Cross-national trends of chronic back pain in adolescents: results from the HBSC study, 2001-2014

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Abstract

Chronic back pain is a common problem that negatively impacts the wellbeing of many adolescents. Prior research suggests that the prevalence of chronic back pain has increased over the last decades, but research on this issue is scarce, single country-based, and has yielded inconsistent results. This study aimed to examine trends in the prevalence of chronic back pain over time in adolescents aged 11, 13 and 15, using data from the Health Behavior in School-aged Children (HBSC) survey. We conducted a secondary analysis of data from 650,851 adolescents, retrieved from four waves (2001/02, 2005/06, 2009/10 and 2013/14) of HBSC data from 33 countries or regions. The prevalence of back pain was higher (1) in each successive survey over time (18.3% in 2001/02, 19.3% in 2005/06, 20.4% in2009/10 and 21.6% in 2013/14), (2) in girls (21.9%) compared to boys (17.8%), and (3) in older adolescents compared to younger ones (14.5% in 11-year-olds, 19.6% in 13-year-olds and 25.5% in 15-year-olds). The increase in prevalence from 2001/02 to 2013/14 was more marked in older girls compared to younger girls, and in older boys compared to younger boys, and it ranged between 1% for 11-year-old boys and 7% for 15-year-old girls. More resources should be allocated to the prevention and treatment of chronic back pain in adolescents, especially for older girls.

Perspective

The prevalence of chronic back pain in adolescents has increased from 2001/02 to 2013/14, especially in older adolescent girls. These findings underline the need of

further research to understand the reason behind the increasing trend, and what programs are better suited to prevent chronic back pain among adolescents.

Key words: Chronic back pain, prevalence, adolescents, trends, multivariate model.

Introduction

Back pain is a common chronic pain problem in adolescents [20,22]. Moreover, back pain and chronic back pain in children and adolescents is associated with lower levels of well-being, higher medical care requirements and costs, and functional limitations [1,12,13,28,33,35]. A review of 27 systematic reviews on back pain in children and adolescents found that its monthly prevalence ranges from 18% to 24%. In most, but not all, of the reviews, the prevalence of back pain was higher for girls than boys, and increased with age [23].

It has been suggested that there has been an increase in the prevalence of pain problems in young people over the last decades [24]. For example, a meta-analysis reported a slight increase of psychosomatic health complaints from 1980 to 2016, including back pain, in adolescents aged 10 to 19 [31]. Also, a different meta-analysis on the prevalence of low back pain in children and adolescents found that the most recent studies reported higher prevalence rates than the oldest ones [6]. To our knowledge, only two studies, both conducted in Finland, have examined trends over time in the prevalence of back pain among adolescents. One of them found that the prevalence of low back pain in adolescents aged 12 to 18 had increased from 1991 to 2001, and that this increase in prevalence was similar for both sexes and all ages considered (i.e., there was not a significant interaction between sex or age and the survey year) [14]. However, the second and most recent study found that the

prevalence of low back pain in adolescents aged 12 to 18 remained stable from 1991 to 2011 [37].

As these studies reached contradictory conclusions and only considered the Finnish population of adolescents with low back pain, there is a need for additional studies looking at changes in the prevalence of chronic back pain in adolescents across time in other countries. Therefore, we sought to examine the prevalence of chronic back pain in adolescents aged 11, 13 and 15, using four waves of a large nationally representative survey conducted mainly in Europe and North America from 2001 to 2014. Based on previous research findings, we hypothesized that: (1) the overall prevalence rate of chronic back pain would show a linear trend of increasing prevalence over time; (2) girls would have a higher overall prevalence of chronic back pain compared to boys; and (3) older adolescents would have a higher overall prevalence of chronic back pain compared to younger adolescents. In addition, we explored the potential moderating effects of sex and age on the hypothesized time effect (i.e., change in global prevalence rate over time with each wave of the survey) on chronic back pain.

Methods

Design, setting and sample

This study uses data from the Health Behavior among School-aged Children (HBSC) study [8]. The HBSC study is a cross-sectional international study conducted in several countries or regions of Europe, North America and Israel by an international alliance of researchers in collaboration with the World Health Organization. Every 4 years, the HBSC study assesses health behaviors (e.g., smoking, exercising), health indicators (e.g., health problems, use of health services) and contextual variables (e.g.,

relationships with family and peers, school environment) in 3 different age groups and for both sexes, using self-reported measures administered in classrooms. The HBSC study provides nationally representative samples of 11-, 13- and 15-year-old boys and girls for each participating country, using a cluster sampling method (with the school classes as the primary sampling unit) and ensuring representation by sex, age and school type. The three age groups were selected to represent the "onset of adolescence, the challenge of physical and emotional changes, and the middle years when important life and career decisions are beginning to be made" [32, p. 143]. Further information regarding the HBSC study methods is available elsewhere [32].

To address the aims of this study, secondary data from 801,648 adolescents were retrieved from 4 consecutive waves (2001/02, 2005/06, 2009/10 and 2013/14) of the HBSC study. Ethical consent was obtained and granted by researchers in each participating country.

Variables and measures

Variables regarding time of assessment, sociodemographic information and data from the HBSC symptoms checklist (HBSC-SCL) were used. The information regarding time of assessment was the survey year (i.e., 2001/02, 2005/06, 2009/10 and 2013/14). Sociodemographic information included both sex (boys *vs*. girls) and age group (11-, 13-, and 15- year-olds). The presence of chronic back pain was extracted from one of the items of the HBSC-SCL, an 8-item symptom checklist which has been found to provide reliable and valid measures of subjective health complaints [16]. This item reads: "In the last six months, how often have you had backaches?" The possible responses are: "About every day", "More than once a week", "About every week", "About every month" and "Rarely or never". The presence of chronic back pain was

deemed positive for those adolescents who reported having back pain weekly or more often for the past 6 months. This dichotomization has been previously used in articles also using items from the HBSC-SCL [11,16].

Missing data

Although the number of missing values was small (3%, n=20,243), we examined the possibility that missing data might bias the results using multiple imputation, a procedure that replaces missing values by several predicted and simulated values. In particular, we used the multivariate imputation by chained equations procedure, as it allows to specify models for different types of variables. A logistic model was used to replace missing data regarding the presence of chronic pain, and an ordered logistic model to impute missing age data. A total of 20 imputed datasets were created and analyzed with a multiple logistic regression containing the same variables used in the complete case analysis. We then planned to compare the findings from these analyses. If the results differed significantly, we planned to provide the multiple imputation model results. If not, we planned to provide the complete case results.

Data analyses

In order to perform the planned analyses, we first eliminated data belonging to participants from countries that did not provide data for each of the four survey years (i.e., Albania, Armenia, Bulgaria, Iceland, Luxembourg, Malta, Republic of Moldova, Romania, Slovakia, Turkey and the United States of America). We then created two different datasets: one without any missing data for complete case analysis and another for the multiple imputation analyses. For the complete case analysis, we removed data from those respondents who did not provide answers to all the study variables. For the multiple imputation analysis, we imputed data for those participants

with missing information. For descriptive purposes, we first computed the number and percentages for categorical variables and means and standard deviations for continuous variables for the sample as a whole. To test the study hypotheses, we conducted two three-stage hierarchical multiple logistic regression with the presence of chronic back pain as the criterion variable, one with the complete case analysis data and another one with the imputed data. The results of these analyses were used to ascertain which subgroups should be considered in order to report accurate estimates of the prevalence of chronic back pain (i.e., either by year of survey, by sex, by age groups, by year of survey and sex, by year and survey and age group, by sex and age group, or by year of survey, sex, and age group altogether). To test the study hypotheses, we entered variables reflecting time, sex, and age as a block in step 1. All these predictors were entered dummy coded (i.e., being surveyed in 2001/02, being female and being 11 years old as the reference categories, respectively). A significant time effect at this step, with an associated increase in the prevalence of chronic back pain over time, would support hypothesis 1. In the same way, a significant sex or age effect at this step, with girls reporting a higher rate of chronic back pain than boys or higher rates in older participants than younger participants, would support hypothesis 2 and 3, respectively. We then entered interaction terms in steps 2 and 3; the Time X Sex, Time X Age and Sex X Age (two-way) interactions terms in step 2 and the Time X Sex X Age (three-way) interaction term in step 3. If any of these interactions emerged as significant, we planned to compute stratum-specific estimates of the prevalence of chronic back pain by the significant effect modifiers. For example, if the three-way interaction was significant, we planned to compute and examine the prevalence rates (%) at each time point separately for boys and girls in each of the three age groups. If

the three-way interaction was not significant, we planned to follow up any significant two-way interaction effects by examining the prevalence rates for boys and girls in each of the three age groups (if a significant sex moderating effect on age was identified), the prevalence at each time point separately (1) for boys and girls (if a significant sex moderating effect on time was identified) and (2) for each of the three age groups (if an age moderating effect on time was identified). The adequacy of the final regression model was evaluated using the Hosmer-Lemeshow goodness-of-fit test. Statistical significance was set at $p < .05$. The statistical analyses were conducted using STATA 14 (Stata Corp., Texas, USA). The command *svyset* and survey weights were used to account for the complex sampling method.

Results

Participant characteristics

We first removed data belonging to participants from the 11 countries that did not participate in the four waves that are the focus of the current study (n=130,564) and from those respondents who had not provided answers to all the study variables (n=20,243). The final sample for the complete case analysis consisted of 650,841 adolescents from 33 countries or regions. The mean age of participants was 13.6 years (SE = 0.002; Range = 9.8 – 17.3). The mean age of respondents was 11.6, 13.6 and 15.6 years for the 11-, 13- and 15-year groups, respectively. The two sexes, the three age groups and the four survey waves had a similar sample size (please see Table 1). The final sample for the multiple imputation analyses consisted of 671,084 adolescents.

[Insert Table 1 about here]

Regression analyses

To test the hypotheses of our study, we performed two multiple logistic regression analyses with chronic back pain as the criterion variable, one using the complete case data and the second using imputed data. Step 1, representing the main effects, step 2, representing the two-way interactions, and step 3, representing the three-way interaction between predictors, were all significant. The results using the multiple imputation data were similar to those using the complete case analysis data (please see Supplementary Table 1). We therefore present the results from the complete case analysis here (see Table 2). The Hosmer-Lemeshow goodness of fit statistic was $\hat{C}$ = 0.01 (df=8, p=.999), indicating that there was a good fit for the final model including the three-way interaction.

[Insert Table 2 about here]

All three study hypotheses were supported, given that time, sex, and age were significantly associated with the presence of chronic back pain in step 1. That is, the global prevalence was higher (1) in each following year of survey (18.3% in 2001/02, 19.3% in 2005/06, 20.4% in 2009/10 and 21.6% in 2013/14), (2) in girls (21.9%) compared to boys (17.8%), and (3) in older adolescents compared to younger ones (14.5% in 11-year-olds, 19.6% in 13-year-olds and 25.5% in 15-year-olds).

Regarding the interactions, two out of the three two-way interactions (Time X Age and Sex X Age) and the three-way interaction (Time X Sex X Age) emerged as statistically significant. The significant Time X Sex X Age interaction indicates that the rate of increase in the prevalence of chronic back pain from 2001/02 to 2013/14 was moderated by both the sex and age of the adolescent. Table 3 displays the prevalence rates at each time point separately for boys and girls in each of the three age groups, as well as the changes in the prevalence of chronic back pain from 2001/02 to 2013/14

for each considered stratum. As can be seen, all subgroups considered showed an increase in the prevalence of chronic back pain from 2001/02 to 2013/14, which ranged between 1% for 11-year-old boys and 7% for 15-year-old girls. There was an increase of 3% in the global prevalence of chronic back pain in the 12-year period of study considered.

[Insert Table 3 about here]

For further details, Table 4 displays the odds ratios (OR) for chronic back pain in 2013/14 compared to the reference year 2001/02, for boys and girls in each of the three age groups. The odds of having chronic back pain in 2013/14 compared to 2001/02 were all significant, and higher in girls compared to boys and in older adolescents compared to younger ones.

[Insert Table 4 about here]

Discussion

Chronic back pain is a common health problem which has been found to negatively impact the lives of those with this condition, including adolescents [23,29,40,41]. In addition, prior research suggests the possibility that the prevalence of chronic back pain might have been increasing among adolescents over the past few decades [14,24]. The findings from the current study not only confirmed this observation across many countries, but also identified higher prevalence ratings in (1) girls compared to boys, and (2) older adolescents compared to younger adolescents. We also found that the increase in prevalence over time was significantly higher in older girls compared to younger girls, and in older boys and compared with younger boys.

To date, only two studies have examined trends in the prevalence of back pain among adolescents over time. These studies, which focused on the evolution in the prevalence of low back pain among Finish adolescents, reported conflicting results. Hakala and colleagues [14] found an increase from 1991 to 2001, whereas Ståhl and colleagues [37] found that the prevalence of low back pain had not changed significantly over a period of time twice as long, specifically from 1991 to 2011. Our results are consistent with the former study, as we found an increasing trend in the prevalence of chronic back pain among adolescents from 2001 to 2014. One potential reason for the conflicting results is the different periods of time considered by the three studies. Another possible explanation for the different results might be differences in the study participants; our analyses used a sample that was representative of the adolescent population of a total of 33 countries and regions of Europe, North America and Israel, whereas the other two studies were conducted only with Finish adolescents.

Although a few national studies have failed to find sex differences in the prevalence rates of back pain among adolescents [21,26,30,38], most national studies (e.g., [24,43,44,46]) have found higher prevalence rates in girls compared to boys, and a review of systematic reviews of back pain prevalence concluded that these prevalence rate differences are reliable [23]. Our findings are consistent with this latter body of research, as we found that chronic back pain was significantly more prevalent in girls compared to boys. Also consistent with the findings from previous research [26,30,38,42,43], we found that older adolescents had a higher overall prevalence of chronic back pain compared to younger adolescents.

To date, and to the best of our knowledge, only one study has tested the moderating effects of sex and age on the increase of prevalence of back pain over time. Hakala and colleagues [13], who examined data from a sample of Finish adolescents, did not find a significant moderating effect of sex or age on the increase in the prevalence of back pain. However, we not only found that sex and age separately moderated the increase in the prevalence of chronic back pain, but also that the effect of time on the prevalence varied as a function of both sex and age. That is, the rate of increase was not only higher in girls compared to boys, and in older adolescents compared to younger ones, but also in older girls compared to younger girls, and in older boys compared to younger boys.

These findings have important financial and clinical implications. There is a consensus that chronic pain conditions in children and adolescents result in a significant economic burden to society [12,19,36]. If our findings are replicated in future studies, and if the prevalence continues to increase over time, we could anticipate that the economic burden associated with chronic back pain in adolescents will only worsen. Also, if the current findings regarding the role of sex on prevalence rates are replicated in future studies, this would suggest that older female adolescents are particularly at risk for developing chronic back pain. This would support the need for research to understand the reasons for this effect (e.g., the role of biological, psychological, and social factors), the findings from which could inform the development of interventions that could reduce the risk of chronic pain development in adolescents in general, and perhaps in girls in particular. Moreover, if this finding is confirmed in other studies, this would support the need for providing greater resources to this segment of the population.

In addition, a number of studies have found that having back pain or low back pain during mid-adolescence significantly increases the odds of having low back pain later on, either in later adolescence [34] or in adulthood [5,15,18,22]. Thus, an increased incidence of this problem in adolescents might translate in more individuals having or developing chronic pain during adulthood. And chronic back pain in adults is already one of the most serious global public health problems [45].

Considering all the factors discussed above, it stands to reason that some preventive efforts and early interventions for those adolescents who have back pain need to be implemented. Landry and colleagues [27] discuss some potential treatment and preventive measures for adolescents with low back pain, based on physical activity, physical therapy exercise, and postural education and hygiene. Also, preventive interventions could be implemented in earlier ages, when the back pain problem is less likely to have evolved into a chronic disabling condition. Along these lines, an educational intervention aiming to improve eight-year-old's knowledge on the prevention and management of low back pain proved successful [25]. Adopting and implementing these and similar measures could potentially reduce the risk that back pain will become chronic and, to some extent, decrease the number of cases of adolescents whose chronic back pain will persist into adulthood.

To date, we have no clear data-driven explanations for the increase in the prevalence of chronic back pain in adolescents, let alone why this increase has been more marked for older female adolescents. A possible explanation for such an increase might be related with the increase in the incidence of the risk factors for back pain. Despite mixed evidence and some inconsistencies in the research around this topic (e.g, screen time, low physical activity, obesity, etc.), Kamper and colleagues found

that psychological distress, smoking, low socioeconomic status, and taller height increase the risk of back pain in children and adolescents [23]. Another review on potential risk factors for back pain in children and young adults added later pubertal status, positive family history of back pain, increased growth spurt and a history of back pain to the list of potential risk factors [2]. For example, the rates of mental health problems among children and adolescents have increased in the last decades [7,10]. Further studies should investigate whether this higher incidence in psychological problems or a higher incidence of any of the other risk factors might account for the increase in the prevalence of chronic back pain over time. Another potential explanation might be related to society's increased emphasis on academic success, which translates into increased school pressure. This might also explain why the increase in the prevalence of chronic back pain has been higher in girls, as school stress is higher in girls compared to boys [20]. Further research on these issues is warranted.

This study has a number of important limitations. First, as the HBSC study is conducted mostly in countries from Europe, the extent to which the findings generalize to other countries outside of Europe is not known. Second, the definition and measurement of pain in the survey/s was based solely on the presence (or not) of back pain; the findings do not speak to the relative magnitude or severity of pain, or pain interference, in the study sample [21]. Future surveys should include measures of pain severity and interference if possible, to determine the rate and extent of disabling chronic pain [17,39]. Third, the HBSC study did not measure gender in addition to sex. This precluded our ability to evaluate gender as a factor that might moderate the presence of chronic back pain. Future studies would benefit from the inclusion of a

measure of gender, in addition to the measure of sex, as the role that gender plays in the presence of chronic back pain remains to be thoroughly explored [4], especially in children and adolescents [3]. Fourth, the regression model did not include other covariates that might have been associated with the presence of chronic back pain, such as the socioeconomic status. Finally, and due to the surveying method, students who were absent on the day when the surveying process took place were not accounted for. This could have biased the findings, as adolescents with health problems are more likely to be absent from school [9].

Despite the study's limitations, to our knowledge this is the first study to report the increase in prevalence of chronic back pain over time in adolescents with data from different countries and regions. Future studies are needed to determine if the increasing trend in the prevalence of chronic back pain continues in future waves of the HBSC study (or in other studies with separate assessment periods over time), as well as to identify the possible reasons for the changes in rates of pain over time and also, the reasons that rates are moderated by both age and sex. Additional research is also needed to study what programs are more suited to prevent chronic back pain among adolescents and whether the results are also dependent on the age and sex of the adolescents. Finally, as an accurate understanding of the trend in adolescent's incidence of chronic back pain is critical for determining population health priorities, future studies should assess if this increasing pattern also occurs with other chronic pain problems.

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Table legends

Supplementary Table 1

Note. CCA= Complete case analysis; MI=multiple imputation; yo= years old.

Table 3

Note. Change computed considering the 2001/02 and 2013/14 waves.

Table 4

Note. CI = confidence interval; OR = odds ratio.