Article Type: Original Manuscript

Title: Prevalence of self-reported chronic pain among adolescents: evidence from 42 countries and regions

Running Head: Self-reported chronic pain among adolescents

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This article has been accepted for publication and undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process, which may lead to differences between this version and the Version of Record. Please cite this article as doi: 10.1002/ejp.1306

Article Type: Original Manuscript

Section: Epidemiology

Declaration:

The manuscript contains original unpublished work and is not being submitted for publication elsewhere. The research is based on WHO collaborative Health Behaviour among School-aged Children study (HBSC). There are no conflicting interests regarding the funding of the study. The study conformed to the ethical standards of each of the countries involved. All authors meet criteria for authorship and all authors discussed the results and commented on the manuscript.

Significance

- Chronic pain co-occurrence is common during adolescence across countries, the prevalence being among girls and in older age groups.
- Significant cross-country variations in the chronic pain prevalence and chronic pain patterns among adolescents exist.
- Significant country differences emerge for specific chronic pain patterns in association with adolescent demographics.

Abstract

Background: Reports of the overall chronic pain prevalence and its associated demographic characteristics among adolescents vary greatly across existing studies. Using internationally comparable data, the present study investigates age, sex and country-level effects in the prevalence of chronic single-site and multi-site pain among adolescents during the last six months preceding the survey.

Methods: Data (n = 214,283) from the 2013/2014 Health Behaviour in School-aged Children (HBSC) study were used including nationally representative samples of 11-, 13- and 15-year-olds from general schools in 42 participating countries. Multilevel logistic regression analyses were used.

Results: The overall proportion of adolescents reporting chronic weekly pain during the last six months was high (44.2%). On average, in comparison with different specific localized types of single-site pain the prevalence of multi-site pain was more common varying from 13.2% in Armenia to 33.8% in Israel. Adolescent age and sex were strong predictors for reporting pain, but significantly different demographic patterns were found in the cross-country analyses. The most consistent findings indicate that multi-site pain was more prevalent among girls across all countries and that the prevalence increased with age.

Conclusions: Internationally comparable data suggest that self-reported chronic pain among adolescents is highly prevalent, but different age and sex patterns across countries exist. Adolescents with chronic pain is not a homogenous group. Chronic pain co-occurrence and differences in chronic pain characteristics should be addressed in both clinical and public health practice for effective adolescent chronic pain management and prevention.

Keywords: chronic pain; multi-site pain; adolescents; HBSC study

Introduction

Operational definitions of chronic pain vary; however, the majority of studies on adolescents define chronic pain as symptoms that occur at least once a week with an exposure time of three or six months (Perquin et al., 2000; Ghandour et al., 2004; Roth-Isigkeit et al., 2004; Petersen et al., 2006; Sundblad et al., 2007; Hoftun et al., 2011; Darlington et al., 2012). The chronic pain lasting for more than 3 or 6 months is being accepted to be of clinical and research relevance by the International Association of for the Study of Pain (Merskey and Boduk, 1994). Overall, there is significant variation in chronic pain prevalence among adolescents across existing studies due to differences in study groups, pain measurements, age variation, and sample size and pain definition. Previous systematic review reports substantial variation in the pain prevalence among adolescents across the studies

ranging from 8% to 83% for headache; from 14% to 24% for back pain; from 4% to 53% for abdominal pain; and for multi-site pain ranging from 4% to 40% (King et al., 2011).

To date, the majority of studies focused on reporting site-specific pain. Among adolescents, multi-site chronic pain has been reported as being more prevalent than single-site pain (Hoftun et al., 2011; Kristjansdóttir, 1997a; Perquin et al., 2000; Petersen et al., 2006; Swain et al., 2014). It is suggested that single-site and multi-site pain might be different phenomena, not only in prevalence but also in demographic distribution and psychosocial impact of chronic pain on adolescents (Borge and Nordhagen, 1995; Kristjansdóttir, 1997b; Petersen et al., 2009; Hoftun et al., 2011, 2012). Since the review on adolescent pain in 1990s (Goodman and McGrath, 1991), the number of epidemiological studies focusing on chronic pain among adolescents has increased. However, comparative studies are still required to provide accurate chronic pain prevalence rates in adolescents (King et al., 2011). Moreover, country-level effects remain to be examined in order to explore chronic pain experience among adolescents' age and sex groups. Internationally comparable population-based prevalence estimates of chronic pain are crucial to understand the chronic pain burden among adolescents across the countries, which may benefit both the clinical and the public health care. The present investigation used data from a large scale WHO collaborative cross-national Health Behaviour in School-aged Children (HBSC) study based on nationally representative samples of adolescents. The HBSC study follows the standardised methodology providing a strong basis for international comparisons (Inchley et al., 2016). The present study builds upon previous work undertaken by Swain et al. (2014) and expands its findings and methods by exploring the country-specific prevalence of chronic pain into details including a larger number of countries, and evaluating country-level variation of chronic pain in association with adolescent demographics.

The present study aimed (1) to describe and compare the prevalence of chronic single-site (only headache or backache, or stomach- ache) and multi-site pain in adolescents cross-nationally; (2) to investigate the patterns of chronic pain by age and sex; and (3) to examine country-level effects on variation of chronic pain, and associations between pain and age.

Methods

Study design and sample

HBSC is a cross-sectional school-based survey carried out in four-year cycles in each of the participating countries. In this study, international data from the 2013/2014 HBSC survey were used. The final sample consisted of 214,283 respondents (49.3% boys and 50.7% girls) from a total of 42 countries and regions (Table 1). The data were collected by following an international study protocol (Currie et al., 2014). In each country, representative samples of 11-, 13- and 15-year-old adolescents from general schools were selected. The average age of the total sample was 13.57 years (SD±1.63). Clustered sampling design was used where the primary sampling unit was either the school or the school class. Data were collected through standardized self-administrated anonymous questionnaires in classrooms. Each country followed national ethical requirements for research. Student-level response rates were over 60% in most countries and regions. For more detailed information on the HBSC study and methodology see Currie et al. (2014).

Measurements

The experience of pain (headache, stomach-ache and backache) during the previous six months was assessed using the HBSC symptom checklist. The frequency of health complaints was measured on a five-point scale: (1) about every day; (2) more than once a week; (3) about every week, (4) about every month; (5) rarely or never. Reported pain that

occurred at least weekly (answer categories from 1 to 3) during the previous six months was studied. The HBSC symptom checklist has shown good reliability and validity (Haugland et al., 2001). Localized 'single-site' pain (pain reported at only one site – either head, or stomach, or backache, by excluding other sites) and 'multi-site pain' (pain reported in at least two sites) were analysed separately.

In the majority of countries, the individual non-response rates on pain items were below 5%, however, in four countries (Armenia, Israel, Spain and Greenland), non-response rates ranged from 10% to 15%. The final study population consists only of those adolescents who have reported at least one of the pain items. The inclusion of non-respondents in the statistical analysis did not result in significant variation of pain prevalence suggesting that the pain distributions for respondents and non-respondents have a similar pattern.

Statistical analysis

Cross-national weekly chronic pain prevalence of specific localized pain (only headache or backache, or stomach-ache) and multi-site pain was calculated. Statistical significance on sex differences by country for each type of pain was tested by the chi-square test of independence. Countries in the tables were grouped into regions using the classification system of geographical regions by the Statistics Division of the United Nations (https://unstats.un.org/unsd/methodology/m49/).

The association between chronic pain and age was examined separately for boys and girls through multilevel logistic regressions that included the country in the model as a second-level factor. This was done after considering the individual probability is statistically dependent on the area of residence of the subjects. Multilevel logistic regression was used also to investigate the odds of pain co-occurrence by age and sex groups.

Log-linear analysis was used to test associations between all three types of pain as it allows examining the relationship between more than two categorical variables at a time. The patterns of pain co-occurrence were studied with logistic regression and the clusters of coexisting pain were illustrated using a three set area-proportional Venn diagram using ellipses with *eulerAPE2* (Micallef and Rodgers, 2014).

To assess the cross-country variation in the association between pain and adolescent demographics, a median odds ratio (MOR) was calculated as a measure of heterogeneity in logistic multilevel regression models to evaluate the random country effect (Rabe-Hesketh and Skrondal, 2008). MOR shows the extent to which the individual probability of having a chronic pain is associated with country. Country-specific data were also studied and data are provided in the supplementary tables. Data analyses were carried out using STATA 14.0 software. A significance level of 0.05 and confidence level of 95% was adopted for all statistical analyses.

Results

Prevalence of chronic headache

On average, 11.3% (SD±1.8) of the adolescents reported localized chronic weekly headache, but not backache or stomach-ache. The rates ranged from 7.9% in Portugal to 15.6% in Finland (Table 2). In all countries, with the exception of France, Iceland, Luxembourg, Malta, and Iceland, the prevalence of chronic headache was significantly higher among girls. In Greece and Albania the prevalence of chronic headache for girls was double than that of boys (Table 2).

For boys, the odds of reporting chronic weekly headache varied little across age groups but among girls, it increased with age. However, multilevel analysis revealed significant country differences in the association between the prevalence of headache and age

(Table 3). For example, in some countries (Austria, Belgium (French), Finland, Greece, Iceland, Norway, TFYR Macedonia, Slovenia, Spain, and Switzerland) the odds of chronic headache increased only in 13- or 15-year old boys, whereas in England and Ireland the odds increased in both older age groups compared with 11-year olds. In Republic of Moldova and Iceland the odds of reporting chronic headache for boys decreased by age. Among girls, the weekly complaints of chronic headache were more prevalent in older age groups. In most countries except Albania, Czech Republic, Finland, France, Iceland, Italy, Malta, and Republic of Moldova, the odds of reporting chronic headache for girls increased with age (tableS1).

Prevalence of chronic backache

In general, 7.7% (SD±1.8) of sampled adolescents reported only chronic backache but not pain in headache or stomach-ache. National estimates of backache ranged from 4.4% in Armenia to 11.8% in France (Table 2). No systematic sex difference emerged across countries. Among half of the studied countries, there were no significant sex differences. However, in 17 countries and regions, the prevalence of chronic backache was significantly higher among boys, whereas in just two countries (Spain and Portugal), more girls reported chronic backache.

In general, the odds of reporting chronic backache increased with age in both sex groups (Table 3). Country-specific data revealed mixed patterns in the association between age and chronic backache among adolescents. For example, in Albania, Denmark, Greenland, Italy, Luxembourg, Malta, Norway, Russia, and Ukraine no age differences were found, whereas in Czech Republic, Finland, Iceland Ireland, Lithuania, Scotland, and Switzerland, the odds of reporting chronic backache steadily increased with age for both sexes. In the remaining countries, there was no consistent age pattern among boys and girls (tableS2).

Prevalence of chronic stomach-ache

On average, the prevalence of reporting chronic stomach-ache without reporting headache or backache was 4.6% (SD±1.2), with country estimates ranging from 1.7% in Poland to 7.1% in Sweden (Table 2). In more than half of the countries or regions, girls were more likely to report chronic stomach-ache. In the remaining countries, no significant sex differences emerged. Moreover, the odds of reporting chronic stomach-ache among adolescents decreased with increasing age for both boys and girls; however, significant country variation existed (Table 3).

The odds of reporting chronic weekly stomach-ache steadily decreased for boys in both older age groups in comparison with 11-year olds in Canada, Iceland, Latvia, Lithuania, Sweden, Switzerland, and Ukraine. In other countries either there were no significant age differences in reporting only stomach-ache for boys or there was significant decrease in the odds of reporting chronic stomach-ache just for 15-year old boys in comparison with 11-year olds (tableS3). On the other hand, for girls in 16 countries or regions the odds of reporting chronic stomach-ache decreased significantly with increasing age. In a minority of countries (Albania, Canada, Czech Republic, England, Germany, Greenland, Lithuania, Israel, Portugal, Slovenia, and Wales) there were no age differences in reporting of stomach-ache. In the remaining countries or regions, the changes of the odds of reporting chronic stomach-ache were less consistent – there was a significant decrease either just for 13-year olds or just for 15-year olds in comparison with 11-year olds (tableS3).

Prevalence of chronic multi-site pain

Overall 20.6% (SD±5.0) adolescents reported to have chronic multi-site pain. The prevalence of multi-site pain (pain at least at two sites) was significantly higher than that for any of single-site pain varying from 13.2% in Armenia to 33.8% in Israel (Table 2). The

lowest prevalence of chronic multi-site pain was found in Portugal (13.8%), TFYR Macedonia (13.9%), and Albania (14.0%), and the highest in France (28.4%), Island (27.4%), and Italy (27.3%). Across all countries, the prevalence of multi-site pain was significantly higher among girls, except Armenia where no sex difference was observed.

In general, the odds of reporting multi-site pain increased with increasing age category for both boys and girls (Table 3); however, the MOR showed a significant country variation. For boys, in most countries or regions (a total of 29), no age differences in reporting multi-site pain were observed. However, in the rest of the countries the odds significantly increased either just for 13-year olds or just for 15-year olds in comparison with the 11-year olds. A more consistent pattern was observed among girls. In almost all countries, the odds of reporting multi-site pain gradually increased with increasing adolescent age. . In a minority of countries (Armenia, Greenland, Israel, TFYR Macedonia, and Ukraine) no significant age differences were observed (tableS4).

The log-linear analysis showed that the two-way and three-way interactions among studied pain were all significant ($p<0.001$). The strongest effect was found for the co-occurrence of headache and stomach-ache ($\chi = 139.04$), but the weakest for the co-occurrence of all three types of pain ($\chi = 7.02$). In Figure 1, a proportional Venn diagram shows the co-occurrence of chronic pain in the sample of all studied adolescents. A total of 44.2% of adolescents reported any type of studied chronic pain. The total proportion of those adolescents reporting any of studied specific localized single-site pain was 23.6% and of those, headache was the most common (11.3%). For those adolescents reporting co-occurrence of chronic pain, reporting all three pain types was the most prevalent (7.3%) followed by the co-occurrence of headache and stomach-ache (6.3%), headache and backache (4.9%) and stomach-ache and backache (2.1%), giving a total of 20.6% of those adolescents reporting any type of pain co-occurrence.

Discussion

To the best of our knowledge, this is the first publication that investigates single-site and multi-site chronic pain occurring at least weekly during previous six months among nationally representative samples of adolescents across 42 countries.

Previous study based on the HBSC data from the earlier surveys investigated monthly headache, stomach-ache and backache without focusing on country level effects (Swain et al., 2014). In Swain's et al. (2014) study, on average, a total of 27.1% of adolescents reported any of monthly single-site pain but 47.3% reported monthly chronic pain in at least two sites. In present study, 23.6% adolescents reported any type of studied weekly localized specific single-site pain, but a total of 20.6% of adolescents reported weekly chronic pain in at least two sites. This may suggest that the choice of either weekly or monthly cut-off frequency for studying chronic pain may largely affect the findings of the proportion of adolescents reporting multi-site pain in comparison with those reporting complaints of single-site pain. Previous research suggests that there may be greater clinical relevance for pain-related disability when pain is measured by a frequency of at least once a week than monthly (Hoftun et al., 2011).

In general, the prevalence of localized specific pain types reported in this study was 11.3% for headache, 7.7% for backache and 4.6% for stomach-ache. These findings are consistent with the results of other studies estimating the prevalence of localized single-site chronic pain among adolescents (Kristjansdóttir, 1997a; Hoftun et al., 2011). The total proportion of adolescents reporting headache, stomach-ache, or backache is higher when studying specific type of pain while not excluding the presence of other pain types (King et al., 2011).

In this study, on average, 20.6% of adolescents reported weekly chronic pain in at least two sites. This finding concurs with previous studies that have suggested that multi-site pain is more prevalent than specific localized single-site pain (Perquin et al., 2000; Petersen et al., 2006; Hoftun et al., 2011; Swain et al., 2014). Pain conditions still might be often treated in isolation; however, in clinical practice it needs to be acknowledged that during adolescence the co-occurrence of chronic pain is highly prevalent. Based on our findings, the co-occurrence of all three pain types was the most prevalent followed by the one of headache and stomach-ache. More detailed studies on different patterns of pain in adolescents with multi-site pain are needed as different subgroups of multi-site pain emerged and heterogeneous effects on health-related quality of life for adolescents with different pain patterns may exist (Holden et al., 2015).

Different age and sex patterns for single-site and multi-site pain were found in this investigation. More specifically, reporting only chronic headache was significantly more prevalent among girls than boys. Fewer sex differences were observed for reporting only stomach-ache or backache. However, in all countries the prevalence of multi-site pain was considerably higher among girls than that among boys. This finding is in line with previous studies suggesting that adolescent sex and gender is a stronger predictor of multi-site pain than single-site pain (Kristjansdóttir, 1997a; Petersen et al., 2006). Previous studies have explored several biological and psychological factors in the quest of explaining the higher prevalence of multi-site pain among adolescent girls, out of which the most relevant would be differences in pubertal development, pain tolerance, or pain coping behaviours (Schmitz et al., 2012; Skrove et al., 2015; Vierhous et al., 2011). Nonetheless, there is still an ongoing discussion of potential biopsychosocial mechanisms that account for both sex and gender differences in adolescent chronic pain needs, and this ought to be explored in future studies.

In general, the odds of reporting localized chronic headaches and backaches increased with age during adolescence, whereas the prevalence of stomach-ache was more likely to decrease with age. However, the median odds ratio, which was used as a measure of heterogeneity in this study and which is statistically independent of the prevalence of the phenomenon, indicated a significant cross-country variation. Different age patterns of localized single-site chronic pain are found also in other studies. For example, in Iceland the adolescents' reports on weekly localized chronic headache and stomach-ache were more prevalent among younger adolescent age groups, but having chronic backache was more common among older adolescents (Kristjansdóttir, 1997a). In Norway, the prevalence of reporting weekly localized chronic headache and backache among adolescents increased with age, whereas no significant age differences were found for weekly chronic pain only in abdomen (Hoftun et al., 2011). Age is important factor as it relates to pain characteristics, but other studies also suggest that pubertal development during adolescence might be a better determinant of pain rather than age itself (LeResche et. al., 2005; Janssen et al., 2011). This fact should also be considered when dealing with chronic pain assessment for adolescents in clinical care.

No consistent geographical patterns of pain prevalence across different countries were observed in this investigation. For example, the prevalence of multi-site pain in the Nordic countries varied from 15.2% in Norway to 27.4% in Iceland whereas in the Baltic states from 15.2% in Estonia to 22.1% in Latvia. It is safe to assume that this variation reflects true differences of self-reported chronic pain between adolescent populations as all countries in this study followed the same study methodology. This research outcome is in line with a recent meta-analysis, which shows no clear geographical pattern in the chronic pain estimates among adults (Steingrímsdóttir et al., 2017). Our study supports this idea that geographical location of is a week determinant of pain differences among adolescents across countries and

perhaps other indicators like language, ethnicity, and national origin may be more appropriate to consider. It has been suggested that cultural influences on the way children interpret their pain may be important in relation to pain behaviour (Finley et al., 2009). However, the empirical evidence on cultural implications of pain is currently limited.

In the current investigation, the country differences on pain prevalence could not be explained by chronic pain prevalence changes across age groups. For example, the highest prevalence of multi-site pain among adolescents was found in Israel. However, in Israel there was no significant association between reporting multi-site pain and age among adolescents for neither boys nor girls. The same age pattern was also found in Armenia, though the prevalence of multi-site pain was the lowest of all here. However, when interpreting the results by age it should be noted that HBSC study is cross-sectional in nature and it is not possible to identify developmental trajectories of pain in adolescents across ages.

Available evidence suggests a deteriorating effect of chronic pain on adolescent general health and well-being, which may negatively influence psychosocial development and daily functioning over time, e.g. school absence, limitations to pursue hobbies or to meet with friends etc. (Roth-Isigkeit et al., 2005; Larsson and Sund, 2007; Hoftun et al., 2011; Caes et al., 2015). Adolescents having multi-site pain are more likely to report impaired quality of life (Huguet and Miró, 2008; Petersen et al., 2009; Holden et al., 2018), subjective disabilities (Hoftun et al., 2011), and higher levels of other health complaints like anxiety and depression (Kristjansdóttir, 1997b; Larsson and Sund, 2007; Hoftun et al., 2012; Zernikow et al, 2012). Thus, previous studies argue that the overall impact on adolescents' health and functioning might be different because of experiencing single-site vs multi-site chronic pain; hence the need to consider these two groups separately in future investigations.

This investigation is subject to a few limitations. It should be noted that only chronic headache, backache and stomach-ache were included in this study. Although these are the most prevalent chronic pain types among adolescents, adolescents may experience also other chronic pain like limb pain, neck or shoulder pain etc. (Huguet and Miró, 2008; Hoftun et al., 2011). Moreover, through the methodology used, the HBSC study includes countries mostly from European regions. Therefore extrapolating this pattern of results to a global level is limited. Another limitation would be the lack of a pain intensity measurement. Pain intensity is likely to be an important indicator of pain severity and pain-related individual burden (Roth-Isigkeit et al., 2005; Huguet and Miró, 2008; Tiira et al., 2012). This study also did not assess pain-related disability in adolescents' daily life, including school-functioning, health care use for chronic pain, which is relevant to estimate the clinical relevance of the chronic pain problem and important to identify proportion of those adolescents with highly disabling chronic pain (Hechler et al., 2015; Wager et al., 2013). However, other studies also show that the increase of pain frequency and the number of pain locations in adolescents are also important determinants of pain-related subjective disabilities and impact on daily functioning (Kristjansdóttir, 1997b; Perquin et al., 2003; Huguet and Miró, 2008; Hoftun et al., 2011, Holden et al., 2018).

This study presents internationally comparable chronic pain prevalence data in different adolescent age and sex groups across 42 countries. This provides important information that could be used to estimate the overall impact of chronic pain in general adolescent population. The international heterogeneity of chronic pain prevalence and differences in chronic pain patterns shows that adolescents with chronic pain is not a homogenous group. Differences in chronic pain characteristics should be addressed in both clinical and public health practice in order to maximize the adolescent chronic pain management and prevention. Chronic pain in adolescents should be managed using a

multidisciplinary approach by taking into account the multidimensionality and biopsychosocial development of pain, and the cross-country differences of chronic pain prevalence.

Conclusions

This study identified high prevalence of self-reported chronic pain among adolescents across the 42 investigated countries. Country differences in the proportions of adolescents with specific pain types exist. Adolescent age and sex was strongly associated with chronic pain but different demographic patterns may exist when studying country-specific data. In all countries, the prevalence of chronic multi-site pain was higher among girls than boys, and it was more common than specific localized single-site pain. Further studies should explore both individual and country-level pain-related factors cross-nationally in more in detail.

Acknowledgements

The authors acknowledge the input of Positive Health focus groups within the Health Behaviour in School-aged Children (HBSC) study network.

The International Coordinator of the 2013/2014 survey was Jo Inchley (University of St Andrews) and the Data Bank Manager was prof. Oddrun Samdal (University of Bergen). The 2013/2014 survey was conducted by Principal Investigators in 42 countries: Albania (G. Qirjako), Armenia (S. Sargsyan), Austria (R. Felder-Puig), Belgium (Flemish) (C. Vareecken and A. Hublet), Belgium (French) (D. Piette), Bulgaria (L. Vasileva), Canada (J. Freeman and W. Pickett), Croatia (M. Kuzman and I. P. Simetin), Czech Republic (M. Kalman), Denmark (P. Due and M. Rasmussen), Estonia (K. Aasvee), Finland (J. Tynjälä), France (E. Godeau), Germany (P. Kolip and M. Richter), Greece (A. Kokkevi), Greenland (B. Niclasen), Hugary (Á. Németh), Iceland (A. Arnarsson), Ireland (S. Nic Gabhainn), Israel (Y. Harel-Fisch), Italy (F. Cavallo), Latvia (I. Pudule), Lithuania (A. Zaborskis), Luxembourg (Y. Wagener), Malta (C. Gauci), Netherlands (W. Vollebergh and T. ter Bogt), Norway (O. Samdal), Poland (J. Mazur), Portugal (M. Gaspar de Matos), Republic of Moldova (G. Lesco), Romania (A. Baban), Russian Federation (O. Churganov), Slovakia (A. Madarasova

Geckova), Slovenia (H. Jericek), Spain (C. Moreno Rodriguez), Sweden (L. Augustine and P. Lofstead), Switzerland (E. Kuntsche), TFYR Macedonia (L. Kostarova Unkovska), Ukraine (O. Balakireva), United Kingdom (England) (A. Morgan and F. Brooks), United Kingdom (Scotland) (C. Currie and J. Inchley), United Kingdom (Wales) (C. Roberts). For details, see http://www.hbsc.org.

Author contributions

I.G. is responsible for the integrity of the work as a whole, from inception to published article. J.V., R.V., J.T., R.W., A.C., F.B., F.C., K.N., M.M., and A.A. contributed substantially to the study conception, drafting the manuscript, data interpretation, revising the article and final approval of the version to be published.

References

Borge, A.I., Nordhagen, R. (1995). Development of stomach-ache and headache during middle childhood: co-occurrence and psychosocial risk factors. Acta Paediatr 84, 795–802.

Caes, L., Fisher, E., Clinch, J., Tobias, J.H., Eccleston C. (2015). The role of pain-related anxiety in adolescents' disability and social impairment: ALSPAC data. Eur J Pain 19, 842–851.

Currie, C., Inchley, J., Molcho, M., Lenzi, M., Veselska, Z. and Wild, F. (eds.) (2014). Health Behaviour in School-aged Children (HBSC) Study Protocol: Background, Methodology and Mandatory items for the 2013/14 Survey. St Andrews: CAHRU. Access at: http://www.hbsc.org

Darlington, A.S., Verhulst, F.C., De Winter, A.F., Ormel, J., Passchier, J., Hunfeld, J.A. (2012). The influence of maternal vulnerability and parenting stress on chronic pain in adolescents in a general population sample: The TRAILS study. Eur J Pain 16, 150–159.

Finley, G.A., Kristjánsdóttir, O., Forgeron, P.A. (2009). Cultural influences on the assessment of children's pain. Pain Res Manag 14, 33–37.

Ghandour, R.M., Overpeck, M.D., Huang, Z.J., Kogan, M.D., Scheidt, P.C. (2004). Headache, stomachache, backache, and morning fatigue among adolescent girls in the United States. Arch Pediatr Adoles Med 158, 797–803.

Gobina, I., Villberg, J., Villerusa, A., Välimaa, R., Tynjälä, J., et al. (2015). Self-reported recurrent pain and medicine use behaviours among 15-year olds: results from the international study. Eur J Pain 19, 77–84.

Goodman, J.E., McGrath, P.J. (1991). The epidemiology of pain in children and adolescents: a review. Pain 46, 247–264.

Haugland, S., Wold, B. (2001). Subjective health complaints in adolescence – reliability and validity of survey methods. J Adolesc 24, 611–624.

Hechler, T., Kanstrup, M., Holley, A. L., Simons, L. E., Wicksell, R., Hirschfeld, G., and Zernikow, B. (2015). Systematic review on intensive interdisciplinary pain treatment of children with chronic pain. Pediatrics, 136(1), 115-127.

Holden, S., Rathleff, M.S., Roos, E.M., Jensen, M.B., Pourbordbari, N., Graven-Nielsen, T. (2018). Pain patterns during adolescence can be grouped into four pain classes with distinct profiles: A study on a population based cohort of 2953 adolescents. Eur J Pain 22, 793–799.

Hoftun, G.B., Romundstad, P.R., Zwart, J.A., Rygg, M. (2011). Chronic idiopathic pain in adolescence – high prevalence and disability: The young HUNT study 2008. Pain 152, 2259–2266.

Hoftun, G.B., Romundstad, P.R., Zwart, J.A., Rygg, M. (2012). Factors associated with adolescent chronic non-specific pain, chronic multisite pain, and chronic pain with high disability: the Young-HUNT study 2008. J Pain 13, 874–883.

Huguet, A., Miró, J. (2008). The severity of chronic pediatric pain: An epidemiological study. J Pain 9,226–236.

Hunfeld, J.A., Perquin, C.W., Duivenvoorden, H.J., Hazebroek-Kampschreur, A.A., Passchier, J., van Suijlekom-Smit, L.W., van der Wouden, J.C. (2001). Chronic pain and its impact on quality of life in adolescents and their families. J of Pediatr Psychol 26, 145–153.

Inchley, J., Currie, D., Young, T., Samdal O., Torhsheim T., et al. (eds.). (2016). Growing up unequal: Gender and socioeconomic differences in young people's and well-being. Health behaviour in school-aged children (HBSC) study: International report from the 2013/2014 survey (Copenhagen, Denmark: WHO Regional Office for Europe).

Janssens, K.A., Rosmalen, J.G., Ormel, J., Verhulst, F.C., Hunfeld, J.A., Mancl, L.A., Oldehinkel, A.J, LeResche, L. (2011). Pubertal status predicts back pain, overtiredness, and dizziness in American and Dutch adolescents. Pediatrics 128, 553–559.

King, S., Chambers, C.T., Huguet, A., MacNevin, R.C., McGrath, P.J., Parker, L., MacDonald, A.J. (2011). The epidemiology of chronic pain in children and adolescents revisited: a systematic review. Pain 152, 2729–2738.

Kristjansdóttir, G. (1997a). Prevalence of pain combinations and overall pain: a study of headache, stomach pain and back pain among school-children. Scand J Soc Med 25, 58–63.

Kristjansdóttir, G. (1997b). The relationship between pain in various discomforts in schoolchildren. Childhood 4, 491–504.

Larsson, B., Sund, A.M. (2007). Emotional/behavioural, social correlates and one-year predictors of frequent pain among early adolescents: influences of pain characteristics. Eur J Pain 11, 57–65.

LeResche L., Mancl, L.A, Drangsholt, M.T., Saunders, K., Von Korff, M. (2005). Relationship of pain and symptoms to pubertal development in adolescents. Pain 118, 201–209.

Merskey, H., and Bogduk, N. (eds.) (1994). Classification of chronic pain: descriptions of chronic pain syndromes and definitions of pain terms. Seattle, IASP Press.

Micallef, L., Rodgerts, P. (2014). eulerAPE: Drawing Are-proportional 3-Venn Diagrams Using Ellipses. PLoS ONE 9, e101717.

Perquin, C.W., Hazebroek-Kampschreur, A.A., Hunfeld, J., Bohnen, A.M., van Suijlekom-Smit, L.W., Passchier, J., van der Wouden, J.C. (2000). Pain in children and adolescents: a common experience. Pain 87, 51–58.

Perquin, C.W., Hunfeld, J., Hazebroek-Kampschreur, A.A., Suijlekom-Smit, L.W., van Passchier, J., Koes, B.W., van der Wouden, J.C. (2003). The natural course of chronic benign pain in childhood and adolescence: a two-year population-based follow-up study. Eur J Pain 7, 551–559.

Petersen, S., Brulin, C., Bergstrom, E. (2006). Recurrent pain symptoms in young schoolchildren are often multi-site. Pain 121, 145–150.

Petersen, S., Hägglöf, B.L., Bergström, E.I. (2009). Impaired health-related quality of life in children with recurrent pain. Pediatrics 124, e759–767.

Rabe-Hesketh, S., Skrondal, A. (2008). Multilevel and Longitudinal Modelling using Stata (College Station, TX: Stata Press).

Roth-Isigkeit, A., Thyen, U., Raspe, H.H., Stöven, H, Schmucker, P. (2004). Reports of pain among German children and adolescents: an epidemiological study. Acta Paediatr 93, 258–263.

Roth-Isigkeit, A., Thyen, U., Stöven, H, Schwarzenberger, J., Schmucker, P. (2005). Pain among children and adolescents: Restrictions in daily living and triggering factors. Pediatrics 115, 152–162.

Schmitz, A.K., Vierhaus, M., Lohous, A. (2012). Pain tolerance in children and adolescents: sex differences and psychosocial influences on pain threshold and endurance. Eur J Pain 17, 124–131.

Skrove, M., Romundstad, P., Indredavik, M.S. (2015). Chronic multisite pain in adolescent girls and boys with emotional and behavioral problems: the Young-HUNT study. Eur Child Adolesc Psychiatry 24, 503–515.

Steingrímsdóttir, O.A., Landmark, T., Macfarlane, G.J., Nielsen, C.S. (2017). Defining chronic pain in epidemiological studies: a systematic review and meta-analysis. Pain 158, 2092–2107.

Sundblad, G.M., Saartok, T., Engström, L.M. (2007). Prevalence and co-occurrence of self-rated pain and perceived health in school-children: age and gender differences. Eur J Pain 11, 171–180.

Swain, M.S., Henschke, N., Kamper, S.J., Gobina, I., Ottová-Jordan, V. and Maher, C.G. (2014). An international survey of pain in adolescents. BMC Public Health 14, 447.

Ståhl, M.K., El-Metwally, A.A., Rimpelä A.H. Time trends in single versus concomitant neck and back pain in Finnish adolescents: results from national cross-sectional surveys from 1991 to 2011. BMC Musculoskelet Disor 2014, 15:296.

Tiira, A.H., Paananen, M.V., Taimela, S.P., Zitting, P.J., Järvelin, M.R., Karppinen, J.I. (2012). Determinants of adolescent health care use for low back pain. Eur J Pain 16, 1467–1476.

Vierhous, M., Lohous, A., Scmitz, A.K. (2011). Sex, gender, coping, and self-efficacy: mediation of sex differences in pain perception in children and adolescents. Eur J Pain 15, 621.e1–621.e8.

Wager, J. (2013). Classifying the severity of paediatric chronic pain - an application of the chronic pain grading. Eur J of Pain 17, 1393–1402.

Zernikow, B., Wager, J., Hechler, T., Hasan, C., Rohr, U., et al. (2012). Characteristics of highly impaired children with severe chronic pain: a 5-year retrospective study on 2249 pediatric pain patients. BMC Pediatr 12, 54.

Table1. Study population: The HBSC 2013/2014 survey

Table2. Prevalence of single-site and multi-site chronic pain in adolescents for boys and girls by country (%)

Table3. Odds of single-site and multi-site chronic pain in adolescent age groups (ref. = "11-year olds") for boys and girls; OR [95%CI]

Figure 1. Co-occurrence of chronic pain in 11-, 13- and 15-year-old adolescents; proportional Venn diagram

Table S1. The odds of reporting headache in adolescent age groups (ref. = "11-year olds") for boys and girls by country; OR [95%CI]

TableS2. The odds of reporting backache in adolescent age groups (ref. = "11-year olds") for boys and girls by country; OR [95%CI]

TableS3. The odds of reporting stomach-ache in adolescent age groups (ref. = "11-year olds") for boys and girls by country; OR [95%CI]

TableS4. The odds of reporting multi-site pain in adolescent age groups (ref. = "11-year olds") for boys and girls by country; OR [95%CI]

Table 1. Study population: The HBSC 2013/2014 survey [a]

Country/region	Boys	Girls	Total
Northern America			
Canada	6230	6427	12657
Western Asia			
Armenia	1642	1868	3510
Israel	2479	2814	5293
Southern Europe			
Albania	2450	2556	5006
Croatia	2765	2798	5563
Greece	2053	2073	4126
Italy	2035	2018	4053
Malta	1109	1091	2200
Portugal	2268	2503	4771
Slovenia	2445	2546	4991
Spain	4890	5131	10021
TFYR Macedonia	1978	2090	4068
Western Europe			
Austria	1588	1817	3405
Belgium (French)	2875	2928	5803
Belgium (Flemish)	2383	1972	4355
France	2838	2807	5645
Germany	3014	2918	5932
Luxembourg	1544	1739	3283
Netherlands	2092	2164	4256
Switzerland	3225	3304	6529
Northern Europe			
Denmark	1762	2040	3802
England	2665	2504	5169
Estonia	2026	2012	4038
Finland	2894	3001	5895
Greenland	420	487	907
Iceland	5275	5265	10540
Ireland	1566	2492	4058
Latvia	2619	2888	5507
Lithuania	2899	2816	5715
Norway	1428	1501	2929
Scotland	2928	2947	5875
Sweden	3776	3837	7613
Wales	2577	2506	5083
Eastern Europe			
Bulgaria	2496	2263	4759
Czech Republic	2408	2659	5067
Hungary	1905	1943	3848
Poland	2208	2263	4471
Republic of Moldova	2348	2300	4648
Romania	1833	2072	3905
Russian Federation	1939	2519	4458
Slovakia	3048	3022	6070
Ukraine	2103	2356	4459
Total	**105026**	**109257**	**214283**

[a] respondents reporting to at least one of the pain item were included

Table 2. Prevalence of single-site and multi-site recurrent pain in adolescents for boys and girls by country (%) [a]

Country/region	Headache [b]				Backache [b]				Stomach-ache [b]				Multi-site pain [c]			
	Total	Boys	Girls	p	Total	Boys	Girls	p	Total	Boys	Girls	p	Total	Boys	Girls	p
Northern America																
Canada	**11.4%**	9.5%	13.3%	***	**8.1%**	8.9%	7.4%	**	**4.0%**	3.7%	4.2%	NS	**20.5%**	13.7%	27.1%	***
Western Asia																
Armenia	**14.5%**	11.4%	17.2%	***	**4.4%**	4.8%	4.2%	NS	**3.6%**	2.7%	4.3%	**	**13.2%**	12.7%	13.6%	NS
Israel	**12.1%**	9.2%	14.6%	***	**4.8%**	5.9%	3.9%	***	**5.1%**	4.8%	5.3%	NS	**33.8%**	29.2%	37.9%	***
Southern Europe																
Albania	**15.1%**	9.7%	20.3%	***	**5.3%**	5.8%	4.8%	NS	**2.7%**	2.2%	3.1%	*	**14.1%**	10.5%	17.5%	***
Croatia	**8.9%**	6.3%	11.5%	***	**8.3%**	9.4%	7.3%	**	**5.3%**	4.0%	6.6%	***	**16.7%**	11.3%	22.1%	***
Greece	**13.1%**	8.9%	17.3%	***	**6.2%**	6.1%	6.2%	NS	**3.9%**	3.4%	4.5%	NS	**14.5%**	9.4%	19.6%	***
Italy	**14.2%**	11.9%	16.6%	***	**8.1%**	9.4%	6.7%	**	**6.2%**	5.7%	6.7%	NS	**27.3%**	18.3%	36.4%	***
Malta	**14.0%**	13.4%	14.5%	NS	**7.0%**	7.2%	6.7%	NS	**3.6%**	2.7%	4.5%	*	**26.5%**	20.6%	32.5%	***
Portugal	**7.9%**	5.3%	10.2%	***	**9.1%**	7.6%	10.3%	***	**1.7%**	1.3%	2.2%	*	**13.8%**	9.0%	18.2%	***
Slovenia	**9.1%**	7.6%	10.5%	***	**6.6%**	7.0%	6.2%	NS	**4.1%**	2.9%	5.2%	***	**14.9%**	9.7%	19.9%	***
Spain	**9.0%**	7.2%	10.7%	***	**9.4%**	8.0%	10.8%	***	**3.6%**	3.1%	4.1%	*	**16.9%**	11.2%	22.3%	***
TFYR Macedonia	**11.7%**	8.2%	15.0%	***	**5.9%**	6.9%	4.9%	**	**6.9%**	5.7%	8.0%	**	**13.9%**	10.3%	17.3%	***
Western Europe																
Austria	**10.2%**	6.6%	13.3%	***	**8.5%**	9.0%	8.0%	NS	**5.0%**	3.9%	5.9%	**	**14.0%**	9.2%	18.3%	***
Belgium (French)	**13.0%**	10.5%	15.4%	***	**10.3%**	11.1%	9.5%	*	**4.0%**	4.2%	3.7%	NS	**26.0%**	19.8%	32.1%	***
Belgium (Flemish)	**9.6%**	8.5%	11.1%	**	**8.8%**	9.7%	7.6%	*	**4.2%**	3.2%	5.3%	***	**18.6%**	13.9%	24.3%	***
France	**8.7%**	8.1%	9.3%	NS	**11.8%**	12.3%	11.3%	NS	**6.3%**	4.9%	7.6%	***	**28.4%**	20.9%	36.0%	***
Germany	**10.2%**	8.2%	12.3%	***	**9.6%**	10.8%	8.4%	**	**6.0%**	4.6%	7.5%	***	**17.4%**	12.0%	23.0%	***
Luxembourg	**11.1%**	10.0%	12.0%	NS	**9.5%**	10.1%	9.0%	NS	**6.1%**	4.4%	7.6%	***	**24.6%**	16.5%	31.8%	***
Netherlands	**12.7%**	9.9%	15.3%	***	**6.3%**	7.4%	5.2%	**	**4.0%**	3.3%	4.7%	*	**16.7%**	10.6%	22.6%	***
Switzerland	**10.3%**	8.9%	11.7%	***	**9.4%**	10.4%	8.4%	**	**5.9%**	4.3%	7.5%	***	**21.9%**	16.3%	27.4%	***
Northern Europe																
Denmark	**10.5%**	8.4%	12.4%	***	**10.2%**	11.2%	9.4%	NS	**4.0%**	3.0%	5.0%	**	**15.4%**	10.6%	19.6%	***
England	**12.3%**	10.5%	14.3%	***	**6.2%**	6.4%	5.9%	NS	**4.4%**	3.8%	4.9%	NS	**17.8%**	12.6%	23.2%	***
Estonia	**13.4%**	10.2%	16.7%	***	**7.0%**	7.3%	6.8%	NS	**4.5%**	4.4%	4.5%	NS	**15.2%**	11.3%	19.1%	***
Finland	**15.6%**	13.8%	17.4%	***	**7.3%**	8.0%	6.7%	NS	**4.2%**	3.5%	4.9%	**	**24.2%**	19.0%	29.2%	***
Greenland	**11.9%**	8.1%	15.2%	***	**4.9%**	5.7%	4.1%	NS	**2.4%**	1.0%	3.7%	**	**17.6%**	12.6%	22.0%	***
Iceland	**9.7%**	9.3%	10.0%	NS	**9.4%**	9.7%	9.1%	NS	**6.5%**	6.1%	6.9%	NS	**27.4%**	21.5%	33.3%	***
Ireland	**12.0%**	9.2%	13.8%	***	**7.2%**	7.8%	6.9%	NS	**3.5%**	3.0%	3.8%	NS	**16.9%**	11.1%	20.5%	***
Latvia	**12.7%**	10.1%	15.0%	***	**6.7%**	7.0%	6.4%	NS	**4.7%**	4.5%	4.8%	NS	**22.1%**	15.8%	27.8%	***
Lithuania	**10.3%**	7.0%	13.6%	***	**6.5%**	7.7%	5.2%	***	**4.5%**	3.7%	5.3%	**	**16.3%**	12.4%	20.3%	***
Norway	**8.5%**	6.6%	10.3%	***	**7.0%**	7.8%	6.2%	NS	**6.4%**	5.8%	6.9%	NS	**15.2%**	10.3%	19.8%	***
Scotland	**10.6%**	8.4%	12.8%	***	**6.3%**	6.7%	6.0%	NS	**4.0%**	3.2%	4.8%	**	**16.0%**	10.0%	21.9%	***
Sweden	**12.5%**	11.1%	13.9%	***	**6.3%**	7.6%	5.1%	***	**7.1%**	6.1%	8.1%	***	**24.3%**	16.9%	31.6%	***
Wales	**12.6%**	10.4%	14.8%	***	**6.3%**	8.5%	4.1%	***	**4.4%**	3.5%	5.3%	***	**18.7%**	12.3%	25.3%	***
Eastern Europe																
Bulgaria	**12.0%**	9.5%	14.8%	***	**5.2%**	5.4%	4.9%	NS	**5.1%**	4.4%	5.9%	*	**18.8%**	14.3%	23.6%	***
Czech Republic	**11.9%**	9.2%	14.4%	***	**11.1%**	11.7%	10.5%	NS	**3.0%**	2.9%	3.2%	NS	**17.5%**	11.3%	23.2%	***
Hungary	**13.0%**	11.5%	14.5%	**	**7.4%**	8.5%	6.4%	*	**5.2%**	5.1%	5.4%	NS	**26.3%**	19.6%	32.8%	***
Poland	**10.2%**	8.6%	11.8%	***	**4.9%**	4.5%	5.2%	NS	**4.0%**	3.0%	4.9%	***	**24.6%**	18.9%	30.2%	***
Republic of Moldova	**11.1%**	9.0%	13.1%	***	**8.4%**	9.2%	7.6%	*	**3.7%**	3.2%	4.2%	NS	**22.7%**	16.6%	28.9%	***
Romania	**11.8%**	8.7%	14.5%	***	**7.8%**	7.9%	7.6%	NS	**3.7%**	3.5%	3.8%	NS	**22.7%**	15.6%	28.9%	***
Russian Federation	**12.2%**	10.4%	13.7%	***	**6.3%**	5.7%	6.9%	NS	**4.3%**	3.7%	4.8%	NS	**21.4%**	18.1%	24.0%	***
Slovakia	**11.4%**	10.6%	12.2%	*	**8.1%**	8.9%	7.3%	*	**5.2%**	4.1%	6.4%	***	**22.2%**	17.6%	26.9%	***
Ukraine	**11.6%**	9.2%	13.8%	***	**6.9%**	7.5%	6.3%	NS	**5.2%**	4.6%	5.6%	NS	**22.2%**	17.6%	26.2%	***
Total	**11.3%**	9.2%	13.4%	***	**7.7%**	8.2%	7.2%	***	**4.6%**	4.0%	5.3%	***	**20.6%**	14.8%	25.6%	***

[a] p value for sex differences: *p<0.05; ** p<0.01; ***p<0.001; NS – non-significant
[b] localized single-site pain by excluding other of studied pain sites
[c] chronic pain (headache and/or backache, and/or stomach-ache) in at least two sites

Table 3. Odds of single-site and multi-site recurrent pain in adolescent age groups (ref. = "11-year olds") for boys and girls; OR [95%CI][a]

	Age group	Boys	Girls
Headache [b]	13-year olds	1.09 [1.03–1.14]***	1.36 [1.30–1.42]***
	15-year olds	1.04 [0.99–1.10]NS	1.72 [1.64–1.80]***
	MOR	*1.26* [1.17–1.35]***	*1.25* [1.17–1.35]***
Backache [b]	13-year olds	1.45 [1.37–1.54]***	1.35 [1.28–1.44]***
	15-year olds	2.09 [1.98–2.22]***	1.57 [1.48–1.66]***
	MOR	*1.33* [1.23–1.46]***	*1.42* [1.30–1.55]***
Stomach-ache [b]	13-year olds	0.72 [0.70–0.81]***	0.65 [0.62–0.70]***
	15-year olds	0.57 [0.53–0.62]***	0.54 [0.51–0.58]***
	MOR	*1.44* [1.31–1.60]***	*1.42* [1.30–1.56]***
Multi-site pain [c]	13-year olds	1.20 [1.15–1.25]***	1.51 [1.45–1.57]***
	15-year olds	1.32 [1.26–1.38]***	2.09 [2.02–2.17]***
	MOR	*1.52* [1.39–1.68]***	*1.48* [1.37–1.63]***

[a] OR, odds ratio; CI, confidence interval; MOR, median odds ratio; *p<0.05; ** p<0.01; ***p<0.001; NS – non-significant

[b] localized single-site pain by excluding other of studied pain sites

[c] chronic pain (headache and/or backache, and/or stomach-ache) in at least two sites

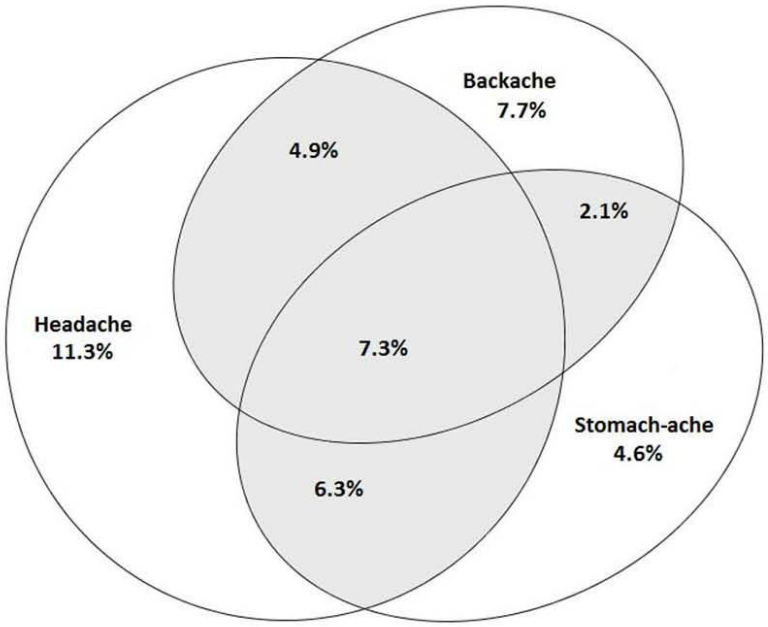

Figure 1. Co-occurrence of chronic pain in 11-, 13- and 15-year-old adolescents; proportional Venn diagram