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# Chronic backpain among adolescents in Denmark: Trends 1991-2018 and association with socioeconomic status

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## **Abstract**

Chronic backpain among adolescents is important because the prevalence is high, above 10%, and more than 10% of all adolescents experience impacts on important day-to-day activities. Chronic backpain tracks into adulthood and is associated with several health problems. The objective was to study trends in the prevalence of chronic backpain among adolescents 1991-2018, to examine the association with socioeconomic status (SES), and whether this association changed over time. The study used data from eight comparable cross-sectional school-surveys of nationally representative samples of 11-15-year-olds in 1991, 1994, 1998, 2002, 2006, 2010, 2014, and 2018, which constitute the Danish arm of the international Health Behaviour in School-aged Children (HBSC) study. The participation rate was 74.6% of the eligible study population, n=29,952. Chronic backpain was defined as self-reported backpain daily or several days a week during the last six months. The prevalence of chronic backpain was 11.1%, significantly increasing from 8.9% in 1991 to 11.7% in 2018. The OR for chronic backpain was 1.20 (95% CI: 1.10-1.31) in middle, and 1.56 (95% CI: 1.41-1.73) in low compared to high SES. Sensitivity analyses with two other cut-points for backpain frequency showed similar associations. *Conclusion:* Chronic backpain is common among adolescents and the prevalence increased from 1991 to 2018. The prevalence was highest in lower SES families. We recommend increased efforts to prevent chronic backpain.

**Key words:** Adolescents; backpain; Health Behaviour in School-aged Children (HBSC) study; social inequality; socioeconomic status; trend study

### **List of abbreviations**

SES: Socioeconomic Status

HBSC: Health Behaviour in School-aged Children

HBSC-SCL: HBSC Symptom Check List

OSC: Occupational Social Class

CI: Confidence Interval

OR: Odds Ratio

### **What is known**

- Chronic backpain among adolescents is common, has a high burden of disability, is associated with several health problems, and tracks into adulthood.

### **What is new**

- The prevalence of chronic backpain among adolescents in Denmark increased from 8.9% in 1991 to 11.7% in 2018
- The prevalence was highest among adolescents from lower SES families

## **Declaratios**

**Funding:** The Nordea foundation (grant number 02-2011-0122) provided economic support for the 2010 study and The Danish Health Authority (grant number 1-1010-274/13) for the 2018 survey. The funding agencies had no role in the study design, data collection, analysis, interpretation or writing of this article.

**Conflict of interest:** The authors have no relevant financial or non-financial interests to disclose.

**Availability of data and material:** The data underlying this article will be shared on reasonable request to the Principal Investigator, Dr. Katrine Rich Madsen ([krma@sdu.dk](mailto:krma@sdu.dk)).

**Code availability:** Not applicable.

**Authors' contributions:** All authors have contributed substantially to the conception and design of the paper, to the interpretation of data, and to the data collection. BEH and MTD performed the analyses. BEH wrote the first draft of the manuscript. All authors contributed to the writing of the manuscript and a critical revision of the intellectual content. All authors have approved the final version of the manuscript and are accountable for all aspects of the work.

**Ethical approval:** There is no formal agency for approval of questionnaire-based surveys in Denmark.

Therefore, we asked the school board as the parents' representative, the headmaster, and the students' council in each of the participating schools to approve the study. The Danish Data Protection Authority has granted acceptance for the 2014 survey (Case No. 2013-54-0576) and the 2018 survey (Case 10 622, University of Southern Denmark).

**Consent to participate:** The participants received oral and written information that participation was voluntary, and that data were treated confidentially. The study complies with national standards for data protection.

**Consent for publication:** Not applicable.

## **Introduction**

Frequent backpain is common among adolescents. A study of 15-year-olds in 45 European countries and Canada showed that 16% reported backpain more than once a week. The prevalence varied considerably across countries. It was 17% and 11% among 15-year-old girls and boys in Denmark. The highest prevalence was among girls in Italy (29%), and the lowest among girls and boys in Azerbaijan (7%) [1]. It is an important public health problem because the prevalence is high, and it causes a high disability burden and use of healthcare services [2]. Further, frequent backpain tracks into adulthood [3-7] and is associated with many other health problems such as headache [4-8], mental health problems, psychological problems, and poor well-being [3, 8, 11, 13-15]. Some of the known risk factors for frequent backpain in adolescence are female gender [4, 16-17], higher age [16, 18-19], physical inactivity [17, 20-21], poor fitness [4], low desk height at school or poor sitting posture [17, 20-21], and daily smoking [4, 12].

Most health complaints among adolescents are associated with the family's socioeconomic status (SES), i. e. more common in socially disadvantaged families [1, 22]. It is not clear whether this association also applies to frequent backpain. Some studies report that this is not the case [14], other studies show higher prevalence among adolescents from lower SES families [22-23], and still other studies report unclear patterns of association between low backpain and SES [19, 24-25]. We expected to find elevated prevalence of chronic backpain in lower SES families because many correlates of backpain (physical inactivity, daily smoking, mental health problems, overweight) are more common among adolescents in lower SES families [26-29].

It is also uncertain whether the prevalence of frequent backpain is stable or changing over time. Trends in symptom prevalence seem to differ by country [30]. A study from Finland showed a steady increase in the prevalence of concomitant neck and low-back pain among adolescents from 1991 to 2010 [31]. A Swiss study [32] found increasing prevalence of backpain 1998-2006, but generally, little is known about time trends in backpain among adolescents. We expected an increasing prevalence of chronic backpain because the prevalence of other unspecific pain (headache, abdominal pain) has been increasing in this period [33-34].

If there is a socioeconomic inequality in the prevalence of frequent backpain, this inequality may also change over time, but little is known about this issue. We expected increasing socioeconomic inequality over time

because socioeconomic inequality in health tends to mirror income inequality [35-38]. The income inequality in Denmark has increased significantly during the past three decades, probably due to macroeconomic processes and changes in taxation [39-40].

Our study focused on chronic backpain defined as self-reported backpain daily or several days a week during at least six months. The aims were: 1) to study trends in the prevalence of chronic backpain among adolescents in Denmark from 1991 to 2018, 2) to examine the association between SES and chronic backpain and 3) to examine if possible socioeconomic inequality changes over time.

## **Materials and Methods**

**Study design and study population:** Health Behaviour in School-aged Children (HBSC) is an international study, which aims to examine adolescents' health and health behaviours in their social setting [1]. This study aim also includes studying the association between SES and health. The HBSC study includes a series of cross-sectional school-surveys of nationally representative samples of three age groups, 11-, 13- and 15-year-olds, carried out every fourth year in currently 50 countries in Europe and North America. The studies are comparable since they adhere to a standard protocol for sampling, measurement, and data collection [1]. We chose to focus on one country (Denmark), because social inequality in frequent backpain may differ by country, trends in the prevalence differ by country, the Danish dataset covers a long period and has more comprehensive data on social background than many other of the participating countries.

Our study used data from eight comparable, cross-sectional, periodical surveys in Denmark in 1991, 1994, 1998, 2002, 2006, 2010, 2014 and 2018. The procedures for sampling and data collection were similar in all study years. First step: Drawing a random sample of schools from a complete list of public and private schools, a new sample in each survey. There were no duplicate schools in adjacent surveys, which minimized the risk of individual students participating twice. Second step: Invitation to participate by separate letters to the school principal, the school board (parents' representatives), and the student board. In each school we invited all students in the fifth, seventh and ninth grade (corresponding to the age groups 11, 13 and 15) to participate. Third step: In schools accepting the invitation, students completed the internationally standardized HBSC questionnaire [41] in the classroom.

**Measurements:** Backpain was measured by one item in the HBSC Symptom Check List (HBSC-SCL) [42-44]: “In the last 6 months, how often have you had backpain?” We dichotomized the responses into chronic (“about every day” and “more than once a week”) vs. episodic (“about every week”, “about every month”, and “rarely or never”). The HBSC-SCL is reliable, assessed by consistent response patterns and valid assessed by qualitative interviews [42-44]. This measurement was similar in all eight surveys.

SES was measured by family occupational social class (OSC). The students answered six questions about their parents’ occupation: “Does your father/mother have a job?”, “If no, why does he/she not have a job?”, “If yes, please say in what place he/she works (for example: hospital, bank, restaurant)”, and “Please write down exactly what job he/she does there (for example: teacher, bus driver)”. The research group coded the answers into OSC from I (high) to V (low). We added OSC VI for economically inactive parents who receive unemployment benefits, disability pension, or other kinds of transfer income, similarly based on students’ responses. The questions about occupation were identical across surveys, and so was the coding procedure [45]. Most students (87.6%) provided enough information for the coding of OSC. Several studies showed that 11-15-year-old schoolchildren can report their parents’ occupation with a high agreement with parents’ own information [46-49], and Pfortner et al. [50] showed that OSC is an appropriate variable for studies of social inequality in adolescents’ health. Each student was categorized by the highest-ranking parent into three levels of OSC: High (I-II, e. g. professionals and managerial positions), middle (III-IV, e. g. technical and administrative staff, skilled workers), and low (V, unskilled workers and VI, economically inactive).

**Inclusion of covariates:** Apart from the independent variable (OSC) and the dependent variable (chronic backpain), the statistical analyses included three standard control variables: Sex, age group and study year. The dataset did not comprise any other variables that could serve as confounders. We considered including explanatory variables, such as physical inactivity and sitting time, but the study design is cross-sectional and there is a possibility that these variables were outcomes of backpain rather than precursors of backpain.

**Statistical procedures:** We calculated age-standardized prevalence proportions of chronic backpain with 95% confidence intervals. The analyses included chi<sup>2</sup>-test for homogeneity and Cochran-Armitage test for trends over time. Initial analyses found similar patterns among boys and girls, so the final analyses combined boys and girls



and standardized for sex. We described social inequality of chronic backpain by prevalence difference between low and high OSC and by logistic regression analyses. The logistic regression analyses included OSC, sex, age group, and survey year in mutually adjusted models, and a final model with inclusion of an interaction term (survey year \* OSC) to assess potential interaction between survey year and OSC. The analyses accounted for the applied cluster sampling by means of multilevel modelling (PROC GLIMMIX in SAS). Sensitivity analyses included analyses with two other cut-points of backpain frequency, 1) daily backpain ("about every day") vs. less often and 2) weekly backpain ("about every day", "more than once a week", "about every week") vs. less often.

## Results

**Participation and study population:** The eligible study population (students enrolled in the participating classes) was 40,134. The participation rate across all eight surveys was 88.0%, n=35,320 (Table 1), but diminishing over time, Cochran-Armitage test,  $p < 0.0001$ . In each survey, we included students with complete data about sex, age group, prevalence of backpain, and parents' OSC, n=29,952 corresponding to 74.6% of the eligible study population; 4,393 students were excluded because of missing OSC data and 975 because of missing backpain data.

**Prevalence and time trends:** In the entire study population, all survey years combined, the sex- and age standardized prevalence of chronic backpain was 11.1% (95% CI: 10.7-11.4%) (Table 1). The prevalence of chronic backpain fluctuated across survey years with an increasing trend,  $p < 0.0001$ . The lowest level was in 1994 (9.2%) and the highest in 2014 (13.0%) (Table 1). The OR (95% CI) for chronic backpain was 1.24 (1.15-1.34) among girls vs. boys, and it was 1.42 (1.29-1.55) and 1.87 (1.70-2.05) among 13- and 15-year-olds vs. 11-year-olds (Table 2).

**Association with SES:** The prevalence of chronic backpain was 9.6% (9.0-10.2%), 11.0% (10.5-11.5%) and 13.4% (12.6-14.3%) in high, middle, and low OSC across all survey years,  $p < 0.0001$  (Table 1). The prevalence of chronic backpain among the 4,393 students without information about OSC was between middle and low OSC (12.4%, not shown in table, not included in the analyses). The above-mentioned increasing tendency from 1991 to 2018 appeared in all OSC groups,  $p_{\text{high}} < 0.0001$ ,  $p_{\text{middle}} = 0.0003$  and  $p_{\text{low}} = 0.0203$  (Fig 1).

The prevalence difference in chronic backpain between low and high OSC was 3.8% in the entire study population. The prevalence difference was statistically significant in 1991, 1994, 1998, 2002, 2006, 2010 (p-values <0.05), but not in 2014 and 2018 (Table 1). It fluctuated across years without any consistent increasing or decreasing pattern; it was highest in 1991 (7.2%) and lowest in 2018 (2.7%). Table 2 shows the results of the logistic regression analyses. The OR for chronic backpain was significantly higher in the three latest surveys (2010, 2014 and 2018) than in 1991. The OR (95% CI) for chronic backpain was 1.20 (1.10-1.31) in middle and 1.56 (1.41-1.73) in low compared to high OSC. There was no significant statistical interaction between survey year and OSC (p=0.0767), meaning that the social inequality in chronic backpain did not change significantly over survey years.

**Sensitivity analyses:** Using the alternative cut-points, the prevalence of daily backpain was 5.3% (5.0-5.5%) and the prevalence of weekly backpain was 20.2% (19.8-20.7%) (not shown in table). The logistic regression analyses with these alternative cut-points showed that the direction of the associations was similar, for instance the OR for backpain increased significantly with decreasing OSC regardless of cut-point (Table 2).

## **Discussion**

Our study confirms what other studies have shown: the prevalence of chronic backpain among adolescents is high. Our finding of an average point prevalence of 11.1% having chronic backpain is slightly lower than the meta-analytic investigation by Calvo-Muños et al. [18], which found a mean point prevalence from ten studies of 12.0%. The mean period prevalence at 12 months from 13 studies was 33.6% [18]. The study by Calvo-Muños et al. covered the period 1990-2011, participants up till 18 years old and a wide variety of mostly European countries. In general, estimates of the prevalence of backpain in adolescence varied considerably across studies and countries [1, 18-19]. Our finding of an increasing prevalence of chronic backpain during the later decades corresponds with studies from Finland and Switzerland [31-32]. In general, trends in prevalence of backpain seem to differ by country, which was one of our reasons for focusing on one country [30, 51].

Our finding of a higher prevalence of chronic backpain among adolescents from lower SES families corresponds with findings from studies among adolescents in Denmark [23], in the Nordic countries [8] and in a study, which included data from 37 countries in Europe and North America [22]. Other studies have found unclear

associations between SES and backpain in adolescence [14, 19, 24-25]. Finally, our expectation of an increasing social inequality in backpain over time was not confirmed since the social inequality was relatively stable during the 37-year observation period.

The study does not contribute to the explanation of the social inequality in chronic backpain. One possible explanation is higher frequency of physical inactivity among students from low SES families [26]. We refrained from including physical inactivity in the analyses because of the cross-sectional study design where it is impossible to detect whether physical inactivity is a determinant of or consequence of backpain. The social inequality in chronic backpain could also be explained by higher frequency of other risk factors in low SES families, e. g. overweight, poor fitness, and poor access to training facilities.

The analyses build upon data from eight nationally representative and comparable studies with a high participation rate among students enrolled in the participating schools (88.0%). Still, there is a risk of selection bias because it is likely that there is an over-representation of students with health problems, such as backpain among the absent and non-participating students. Therefore, the study may under-estimate the prevalence of chronic backpain. There is also a risk of measurement bias because the measurement of backpain may be too crude. The measurement focuses on frequency but does not include pain intensity or pain location. Some researchers recommend separating data on neck pain, middle backpain, and low-back pain, as they should be regarded as specific entities [51-52]. Measurement of SES by self-reports among adolescents is a challenge. It is a limitation that we do not have data about parents' education, which probably is the most valid and stable indicator of SES. Most children in these age groups are able to report their parents' occupation, but not education. Occupation is a stable and appropriate measure of SES and according to several validation studies an appropriate measure for studies of social inequality in adolescents' health [45-50]. Another limitation is the missing data on OSC among the 4,393 students, but the prevalence of chronic backpain among students without OSC data was only slightly higher than among students with OSC data.

We considered including other variables in the statistical models to control for confounding factors, and to explain the association between OSC and chronic backpain. Unfortunately, the dataset did not comprise other confounders than sex, age group and study year. We were reluctant to expand the statistical models with

potential explanatory variables such as physical inactivity and sitting time because there is a risk that these variables were outcomes of backpain rather than precursors of backpain.

From a research point of view, it is important to unravel the processes, which result in higher prevalence of chronic backpain among adolescents from low SES families. Reducing socioeconomic inequalities in childhood and adolescent health, including chronic pain, is an important public health priority because of its multiple long-term adverse health consequences [53]. One way to gain insight is to study how health inequalities have changed over time. We also recommend continued monitoring of the prevalence of chronic backpain, preferably by studies that provide separate data about pain from different parts of the spine. Further, we recommend repeating the study using the international HBSC dataset. Such a study would reveal whether trends and social inequality in backpain among adolescents are country specific or universal. Furthermore, use of the international dataset may help identifying societal circumstances that are related to trends in the prevalence of backpain.

From a public health point of view, we recommend increased focus on this health problem: It is common, it tracks into adulthood [1, 3-7, 9-15], and it is self-limiting [54]. According to MacDonald et al. [54] most causes of backpain in adolescence are musculoskeletal and benign in their clinical course. Nevertheless, when more than 10% of adolescents suffer from chronic backpain, it is worth taking seriously. It is important to implement preventive efforts such as sufficient physical activity, leisure-time activities with a balanced and not too high physical impact, restriction of sitting-time, non-smoking, appropriate sitting posture, optimal desk height at school, and improvement of school backpack habits. Finally, physicians should recognize the importance of a proper history, physical examination, and general knowledge of the lumbar spine and pelvic anatomy relevant to the child in their evaluation with this presenting symptom [54].

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**Table 1** Study population and prevalence of chronic backpain <sup>a</sup> by year of data collection

	Year of data collection								Total
	1991	1994	1998	2002	2006	2010	2014	2018	
Eligible participants <sup>b</sup>	2,061	4,519	5,788	5,400	7,056	5,704	5,292	4,314	40,134
Participation rate <sup>c</sup>	90.2%	89.5%	89.9%	89.3%	88.8%	86.3%	85.7%	84.8%	88.0%
N	1,860	4,046	5,205	4,824	6,269	4,922	4,534	3,660	35,320
Included in the study <sup>d</sup>	1,647	3,546	4,671	4,256	4,975	4,117	3,787	2,953	29,952
<b>Study population</b>									
<b>... by sex</b>									
% boys	49.8	49.2	49.6	48.1	48.4	49.1	47.9	48.4	48.7
% girls	50.2	50.9	50.4	51.9	51.6	50.9	52.1	51.6	51.3
<b>... by age group</b>									
% 11-year-olds	29.9	30.7	33.3	35.3	36.3	35.1	28.4	39.0	33.8
% 13-year-olds	34.7	34.3	35.5	33.3	35.9	34.7	36.4	34.4	35.0
% 15-year-olds	35.4	35.0	31.1	31.4	27.7	30.2	35.2	26.6	31.2
<b>... by OSC <sup>e</sup></b>									
% high	28.2	33.2	28.1	24.9	27.8	38.9	42.4	43.1	33.0
% middle	51.8	48.5	49.8	54.4	49.7	42.3	41.5	44.6	47.8
% low	20.0	18.3	22.1	20.8	22.6	18.8	16.1	12.3	19.3
<b>Prevalence (%) of chronic backpain <sup>f, g</sup></b>									
... 95% CI	4.4	3.7	4.7	5.1	5.9	6.0	6.4	5.3	5.3
... 95% CI	3.4-5.3	3.1-4.3	4.1-5.3	4.4-5.7	5.2-6.6	5.3-6.7	5.6-7.1	4.5-6.1	5.0-5.5
<b>Prevalence (%)</b>									
... in high OSC <sup>f, g</sup>	7.0	7.8	8.4	8.9	9.1	9.4	12.4	11.7	9.6
... 95% CI	4.7-9.4	6.2-9.3	6.9-9.9	7.2-10.6	7.6-10.7	7.9-10.8	10.8-14.1	9.9-13.4	9.0-10.2
... in middle OSC <sup>f, g</sup>	8.9	9.3	11.4	9.8	11.5	12.7	12.8	11.7	11.0
... 95% CI	7.0-10.8	8.9-10.7	10.1-12.7	8.6-11.0	10.3-12.8	11.2-14.3	11.1-14.4	10.0-13.4	10.5-11.5
... in low OSC <sup>f, g</sup>	14.4	11.4	11.6	13.8	13.9	14.9	15.2	14.6	13.4
... 95% CI	10.6-18.2	9.9-13.9	9.7-13.6	11.5-16.1	11.9-15.9	12.4-17.4	12.3-18.0	11.0-18.3	12.6-14.3
<b>Prevalence difference (high-low OSC) <sup>e</sup></b>									
... 95% CI	7.4 <sup>h</sup>	3.6 <sup>h</sup>	3.2 <sup>h</sup>	4.9 <sup>h</sup>	4.8 <sup>h</sup>	5.5 <sup>g</sup>	2.8	2.9	3.8 <sup>h</sup>

<sup>a</sup> Self-reported backpain daily or several days a week during the last six months.

<sup>b</sup> Number of schoolchildren enrolled in the participating classes.

<sup>c</sup> Number of participants in the data file as percentage of schoolchildren enrolled in the participating classes.

<sup>d</sup> Participants with full information on sex, age group, occupational social class and backpain.

<sup>e</sup> OSC = Occupational Social Class.

<sup>f</sup> Sex- and age-standardized prevalence.

<sup>g</sup> Increasing trend 1991-2018; statistically significant assessed by Cochran-Armitage test,  $p < 0.05$

<sup>h</sup> The prevalence difference was statistically significant,  $p < 0.05$ .

**Table 2** Mutually adjusted OR (95% CI) for chronic backpain <sup>a</sup>

Independent variable	Category	Main analysis: OR (95% CI) for chronic backpain <sup>b</sup>	Sensitivity analyses with other cut-points	
			OR (95% CI) for daily backpain <sup>c</sup>	OR (95% CI) for weekly backpain <sup>d</sup>
Sex	Boys (ref.)	1	1	1
	Girls	<i>1.24 (1.15-1.34)</i>	<i>1.45 (1.31-1.61)</i>	<i>1.10 (1.04-1.16)</i>
Age group	11-year-olds (ref.)	1	1	1
	13-year-olds	<i>1.42 (1.29-1.55)</i>	<i>1.36 (1.19-1.55)</i>	<i>1.46 (1.36-1.57)</i>
	15-year-olds	<i>1.87 (1.70-2.05)</i>	<i>1.58 (1.39-1.80)</i>	<i>2.02 (1.88-2.17)</i>
Year	1991 (ref.)	1	1	1
	1994	0.97 (0.80-1.19)	0.85 (0.63-1.13)	1.06 (0.92-1.24)
	1998	1.13 (0.93-1.36)	1.07 (0.81-1.40)	<i>1.16 (1.00-1.34)</i>
	2002	1.10 (0.91-1.33)	1.16 (0.88-1.52)	1.07 (0.92-1.23)
	2006	1.19 (0.99-1.44)	<i>1.32 (1.02-1.72)</i>	1.05 (0.91-1.21)
	2010	<i>1.30 (1.08-1.58)</i>	<i>1.43 (1.09-1.87)</i>	1.15 (0.99-1.33)
	2014	<i>1.47 (1.22-1.78)</i>	<i>1.55 (1.19-2.03)</i>	<i>1.30 (1.13-1.51)</i>
	2018	<i>1.35 (1.11-1.65)</i>	1.28 (0.96-1.71)	<i>1.30 (1.11-1.51)</i>
Occupational social class	High (ref.)	1	1	1
	Middle	<i>1.20 (1.10-1.31)</i>	<i>1.29 (1.14-1.46)</i>	<i>1.12 (1.05-1.20)</i>
	Low	<i>1.56 (1.41-1.73)</i>	<i>1.81 (1.57-2.09)</i>	<i>1.42 (1.31-1.54)</i>

<sup>a</sup> Multivariate multilevel logistic regression analyses using SAS PROC GLIMMIX to account for the cluster sampling.

<sup>b</sup> ("about every day" and "more than once a week") vs. ("about every week", "about every month", and "rarely or never")

<sup>c</sup> "about every day" vs. less often.

<sup>d</sup> ("about every day", "more than once a week" and "about every week") vs. less often. Estimates in italics are significantly higher than 1.0

Fig 1 Sex- and age-standardized prevalence of chronic backpain by year and occupational social class

