutes to and from school. Pain caused by backpack use was reported by 33.5% of the students. Perceived backpack weight, duration of backpack carriage, posture, gender and school district were significantly associated with reported symptoms (Talbott, Bhattacharya, Davis, Shukla, & Levin, 2009).

A prospective study among adolescent British school children showed a non-significant increase in the risk for future low back pain for carrying a heavy backpack weight (Jones, Watson, Silman, Symmons, & Macfarlane, 2003). Whereas Brattberg (2004) and Hestbaek, Leboeuf-Yde, Kyvik, and Manniche (2006) concluded that there is an increased incidence of back pain among adults who had back pain as adolescents, studies measuring the relationship between a student's backpack weight as a percentage of body weight and low back pain have been conflicting (Skaggs, Early, D'Ambra, Tolo, & Kay, 2006; Viry, Creveuil, & Marcelli, 1999).

Carrying loads on the back by young people has been associated with spinal pain, and the amount of resultant postural change has been used as a measure of the potential to cause tissue damage (Lanes et al., 1995; Van Tulder, Koes, & Bouter, 1997). Back pain seems to be more common among children than was previously thought. Research shows that 10%-30% of healthy teenagers experience back pain, especially low back pain (Grimmer et al., 2002; Mohan et al., 2007). Therefore, investigating postural responses to load carrying will provide more information and understanding the impact of school backpacks on children. Hence, this study was carried out to investigate the relationship between the weight of backpacks and musculoskeletal pain among Iranian elementary school students. In addition, this study aims to identify the common pain areas reported among Iranian elementary school students as a result of carrying heavy backpacks.

Methodology

Participants

Data for this study was obtained from the 6592 primary school children including 1118 females and 5474 males aged between 7 and 12 years, in 5 grades. Children were randomly assigned from schools located in the city in Iran.

Table 1: Participants Profiles

Grades	Male	Female	Total
1	820	250	1070
2	980	235	1215
3	939	117	1056
4	870	270	1140
5	890	199	1089
6	975	156	1134
Total	5474	1118	6592

Data Collection

A student survey questionnaire including personal information, carrying habits and health information was prepared to gather descriptive information. The subjects were later instructed to remove their shoes and to stand on the force plate so that their weights were recorded using a calibrated weighing scale. Then the subjects were instructed to stand on the height scale and the height in centimeters was noted. In addition, a researcher develop structural musculoskeletal questionnaire with a reliability coefficient of 0.74 was administered to 23% of female and 9% of male students. An interview was carried out using the structural questionnaire to gather information regarding the common pain areas suffer by the students as the result of carrying backpacks

Statistical Analysis

Two-way Analysis of variance (ANOVA) followed by Tukey's *post hoc* tests was used for evaluation of weights. The relationship between prevalence rates with gender and grade level were assessed by binary logistic regression analyses. The factors included in the final logistic regression model were individual factors including age, gender, body mass index (BMI in weight/height²) (less than 19, 19-24, more than 24), as well as school bag weight expressed as a percentage of body weight (% BW) (less than 10% BW and equal or more than 10% BW). The odds ratios (OR) and their 95% confidence interval (CI) were calculated from multiple logistic regression models. *P*-Values <0.05 were considered as significant for all analyses. In this quasi-experimental study, the standard weight of a person's bag or the backpack was set to be 3-5 percent of his or her body weight as indicated in (Ramprasad, Alias, & Raghuvver, 2010).

Results

In the present study, after investigating the weights of bags and backpacks of students in each grade of elementary school, as the figure 1 shows male first and third graders carried backpacks which were respectively 9.9% and 9.0% of their body weights and female first and third graders' backpack were 10.2% and female second graders' backpack were 10.4% of their body weights, which were in fact the heaviest weights carried by the students (Figure 1).

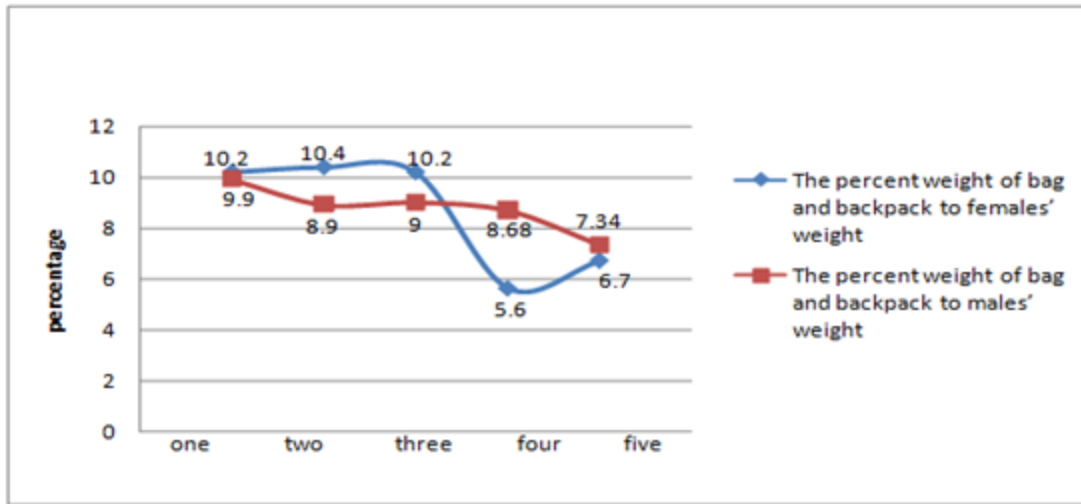


Figure 1. The mean percent of bag and backpack weight to body weight in each grade of males and females

Therefore, due to muscular weakness and lack of physical fitness, male and female students in first, second and third grades showed the highest rates of side effects. The disproportionate height and weight development in male students was evident from second grade to third grade with the lowest weight development 1.96kg and the highest height development 10.40cm (Figure 2). In females also, the greatest differences between height and weight developments were observed among third to fourth graders and first to second graders, which due to carrying heavy bags and backpacks. This will later made them prone to musculoskeletal problems. The disproportionate height and weight development in female students were reported from third to fourth graders with the lowest weight development 5.79kg and the highest height development 9.31cm (Figure 3).

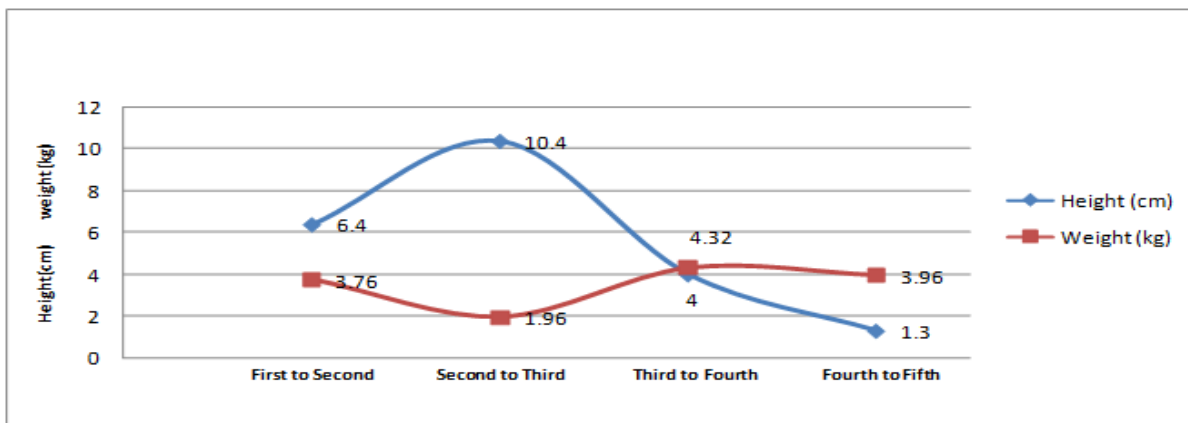


Figure 2. Comparison of the height and weight development in male students

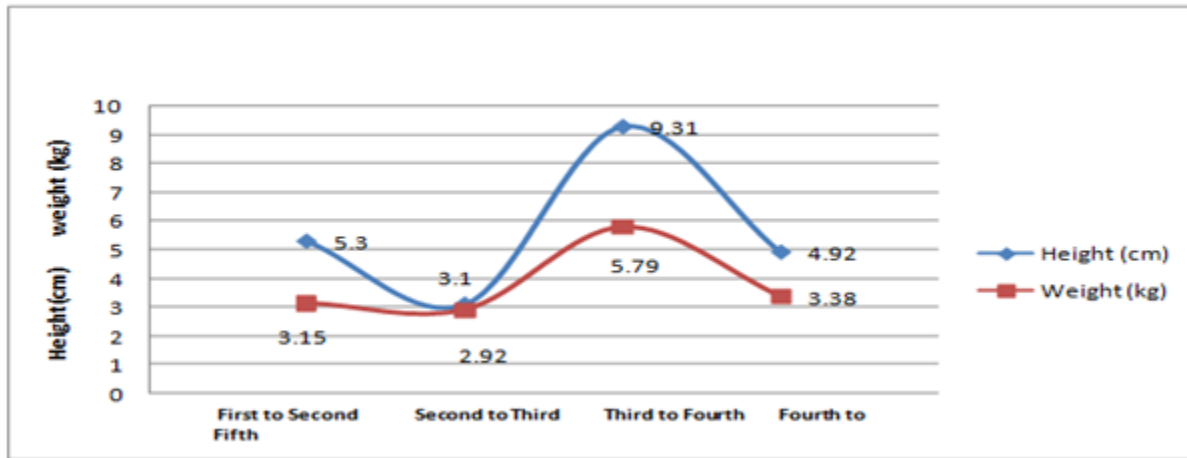


Figure 3. Comparison of the height and weight development in female students

The commonest pain areas among males were ankle (24.9%) backbone (24.6%) as indicated in Figure 4. Meanwhile, according to Figure 5, for the females, the commonest pain areas reported were the shoulder (51.9%) and knee (34.5%).

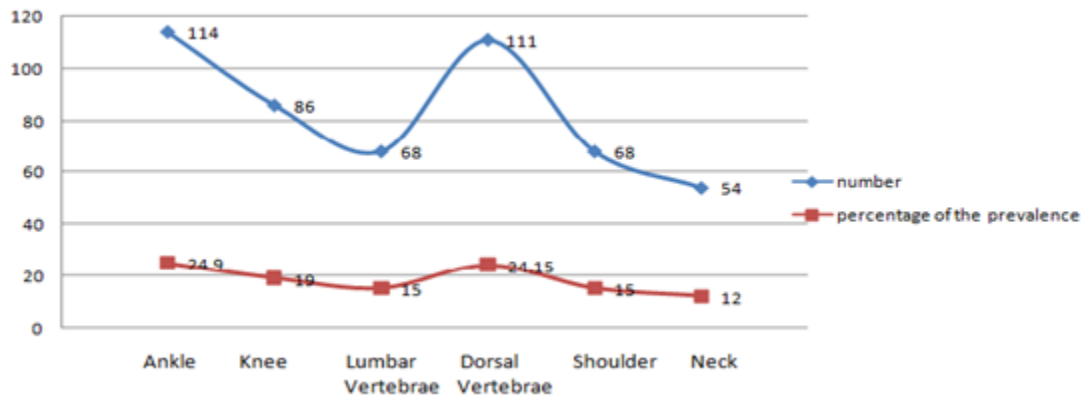


Figure 4. Frequency and percentage of the prevalence of musculoskeletal pains in males

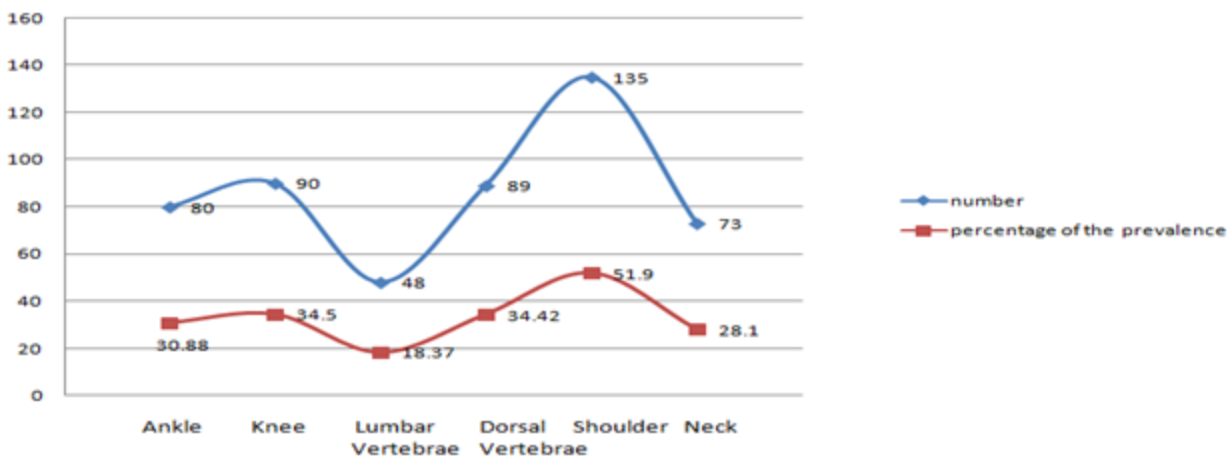


Figure 5. Frequency and percentage of the prevalence of musculoskeletal pains in females

Discussion

This study investigates the relationship between the weight of backpacks and musculoskeletal pain among Iranian elementary school students. The results indicated that elementary students considering their average weight carry heavy bags to school (higher than the standard bag weight, i.e., 3-5% of body weight). The male first and third-graders carried backpacks which were respectively 9.9% and 9.0% of their body weight. While the female first and third-graders' backpacks and second-graders' were reported to be heavier with the backpacks weight of 10.2% and 10.4% of their body weights, respectively. In addition, the findings showed the existence of different musculoskeletal problems among female and male students. In present study approximately 50% of boys and 85% of girls reported some type of musculoskeletal symptoms, which shoulder complaints, was the most reported symptom (51.9%). The commonest pain areas among males were neck (24.9%) and backbone (24.6%) and among females were knees (51.9%) and shoulders (34.5%) which is similar to findings reported by Whittfield et al. (2005) among secondary school students in New Zealand (Jannine Whittfield, Legg, & Hedderley, 2005).

Some researchers have reported a relationship between back pain and school bag weight (Grimmer & Williams, 2000; Viry et al., 1999; Jannine Whittfield et al., 2005). According to the findings of present study, the mean school bag weight (as expressed by % BW) carried by children is well within the recommended weight limit of 10% BW recommended in the literature (Devroey, Jonkers, De Becker, Lenaerts, & Spaepen, 2007; Mackie & Legg, 2008). However, the prevalence of musculoskeletal symptoms reported by the children in the current study is relatively high which can support the findings of Mohan et al. (2007) that mentioned that carrying a backpack 10% of body weight would be too heavy for the child to maintain normal cervical and shoulder posture alignment. It seems that the percentage of body weight may not alone represent the demands on the musculoskeletal systems of school children and

recommendations regarding a weight limit for school bag carriage should take into account when other conditions involved. Another possible explanation is the current proposed weight limit for school bag carriage may not be appropriate for elementary school children. This is simply because these recommendations regarding weight limit are mostly based on studies that have studied older age group of school students than those studied in the current study. However, further studies are recommended to investigate this possibility. Awareness should be raised among health care professionals, teachers, parents to limit backpack load to less than 5% of children's bodyweight by using school locker shelves, compact discs, USB flash drives. There is also a need to monitor the musculoskeletal problems associated with carrying heavy backpack load in preadolescent children regularly.

Conclusion

Several limitations to this study need to be acknowledged. As in any epidemiological study, in this study data on musculoskeletal symptoms were based on self-report questionnaires, which may be subject to recall and other biases. In future studies it is recommended that the Borg Pain Scale which is a semi quantitative method should be used to assess pain (Borg, 1998). Another limitation is the cross-sectional nature of the study, which prevented an evaluation of the relationship between cause and effect. Therefore, the results should be regarded as a general indication of the problem and a selection bias may be confounding the results. The relationship between musculoskeletal dysfunction and preadolescent postural responses to backpack load, need to be studied further, through longitudinal and prospective studies to determine whether carrying backpacks increases the occurrence of regional pain and to correlate these clinical implications on school children. The commonsense guidelines for safe carry-on weight by schoolchildren, deal with the percentage of body weight. A disadvantage of this is that, a short heavy child and a tall thin child might have the same weights, but their weight distribution and centre of gravity will be different. The Body Mass Index (BMI) is defined as a ratio of weight to the square of height [$W/(H^2)$, kg/m²] (Baumgartner & Jackson, 1998) Thus, a better criteria than percentage of body weight, maybe the BMI. Considerably more work will need to be done to determine appropriate backpack load based on BMI instead of percent of body weight.

References

- Baumgartner, T. A., & Jackson, A. S. (1998). *Measurement for evaluation in physical education and exercise science*: WCB/McGraw-Hill.
- Borg, G. (1998). *Borg's perceived exertion and pain scales*: Human kinetics.
- Brattberg, G. (2004). Do pain problems in young school children persist into early adulthood? A 13-year follow-up. *European Journal of Pain*, 8(3), 187-199.
- Devroey, C., Jonkers, I., De Becker, A., Lenaerts, G., & Spaepen, A. (2007). Evaluation of the effect of backpack load and position during standing and walking using biomechanical, physiological and subjective measures. *Ergonomics*, 50(5), 728-742.

- Dianat, I., Javadivala, Z., & Allahverdipour, H. (2011). School bag weight and the occurrence of shoulder, hand/wrist and low back symptoms among Iranian elementary schoolchildren. *Health Promotion, 1*(1), 76-85.
- Gillam, S., Yates, J., & Badrinath, P. (2012). *Essential public health: Theory and practice*: Cambridge University Press.
- Goodgold, S., Corcoran, M., Gamache, D., Gillis, J., Guerin, J., & Coyle, J. Q. (2002). Backpack use in children. *Pediatric Physical Therapy, 14*(3), 122-131.
- Grimmer, K., Dansie, B., Milanese, S., Pirunsan, U., & Trott, P. (2002). Adolescent standing postural response to backpack loads: a randomised controlled experimental study. *BMC Musculoskeletal Disorders, 3*(1), 1-10.
- Grimmer, K., & Williams, M. (2000). Gender-age environmental associates of adolescent low back pain. *Applied ergonomics, 31*(4), 343-360.
- Hestbaek, L., Leboeuf-Yde, C., Kyvik, K. O., & Manniche, C. (2006). The course of low back pain from adolescence to adulthood: eight-year follow-up of 9600 twins. *Spine, 31*(4), 468-472.
- Heuscher, Z., Gilkey, D. P., Peel, J. L., & Kennedy, C. A. (2010). The association of self-reported backpack use and backpack weight with low back pain among college students. *Journal of manipulative and physiological therapeutics, 33*(6), 432-437.
- Jacobs, K., Kaldenberg, J., Markowitz, J., Wuest, E., Hellman, M., Umez-Eronini, A., . . . Ciccarelli, M. (2013). An ergonomics training program for student notebook computer users: Preliminary outcomes of a six-year cohort study. *Work: A Journal of Prevention, Assessment and Rehabilitation, 44*(2), 221-230.
- Jones, G. T., Watson, K. D., Silman, A. J., Symmons, D. P., & Macfarlane, G. J. (2003). Predictors of low back pain in British schoolchildren: a population-based prospective cohort study. *Pediatrics, 111*(4), 822-828.
- Lanes, T. C., Gauron, E. F., Spratt, K. F., Wernimont, T. J., Found, E. M., & Weinstein, J. N. (1995). Long-term follow-up of patients with chronic back pain treated in a multidisciplinary rehabilitation program. *Spine, 20*(7), 801-806.
- Mackie, H., & Legg, S. (2008). Postural and subjective responses to realistic schoolbag carriage. *Ergonomics, 51*(2), 217-231.
- Micheli, L. (1983). Overuse injuries in children's sports: the growth factor. *The Orthopedic clinics of North America, 14*(2), 337-360.
- Micheli, L. J., & Fehlandt Jr, A. F. (1992). Overuse injuries to tendons and apophyses in children and adolescents. *Clinics in sports medicine, 11*(4), 713-726.
- Mohan, M., Singh, U., & Quddus, N. (2007). Effect of backpack loading on cervical and shoulder posture in Indian school children. *Indian Journal of Physiotherapy and Occupational Therapy, 1*(2), 3-12.
- Negrini, S., & Carabalona, R. (2002). Backpacks on! Schoolchildren's perceptions of load, associations with back pain and factors determining the load. *Spine, 27*(2), 187-195.
- Ramprasad, M., Alias, J., & Raghuv eer, A. (2010). Effect of backpack weight on postural angles in preadolescent children. *Indian pediatrics, 47*(7), 575-580.

- Sheir-Neiss, G. I., Kruse, R. W., Rahman, T., Jacobson, L. P., & Pelli, J. A. (2003). The association of backpack use and back pain in adolescents. *Spine*, 28(9), 922-930.
- Skaggs, D. L., Early, S. D., D'Ambra, P., Tolo, V. T., & Kay, R. M. (2006). Back pain and backpacks in school children. *Journal of Pediatric Orthopaedics*, 26(3), 358-363.
- Talbott, N. R., Bhattacharya, A., Davis, K. G., Shukla, R., & Levin, L. (2009). School backpacks: it's more than just a weight problem. *Work: A Journal of Prevention, Assessment and Rehabilitation*, 34(4), 481-494.
- Van Tulder, M. W., Koes, B. W., & Bouter, L. M. (1997). Conservative treatment of acute and chronic nonspecific low back pain: a systematic review of randomized controlled trials of the most common interventions. *Spine*, 22(18), 2128-2156.
- Viry, P., Creveuil, C., & Marcelli, C. (1999). Nonspecific back pain in children. A search for associated factors in 14-year-old schoolchildren. *Revue du rhumatisme (English ed.)*, 66(7-9), 381-388.
- Voll, H., & Klimt, F. (1977). Strain in children caused by carrying schoolbags (author's transl)]. *Das Offentliche Gesundheitswesen*, 39(7), 369-378.
- Whittfield, J., Legg, S., & Hedderley, D. (2001). The weight and use of schoolbags in New Zealand secondary schools. *Ergonomics*, 44(9), 819-824.
- Whittfield, J., Legg, S., & Hedderley, D. (2005). Schoolbag weight and musculoskeletal symptoms in New Zealand secondary schools. *Applied ergonomics*, 36(2), 193-198.