European Journal of Human Movement

OPEN ACCESS

Article

Effects of a postural education program on backpack use habits in schoolchildren: The PEPE Study.

Josep Vidal-Conti*, Aina Maria Galmes-Panades[1], Adrià Muntaner-Mas, Pere Palou and Pere Antoni Borràs,

Physical Activity and Sport Sciences Research Group (GICAFE). Institute for Educational Research and Innovation (IRIE). University of the Balearic Islands. Palma. ES-07122. Spain.

*Correspondence: (JVC) josep.vidal@uib.es. 0000-0003-4782-2178

Received: date; Accepted: date; Published: 31/12/2023

Abstract: One of the concerns of educational and health authorities, parents, and professionals from different sectors is the incorrect use of the school backpack and its repercussions on the musculoskeletal system, especially on the back. Health Literacy education programs have been carried out in the primary and secondary education system with the aim of preventing musculoskeletal disorders in children and adolescents and initiatives are being taken to reduce the weight that students carry in their backpacks. The aim of the current study is to investigate the effects of a postural education program on backpack use habits related to LBP in schoolchildren aged 10-12 years. This randomized controlled trial (RCT) was carried out in Majorca (Spain), with 224 primary schoolchildren aged 10 to 12. The sample was selected from different clusters (schools) using convenience sampling and randomly distributed into an experimental group (5 schools) or a control group (5 schools). A 16-week intervention program was implemented, which was carried out telematically because it was in times of COVID-19. Three structured and self-administered questionnaires were used to examine the prevalence of low back pain and backpack use habits. Results showed how backpack habits and single questions related to the use of backpack did not improve after the intervention in the experimental group, and in the control group also. The main conclusion is that no improvements were observed in the intervention group attributable to the effect of the intervention.

Keywords: School bags; Backpack; Low back pain; Postural Education; Health promotion.

1. Introduction

Low back pain (LBP) is one of the biggest health problems in the world (Steffens et al., 2016) affecting populations of all ages. Back pain usually debuts in childhood, however, in adolescents, the prevalence rate of LBP episodes follows the same pattern as in adults (Michaleff et al., 2014). The presence of a previous episode of back pain is a significant sign of future pain problems (Chiang et al., 2006; Diepenmaat et al., 2006), so prevention in young people is essential. In addition, there are numerous adverse effects derived from back pain, such as the increase in days of school absenteeism, loss of education levels, the reduction of physical activity levels, or a combination of these different factors in a frequent way

(Calvo-Muñoz et al., 2018; MacDonald et al., 2017), in addition to affecting the quality of life.

According to the scientific literature, nonspecific back pain in children and adolescents varies between 3% and 63% (Masiero et al., 2008). These variations can be attributed to differences in study design (horizontal or vertical), how to collect data (questionnaires, checklists, the definition of the concept of back pain) or the differences in the age groups, and the comparison between population or geographical area (Burton et al., 1996; Masiero et al., 2008). However, a general increase in the prevalence of LBP in adolescents has recently been observed, albeit with limited studies to support the epidemiology and etiology (Hwang et al., 2019; Santos et al., 2021).

One of the concerns of educational and health authorities, parents, and professionals from different sectors is the incorrect use of the school backpack and its repercussions on the musculoskeletal system, especially on the back (Perrone et al., 2018). Health Literacy education programs have been carried out in the primary and secondary education system with the aim of preventing musculoskeletal disorders in children and adolescents (Miñana-Signes, Monfort-Pañego, Valiente, 2021; Veshovda et al., 2023) and initiatives are being taken to reduce the weight that students carry in their backpacks, such as the installation of lockers in schools (Bort Saborit & Simó Pitarch, 2002), the conversion of "spine" books into chip books (Quintana Aparicio et al., 2005), the substitution of subject notebooks for stackable notebooks, etc. In addition, the number of scientific studies related to the subject has increased considerably in recent years (Alberola López et al., 2010; Ramos Espada et al., 2004).

Aspects such as the design, the method of transport (Barbosa et al., 2019), and the maximum load of the backpack (Tomal et al., 2022) have been studied to determine the use of the school backpack as a possible risk factor for back pain. The correct use of the backpack can be considered as part of the health Literacy curricula in school-age children, in terms of achieving a good posture. Health literacy implies the achievement of a level of knowledge, personal skills, and confidence to take action to improve personal and community health by changing personal lifestyles and living conditions (Health Promotion Glossary of Terms, 2021; Miñana-Signes, Monfort-Pañego, Valiente, 2021).

It could be a well-known reality that incorrect positioning within the womb, asymmetry of muscle tone, untimely birth, and adoption of off-base posture whereas sitting or playing are fair a few of the factors contributing to the advancement of defective body posture in children. Usually genuine in any case of the issue: knock knees, level feet, scoliosis, etc. The issue at hand influences the complete body of a child because the inaccurate arrangement of structures in one zone brings around more misalignment in another. Concurring to current information, 34–50% of children and teenagers have different degrees of erroneous posture, and backpack use can be related to a correct posture (Rusek et al., 2021).

In relation to the weight of the school backpack, several studies suggest that students should carry only what is necessary in their backpacks (Hernández et al., 2020; Skaggs et al., 2006), with the recommended load limit being between 10%-15% of the child's body weight. It has been shown that when the weight of the backpack exceeds the recommended limits, energy consumption increases, producing an increase in the forward lean of the body and even an alteration in energy consumption, with the consequent decrease in lung volume (Hong et al., 2000; Perrone et al., 2018).

Despite the controversy over whether or not the weight of backpacks is associated with increased LBP, the use of heavy backpacks causes discomfort and muscle fatigue in students, so it is important to develop strategies to reduce the weight of backpacks (Minghelli et al., 2021).

Albeit there is no convincing evidence about the effects of the school bag on back pain in children and adolescents (Yamato et al., 2018), however due to the small number of prospective studies and the quality of the studies found in the reviews, there is still need for identifying risk factors for back pain.

The aim of the current study is to investigate the effects of a postural education program on backpack use habits related to LBP in schoolchildren aged 10-12 years.

2. Materials and Methods

Study design —A 4.5 monthly intervention program was implemented. Participants were evaluated at baseline (before intervention) and after 4.5 months (post-intervention). All participants (students, teachers, and parents) were informed about the purpose of the study and its procedure. Moreover, students' parents or tutors were requested to give their consent for children to participate in the study. An informative session was held with the teachers in order to explain in detail the procedures, aims, and characteristics of the intervention program. Written information was also delivered to the teachers and parents, and a webpage (http://gicafe.uibvirtual.es/) was created ad hoc for this study. The study was approved by the Research Ethics Committee of the University of the Balearic Islands (reference number: 130CER19).

Participants —The current investigation, which is nested in the PEPE (School-based Postural Education Program) randomized controlled trial, reports on the effect of the intervention on the postural habits of the kids' population (Spain). This interventional trial, which has been published elsewhere (Borras & Vidal-Conti, 2022), attempts to prevent LBP in school children.

The study was carried out in Majorca (Spain), with 224 primary schoolchildren. Children in the fifth and sixth grades, aged 10 to 12 (X=11.29, SD=0.89), were the target audience. Based on previous studies (Kovacs et al., 2003; Taimela et al., 1997; Vidal-Conti et al., 2021). These data suggest the need to promote postural educations programs already in primary school children.

The sample was selected from different clusters (schools) using convenience sampling and randomly distributed into experimental group (5 schools) or control group (5 schools). The study flow is depicted in Figure 1.

The inclusion criteria were as follows: students must be aged between 10 and 12 years old and attending 5th or 6th grade primary school. Exclusion criteria were as follows: students whose parents or guardians did not return the informed consent form signed and those who did not participate due to illness or disability.

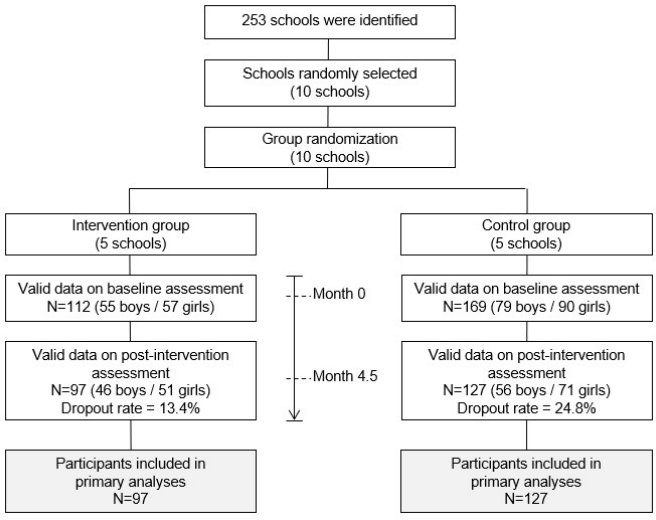

Figure 1. Flow chart.

Intervention —The overall strategy for developing the project was based on 1) intervention on classroom teachers, physical education teachers, and school management team; 2) awareness of the educational community (teachers, students, families); 3) teacher training; 4) a continuous intervention throughout the academic year. Therefore, the intervention is not carried out directly on children, but in their school environment.

A 16-week intervention program was carried out between February and June 2021 based on the following components:

(1) Online theoretical training in postural education for teachers (both physical education teachers and classroom teachers) through nine recorded videos (10–15 min of duration each) uploaded on the Internet. The following topics were addressed: scientific evidence of LBP, human anatomy and physiology, LBP risk factors, healthy physical exercise, ergonomics, postural hygiene, analysis of the use of schoolbags, healthy habits, back care recommendations for Physical Education subjects, and how to develop health promoting school projects.

(2) Implementation of active breaks for classroom teachers. Teachers were trained to learn how to apply active breaks in their classes throughout the school day during the whole intervention. In addition, a support manual was provided.

(3) Development of a postural education teaching unit for physical education. The duration of the teaching unit was 3 weeks (6 sessions), implemented during weeks 7–9 of the intervention. Sessions consisted of postural analysis; how to lift and carry objects correctly; carrying a backpack safely; balance, breathing and relaxation (Galmes et al., 2023)

(4) Information and awareness campaign implemented by the school (i.e., via posters, school website, social networks, etc.). The dissemination of the information was carried out throughout the 16 weeks of the intervention.

Instrumentation —Three structured and self-administered questionnaires were used to examine the prevalence of LBP and backpack use habits in a group of children aged 10 to 12 years old.

The students completed questionnaires at the two measurement times (baseline and post-test) and they were given out at school or at home. Teachers distributed the questionnaires using laptops in the classroom or supplied families with guidance to fill them out. The questionnaires were available on Google Forms.

The data relating to back pain was obtained using a validated questionnaire (Palou et al., 2010) that included lifetime prevalence of LBP (never/just once/sometimes/frequently/almost constantly), last 7-days prevalence of LBP (yes/no), the point prevalence of LBP (yes/no), and also included sex (boy/girl) and age (date of birth). In addition, height and weight were included in the questionnaire to determine the body mass index (BMI).

The Spanish version for adolescents (Miñana-Signes, Monfort-Pañego, Morant, Noll, 2021) of the Back Pain and Body Posture Evaluation Instrument (BackPEI) (Noll et al., 2013) was used to assess the correct use of backpack. The data included type of schoolbag (wheeled backpack/backpack with 2 straps/backpack with 1 strap/another) and how to carry the schoolbag (on 1 shoulder/on 2 shoulders/as a handbag/another).

The Hebacaknow questionnaire (Monfort-Pañego et al., 2016) was used to assess the knowledge level of postural education related to the correct use of backpacks. The score for each item was 0 (wrong option) or 1 (correct option). The 6

multiple-choice items of the category "habits in carrying heavy objects in a backpack" of the questionnaire were used to compute a sum score, namely backpack habits score (range from 0 to 6), so that the higher the score the healthier use related to LBP.

Data analysis —The analyses were performed with those participants that had complete data at the two measurement points (baseline and post-test) using PASW (Predictive Analytics SoftWare, formerly SPSS), version 23.0 SPSS Inc., Chicago, IL, USA. The level of significance was set at <0.05 for all the analyses. One-way analysis of variance (ANOVA) or Chi-squared tests were used to analyze group differences in continuous and nominal variables, respectively, at baseline. In order to examine the effect of the intervention, the Students' t test and Chi-Square test were used to analyze baseline and post-test group differences in continuous and nominal variables, respectively.

3. Results

Characteristics of the study sample by study group are shown in Table 1. Participants were 11.02 years old and had 40.7 kg, 147.9 cm and 18.7 kg/m2 of weight, height and body mass index, respectively. Lifetime LBP prevalence rate was 54.9% in the study sample. Last 7-days LBP prevalence was 17.4% and LBP point prevalence was 8%. In a range score from 0 to 6, the average of knowledge level of postural education related to the correct use of backpacks was 2.3.

Participants in both study groups had similar baseline characteristics, with the exception of the control group's lower BMI (~1.5 kg/m2, P=0.01). Low back pain prevalence, backpack habits and single questions related to the use of backpack did not differ between study groups. (Table 1)

Table 2 shows how backpack habits and single questions related to the use of backpack did not improve after the intervention in experimental group, and also in control group.

4. Discussion

The present study aims to investigate the effects of a postural education program on backpack use related to LBP in schoolchildren aged 10-12 year.

Results from this interventional study show that the weight of the backpack increased during the study in both intervention and control groups, with a significant increase in the intervention group. This increase in the weight of the backpack could be related to the time of the school year and the students' workload outside school. It is notable that the percentage of students with a "heavy" or "very heavy" backpack was higher in the control group compared to the intervention group in the post-test. Other studies had observed a decrease in the weight of the backpacks after the intervention, but this was still high, considering the recommendation of less than 10% of body weight (Minghelli et al., 2021) . On the contrary, other studies did not find an association between overweight school backpacks and postural changes or LBP (Minghelli et al., 2021; Yamato et al., 2018; Zwerver & de Vos, 2018).

In the present study, knowledge about the use of the backpack and the use of the backpack did not improve after the intervention in the experimental group, nor in the control group. Therefore, the present intervention has not shown any effect of the use of backpacks and the knowledge of how to use them on LBP.

In relation to the correct use of the backpack, although no improvements were found in the post-test, the majority of students (>95%) used a backpack with two

handles, and used it correctly, carrying the weight on both shoulders (>86%). Nevertheless, although the percentage of students who use backpacks incorrectly is low, it is relevant to highlight the importance of promoting health literacy education during childhood and adolescence (F. Kovacs et al., 2011; Winkelman et al., 2016), due to low health literacy being associated with worse child health outcomes (DeWalt & Hink, 2009).

Table 1. Characteristics of the study sample at baseline by study group.

	Total sample (N=224)		Experimental group (N=97)		Control Group (N=127)		*p
	Mean	(SD)	Mean	(SD)	Mean	(SD)	
Age (years)	11.02	(0.638)	11.35	(0.692)	10.78	(0.467)	<0.001
Weight (kg)	40.68	(9.492)	43.10	(11.15)	38.76	(7.453)	0.002
Height (cm)	147.9	(8.912)	148.9	(9.743)	147.1	(8.114)	0.159
Body mass index	18.73	(3.786)	19.53	(4.528)	18.08	(2.901)	0.013
Backpack use knowledge	2.30	(1.283)	2.16	(1.170)	2.41	(1.359)	0.158
	n	(%)	n	(%)	n	(%)	
Lifetime LBP (ever)	123	(54.9%)	55	(56.7%)	68	(53.5%)	0.638
Last week LBP	39	(17.4%)	15	(15.5%)	24	(18.9%)	0.502
LBP point prevalence (today)	18	(8.0%)	9	(9.3%)	9	(7.1%)	0.550
How heavy is your backpack?							
Very light	41	(19.6%)	16	(18.2%)	25	(20.7%)	
Light	62	(29.7%)	24	(27.3%)	38	(31.4%)	
Normal weight	55	(26.3%)	27	(30.7%)	28	(23.1%)	0.627
Heavy	40	(19.1%)	15	(17.0%)	25	(20.7%)	
Very heavy	11	(5.3%)	6	(6.8%)	5	(4.1%)	
Do you get tired carrying your backpack?							
No	64	(28.6%)	31	(32.0%)	33	(26.0%)	
A little bit	119	(53.1%)	55	(56.7%)	64	(50.4%)	0.130
Quite	29	(12.9%)	8	(8.2%)	21	(16.5%)	
A lot	12	(5.4%)	3	(3.1%)	9	(7.1%)	
Type of schoolbag							
Wheeled backpack	7	(3.1%)	4	(4.1%)	3	(2.4%)	
Backpack with 2 straps	215	(96.0%)	93	(95.9%)	122	(96.1%)	0.355
Backpack with 1 strap	0	(0%)	0	(0%)	0	(0%)	
Another	2	(0.9%)	0	(0%)	2	(0.9%)	
How to carry the schoolbag							
On 1 shoulder	16	(7.4%)	8	(8.5%)	8	(6.5%)	
On 2 shoulders	199	(91.7%)	86	(91.5%)	113	(91.9%)	0.402
As a handbag	0	(0%)	0	(0%)	0	(0%)	
Another	2	(0.9%)	0	(0%)	2	(0.9%)	

LBP indicates low back pain.

** One-way analyses of variance and Chi-squared tests were used to analyse group differences in continuous and nominal variables, respectively.*

Table 2. Correct use of backpack score at baseline and post-test by study group.

	Experimental group (N=97)						Control Group (N=127)					
	Baseline		Post-test				Baseline		Post-test			
	Mean	(SD)	Mean	(SD)	*p	Effect size	Mean	(SD)	Mean	(SD)	*p	Effect size
Backpack use knowledge	2.16	(1.170)	2.42	(1.353)	0.160	-0.144	2.41	(1.359)	2.44	(1.251)	0.838	-0.018
	n	(%)	n	(%)			n	(%)	n	(%)		
How heavy is your backpack?												
Very light	16	(18.2%)	3	(3.4%)	0.001	0.666	25	(20.7%)	3	(2.5%)	0.210	0.409
Light	24	(27.3%)	17	(19.3%)			38	(31.4%)	6	(5.0%)		
Normal weight	27	(30.7%)	37	(42.0%)			28	(23.1%)	60	(49.6%)		
Heavy	15	(17.0%)	23	(26.1%)			25	(20.7%)	38	(31.4%)		
Very heavy	6	(6.8%)	8	(9.1%)			5	(4.1%)	14	(11.6%)		
Do you get tired carrying your												
No	31	(32.0%)	33	(34.0%)	0.167	0.365	33	(26.0%)	30	(23.6%)	0.752	0.215
A little bit	55	(56.7%)	46	(47.4%)			64	(50.4%)	73	(57.5%)		
Quite	8	(8.2%)	14	(14.4%)			21	(16.5%)	14	(11.0%)		
A lot	3	(3.1%)	4	(4.1%)			9	(7.1%)	10	(7.9%)		
Type of schoolbag												
Wheeled backpack	4	(4.1%)	2	(2.1%)	0.919	-0.030	3	(2.4%)	3	(2.4%)	0.939	0.031
Backpack with 2 straps	93	(95.9%)	95	(97.9%)			122	(96.1%)	124	(97.6%)		
Backpack with 1 strap	0	(0%)	0	(0%)			0	(0%)	0	(0%)		
Another	0	(0%)	0	(0%)			2	(0.9%)	0	(0%)		
How to carry the schoolbag												
On 1 shoulder	8	(8.5%)	8	(8.6%)	0.529	0.154	8	(6.5%)	4	(3.3%)	0.846	0.053
On 2 shoulders	86	(91.5%)	80	(86.0%)			113	(91.9%)	116	(96.7%)		
As a handbag	0	(0%)	1	(1.1%)			0	(0%)	0	(0%)		
Another	0	(0%)	4	(4.3%)			2	(0.9%)	0	(0%)		

** Students' t test and Chi-squared test were used to analyse baseline and post-test group*

In relation to the lack of improvement after the intervention, this may be due to the fact that the intervention was carried out telematically due to the COVID-19 pandemic, when it was initially designed to be carried out in person. While it is true that some telematics interventions on healthy habits have had positive results in the adult population (Bian et al., 2017; Fischer et al., 2016), there are conflictive results (Nanditha et al., 2020), and to the best of our knowledge, no telematics interventions with positive results on behavior change in children have been performed (Dullien et al., 2018).

When reviewing other studies on the use of backpacks and the prevention of LBP in children and adolescents, we found that the interventions that seem to have the most positive effects are those of longer duration, with a higher frequency of weekly sessions, that combine theoretical and practical interventions, and with individualized feedback (Geldhof et al., 2006, 2007; Minghelli et al., 2021). Another very interesting aspect is the applicability of the feedback in the real environment of the students, that is, that the postural corrections were made in the classroom or in the physical education sessions, performing postures or using the tables and chairs that the students use daily, can facilitate the transfer of knowledge and the internalization of these new habits (Minghelli et al., 2021). These recommendations should be considered for future intervention studies.

Another very interesting aspect, which highlights the importance of addressing postural education in physical education, is the lack of body consciousness observed in students, so that, despite learning theoretically what the best posture is, they were unable to adopt a correct posture (Minghelli et al., 2021), which highlight the importance of motor skill competence development during childhood (Castelli & Valley, 2007).

5. Practical Applications.

The importance to carry out health intervention programs to promote health habits in schools. We recommend the use of mixed face to face and telematic interventions to achieve better results. There are some limitations in this study. The use of self-reported postural habits questionnaire has the potential to be limiting. Future research should look into the possibilities of improving the measure's precision. Another disadvantage could be the lack of follow-up, which would provide information on how long an intervention's effects can be retained by children. While it is true that the present study has considered the weight of school bags, which is a relevant and innovative aspect of the LBP study, it has not taken into account other variables that could be of interest, such as whether there were lockers in the schools, or whether traditional books were replaced by other lighter options, as in the case of the stackable notebooks. Another limitation could be the telematics implementation of the intervention. The study was initially designed to be conducted face-to-face, but due to complications arising from the COVID-19 pandemic, it was conducted telematically. On the other hand, as it was carried out telematically, it may provide interesting information for future research, as very few telematics interventions have been carried out in a childhood population. Lastly, it is important to publish the ineffectiveness of the intervention in order to guide future research, as well as to guarantee the reliability of systematic reviews and meta-analyses.

Marked strengths of this study were the use of a case-control design in a large cohort of school-children, across different schools in Majorca. Moreover, the questionnaires used in this study were previously validated for

accurate understanding of the children, validity, and reliability in a sample of similar characteristics. Another strength is the involvement of the whole educational community in the intervention, which allowed postural education to be addressed by the different agents present in the children's daily lives, such as teachers and parents.

6. Conclusions

In conclusion, the results of the present study, carried out in a population of 10-12 years old, show that the intervention group increased the weight of their backpacks during the intervention, and that the weight of the backpacks of the control group was higher. More research studies are needed to objectively analyze which factors influence in the occurrence of low back pain in children

Funding: This research and the APC was funded by Ministry of Science and Innovation MCIN/AEI/10.13039/501100011033 and by "European Regional Development Fund (ERDF) A way of making Europe", grant number RTI2018-101023-A-I00.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

References

Alberola López, S., Pérez García, I., Casares Alonso, I., Cano Garcinuño, A., & Andrés De Llano, J. M. (2010). Mochilas escolares y dolor de espalda en la población infantil. Revista Pediatría de Atención Primaria, 47, 385–397.

Barbosa, J. P., Marques, M. C., Neiva, H. P., Esteves, D., Alonso-Martínez, A. M., Izquierdo, M., Ramirez-Campillo, R., Alvarez, C., & Marinho, D. A. (2019). Effects of Backpacks on Ground Reaction Forces in Children of Different Ages When Walking, Running, and Jumping. International journal of environmental research and public health, 16(24), 5154. https://doi.org/10.3390/ijerph16245154

Bian, R. R., Piatt, G. A., Sen, A., Plegue, M. A., de Michele, M. L., Hafez, D., Czuhajewski, C. M., Iuis, L. R., Kaufman, N., & Richardson, C. R. (2017). The Effect of Technology-Mediated Diabetes Prevention Interventions on Weight: A Meta-Analysis. Journal of Medical Internet Research, 19(3). https://doi.org/10.2196/JMIR.4709

Borras, P. A., & Vidal-Conti, J. (2022). An on-line school-based randomised controlled trial to prevent non-specific low back pain in children: Health Education Journal, 81(3), 352–362. https://doi.org/10.1177/00178969221077408

Bort Saborit, N., & Simó Pitarch, A. (2002). Carritos o mochilas en la edad escolar. Fisioterapia, 24(2), 63–72. https://doi.org/10.1016/S0211-5638(02)72983-0

Burton, A. K., Clarke, R. D., McClune, T. D., & Tillotson, K. M. (1996). The natural history of low back pain in adolescents. Spine, 21(20), 2323–2328.

Calvo-Muñoz, I., Kovacs, F. M., Roqué, M., Fernández, I. G., & Calvo, J. S. (2018). Risk Factors for Low Back Pain in Childhood and Adolescence: A Systematic Review. The Clinical Journal of Pain, 34(5), 468–484. https://doi.org/10.1097/AJP.0000000000000558

Castelli, D. M., & Valley, J. A. (2007). Chapter 3: The Relationship of Physical Fitness and Motor Competence to Physical Activity. Journal of Teaching in Physical Education, 26(4), 358–374.

Cheung, J. M. Y., Bartlett, D. J., Armour, C. L., Laba, T. L., & Saini, B. (2018). To drug or not to drug: A qualitative study of patients' decision-making processes for managing insomnia. Behavioral Sleep Medicine, 16(1), 1-26. doi:10.1080/15402002.2016.1163702

Chiang, H. Y., Jacobs, K., & Orsmond, G. (2006). Gender-age environmental associates of middle school students' low back pain. Work, 26(1), 19–28.

DeWalt, D. A., & Hink, A. (2009). Health literacy and child health outcomes: a systematic review of the literature. Pediatrics, 124 Suppl 3(SUPPL. 3). https://doi.org/10.1542/PEDS.2009-1162B

Diepenmaat, A. C., van der Wal, M. F., de Vet, H. C., & Hirasing, R. A. (2006). Neck/shoulder,

low back, and arm pain in relation to computer use, physical activity, stress, and depression among Dutch adolescents. Pediatrics, 117(2), 412–416. https://doi.org/117/2/412 [pii]

Dullien, S., Grifka, J., & Jansen, P. (2018). Cluster-randomized, controlled evaluation of a teacher led multi factorial school based back education program for 10 to 12-year old children. BMC Pediatrics, 18(1). https://doi.org/10.1186/s12887-018-1280-y

Fischer, H. H., Fischer, I. P., Pereira, R. I., Furniss, A. L., Rozwadowski, J. M., Moore, S. L., Durfee, M. J., Raghunath, S. G., Tsai, A. G., & Havranek, E. P. (2016). Text Message Support for Weight Loss in Patients With Prediabetes: A Randomized Clinical Trial. Diabetes Care, 39(8), 1364–1370. https://doi.org/10.2337/DC15-2137

Galmés, A.M., Vidal-Conti, J., Bermejo, J.M., Ponseti, X., Borràs, P.A., Muntaner, A., Cantallops, J., Palou, P. (2023). Bel Postura. Palma: Edicions UIB. ISBN 978-84-8384-475-5

Geldhof, E., Cardon, G., de Bourdeaudhuij, I., & de Clercq, D. (2006a). Effects of a two-school-year multifactorial back education program in elementary schoolchildren. Spine, 31(17), 1965–1973. https://doi.org/10.1097/01.BRS.0000228722.12968.D2

Geldhof, E., Cardon, G., de Bourdeaudhuij, I., & de Clercq, D. (2007). Back posture education in elementary schoolchildren: a 2-year follow-up study. European Spine Journal : Official Publication of the European Spine Society, the European Spinal Deformity Society, and the European Section of the Cervical Spine Research Society, 16(6), 841–850. https://doi.org/10.1007/S00586-006-0227-4

Health Promotion Glossary of Terms. (2021). Retrieved January 21, 2022, from https://www.who.int/publications/i/item/9789240038349

Hernández, T. L., Ferré, M. C., Martí, S. G., & Salvat, I. S. (2020). Relationship between School Backpacks and Musculoskeletal Pain in Children 8 to 10 Years of Age: An Observational, Cross-Sectional and Analytical Study. International Journal of Environmental Research and Public Health, 17(7). https://doi.org/10.3390/IJERPH17072487

Hong, Y., Li, J. X., Wong, A. S. K., & Robinson, P. D. (2000). Effects of load carriage on heart rate, blood pressure and energy expenditure in children. Ergonomics, 43(6), 717–727. https://doi.org/10.1080/001401300404698

Hwang, J., Louie, P. K., Phillips, F. M., An, H. S., & Samartzis, D. (2019). Low back pain in children: a rising concern. European Spine Journal, 28(2), 211–213. https://doi.org/10.1007/s00586-018-5844-1

Kovacs, F. M., Gestoso, M., Gil del Real, M. T., Lopez, J., Mufraggi, N., & Mendez, J. I. (2003). Risk factors for non-specific low back pain in schoolchildren and their parents: a population based study. Pain, 103(3), 259–268. https://doi.org/S0304395902004542 [pii]

Kovacs, F., Oliver-Frontera, M., Plana, M. N., Royuela, A., Muriel, A., & Gestoso, M. (2011). Improving schoolchildren's knowledge of methods for the prevention and management of low back pain: a cluster randomized controlled trial. Spine, 36(8). https://doi.org/10.1097/BRS.0B013E3181DCCEBC

MacDonald, J., Stuart, E., & Rodenberg, R. (2017). Musculoskeletal Low Back Pain in School-aged Children: A Review. JAMA Pediatrics, 171(3), 280–287. https://doi.org/10.1001/JAMAPEDIATRICS.2016.3334

Masiero, S., Carraro, E., Celia, A., Sarto, D., & Ermani, M. (2008). Prevalence of nonspecific low back pain in schoolchildren aged between 13 and 15 years. Acta Paediatrica, 97(2), 212–216. https://doi.org/10.1111/j.1651-2227.2007.00603.x [doi]

Michaleff, Z. A., Kamper, S. J., Maher, C. G., Evans, R., Broderick, C., & Henschke, N. (2014). Low back pain in children and adolescents: a systematic review and meta-analysis evaluating the effectiveness of conservative interventions. European Spine Journal, 23(10), 2046–2058. https://doi.org/10.1007/s00586-014-3461-1

Minghelli, B., Nunes, C., & Oliveira, R. (2021). Back school postural education program: Comparison of two types of interventions in improving ergonomic knowledge about postures and reducing low back pain in adolescents. International Journal of

Environmental Research and Public Health, 18(9). https://doi.org/10.3390/ijerph18094434

Miñana-Signes, V., Monfort-Pañego, M., & Valiente, J. (2021). Teaching Back Health in the School Setting: A Systematic Review of Randomized Controlled Trials. International journal of environmental research and public health, 18(3), 979. https://doi.org/10.3390/ijerph18030979

Miñana-Signes, V., Monfort-Pañego, M., Morant, J., & Noll, M. (2021). Cross-cultural adaptation and reliability of the back pain and body posture evaluation instrument (Backpei) to the spanish adolescent population. International Journal of Environmental Research and Public Health, 18(3), 854.

Monfort-Pañego, M., Molina-García, J., Miñana-Signes, V., Bosch-Biviá, A. H., Gómez-López, A., & Munguía-Izquierdo, D. (2016). Development and psychometric evaluation of a health questionnaire on back care knowledge in daily life physical activities for adolescent students. European Spine Journal, 25(9), 2803–2808. https://doi.org/10.1007/s00586-016-4627-9

Nanditha, A., Thomson, H., Susairaj, P., Srivanichakorn, W., Oliver, N., Godsland, I. F., Majeed, A., Darzi, A., Satheesh, K., Simon, M., Raghavan, A., Vinitha, R., Snehalatha, C., Westgate, K., Brage, S., Sharp, S. J., Wareham, N. J., Johnston, D. G., & Ramachandran, A. (2020). A pragmatic and scalable strategy using mobile technology to promote sustained lifestyle changes to prevent type 2 diabetes in India and the UK: a randomised controlled trial. Diabetologia, 63(3), 486–496. https://doi.org/10.1007/S00125-019-05061-Y

Noll, M., Tarragô Candotti, C., Vieira, A., & Fagundes Loss, J. (2013). Back Pain and Body Posture Evaluation Instrument (BackPEI): Development, content validation and reproducibility. International Journal of Public Health, 58(4), 565–572. https://doi.org/10.1007/s00038-012-0434-1

Palou, P., Kovacs, F. M., Vidal, J., Gili, M., Borràs, P. A., Gestoso, M., & Ponseti, X. (2010). Validation of a questionnaire to determine risk factors for back pain in 10-12 year-old school children. Gazzetta Medica Italiana Archivio per Le Scienze Mediche, 169(5).

Perrone, M., Orr, R., Hing, W., Milne, N., & Pope, R. (2018). The Impact of Backpack Loads on School Children: A Critical Narrative Review. International Journal of Environmental Research and Public Health, 15(11). https://doi.org/10.3390/IJERPH15112529

Quintana Aparicio, E., Martín Nogueras, A. M., López Sendín, N., Romero Alonso, A. B., Sánchez Pedraz, L., & Calvo Arenillas, J. I. (2005). Influencia del tipo de jornada escolar en el peso de las mochilas escolares. Fisioterapia, 27(1), 6–15. https://doi.org/10.1016/S0211-5638(05)73410-6

Ramos Espada, D., González Montesinos, J., Mora Vicente, J., Ares Camerino, A., & Martínez González, J. (2004). Desarrollo y aplicación de un cuestionario en una población escolar sobre el transporte de mochilas y su influencia en el dolor de espalda. Revista de Pediatría de Atención Primaria, 6(22), 199–208.

Rusek, W., Baran, J., Leszczak, J., Adamczyk, M., Baran, R., Weres, A., Inglot, G., Czenczek-Lewandowska, E., & Pop, T. (2021). Changes in Children's Body Composition and Posture during Puberty Growth. Children, 8(4). https://doi.org/10.3390/CHILDREN8040288

Santos, E. D. S., Bernardes, J. M., Noll, M., Gómez-Salgado, J., Ruiz-Frutos, C., & Dias, A. (2021). Prevalence of Low Back Pain and Associated Risks in School-Age Children. Pain Management Nursing: Official Journal of the American Society of Pain Management Nurses, 22(4), 459–464. https://doi.org/10.1016/J.PMN.2021.01.017

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 Orthopedics, 26(3), 358–363. https://doi.org/10.1097/01.bpo.0000217723.14631.6e

Steffens, D., Maher, C. G., Pereira, L. S. M., Stevens, M. L., Oliveira, V. C., Chapple, M., Teixeira-Salmela, L. F., & Hancock, M. J. (2016). Prevention of Low Back Pain: A Systematic Review and Meta-analysis. JAMA Internal Medicine, 176(2), 199–208. https://doi.org/10.1001/jamainternmed.2015.7431

Taimela, S., Kujala, U. M., Salminen, J. J., & Viljanen, T. (1997). The prevalence of low

back pain among children and adolescents. A nationwide, cohort-based questionnaire survey in Finland. Spine, 22(10), 1132–1136.

Tomal, P., Fryzowicz, A., Skorupska, E., & Dworak, L. B. (2022). Influence of School Backpack Load as a Variable Affecting Gait Kinematics among Seven-Year-Old Children. International journal of environmental research and public health, 19(7), 3843. https://doi.org/10.3390/ijerph19073843

Veshovda, S., Eik, H., Andersen, M. H., Jahre, H., & Riiser, K. (2023). Health literacy and musculoskeletal disorders in adolescents: a scoping review. BMJ open, 13(6), e072753. https://doi.org/10.1136/bmjopen-2023-072753

Vidal-Conti, J., Borràs, P. A., Palou, P., & Muntaner-Mas, A. (2021). Prevalence of low back pain among school-aged children between 10 and 12 years. Sustainability (Switzerland), 13(21). https://doi.org/10.3390/su132112254

Winkelman, T. N. A., Caldwell, M. T., Bertram, B., & Davis, M. M. (2016). Promoting Health Literacy for Children and Adolescents. Pediatrics, 138(6). https://doi.org/10.1542/PEDS.2016-1937

Yamato, T. P., Maher, C. G., Traeger, A. C., Wiliams, C. M., & Kamper, S. J. (2018). Do schoolbags cause back pain in children and adolescents? A systematic review. British Journal of Sports Medicine, 52(19), 1241–1245. https://doi.org/10.1136/BJSPORTS-2017-098927

Zwerver, J., & de Vos, R. (2018). Bag to school. British Journal of Sports Medicine, 52, 1219–1220.