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Gender and secular trends in adolescent mental health over 24 years – The role of school-related stress

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A B S T R A C T

Increasing levels of psychosomatic symptoms, and other mental health problems, among adolescents, and especially among girls, have been reported across various countries. The "educational stressors hypothesis" states that this trend can be explained by an increasing amount of stressors in the school environment. This study tests this hypothesis, using repeated cross-sectional data, between the years 1993–2017, from the Health Behaviours of School-aged Children (HBSC) survey. Regression and decomposition techniques are used to investigate the role of school stress for trends in psychosomatic symptoms, and for gender differences in symptoms.

Results show that the effects of school stress on psychosomatic symptoms have become stronger over time, but that they can only account for a small share of the overall increase in symptoms since 1993. However, school stress has increased more among girls than among boys, and it explains about half of the growth of the gender gap in symptoms. Thus, school stress accounts for a substantial portion of the increase in symptoms for girls, but only a minor share of the increase for boys. In sum, we found weak evidence for the educational stressors hypothesis in regard to the overall trend in symptoms, but strong evidence for it in explaining the growing gender gap.

1. Introduction

Increasing levels of psychosomatic symptoms, and other mental health problems, have been reported in adolescents across many countries. Recent reviews of studies on trends report a secular increase in levels of self-reported health problems and symptoms since the 1980s (Bor et al., 2014; Calling et al., 2017; Collishaw, 2015; Hagquist et al., 2019; Potrebny et al., 2017). The trend has generally been stronger among girls than boys, thus widening the gender gap in psychosomatic symptoms among adolescents (Calling et al., 2017; Collishaw et al., 2010; Ross et al., 2017). Against this background, adolescent health, especially mental health, has increasingly been raised as an emergent public health concern, and as a leading cause of adolescent disability in high-income countries (Erskine et al., 2014). While several studies have documented trends in psychosomatic symptoms, fewer have aimed to explain them, and there is still a vast knowledge gap regarding their underlying determinants (Bor et al., 2014; Potrebny et al., 2017).

The "educational stressors hypothesis" states that trends in symptoms can be explained by more stressors related to the school environment (West and Sweeting, 2003; see also Giota; Gustafsson, 2017; Potrebny et al., 2017). Yet, despite the accumulating evidence for the importance of school stress in adolescent health (e.g. Schraml et al., 2011), the role of stress, or other school-related factors, in the growth of, or the widening gender gap in, psychosomatic symptoms has rarely been investigated.

The present study uses decomposition techniques to break down the increase in psychosomatic symptoms in Sweden into its constituent determinants, with a specific focus on the role of school stress. Decomposition techniques enable us to quantify and evaluate the relative importance of different determinants. The majority of previous studies on health trends looked at broad and upstream risk factors, such as economic conditions, while recent reviews of the field have called for research on the more proximate individual-level mechanisms, such as school stress (Collishaw, 2015). This study utilizes equivalent measures of both psychosomatic symptoms and school stress, as well as a range of other potential determinants, with data spanning more than two decades. Such data provide an unusual opportunity for disentangling health trends (von Soest; Wichstrøm, 2014).

To the best of our knowledge, this study presents the first decomposition of trends in adolescent health. Sweden is one of the countries where the increase in symptoms has been large (Hagquist et al., 2019; Potrebny et al., 2017), making it an ideal setting for investigating the determinants of adolescent health trends.

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2. Previous research

2.1. The educational stressors hypothesis

In 2003, West and Sweeting (2003) noted a trend towards poorer psychosomatic health among girls, especially, in Scotland, and related this to the "educational stressors hypothesis". Briefly, the hypothesis states that modern knowledge societies put a greater emphasis on education, which entails several stressors related to the school environment. Among the most notable of these is the increased pressure to perform in school, the growth in testing, and the associated experiences of being evaluated (West and Sweeting, 2003). Since performance-based self-esteem, as related to school performance, is more common among girls than among boys, and as girls tend to value schoolwork higher, girls also experience more stressors, and are more sensitive to stressors, in the school environment (Landstedt et al., 2009; Schraml et al., 2011).

Several studies have corroborated the strong relationship between school stress or demands, and psychosomatic symptoms or mental health (Ang and Huan, 2006; Giota and Gustafsson, 2017; Nygren and Hagquist, 2017). Swedish adolescents report pressure from school to be more stressful than pressure from home (Schraml et al., 2011; Wiklund et al., 2012). As for gender differences, girls report higher levels of school stress and demands (Östberg et al., 2015), and the effect of stress on psychosomatic symptoms is stronger for girls (Sonmark et al., 2016; West and Sweeting, 2003).

The "educational stressors hypothesis" can refer either to the role of educational stressors in the increase in psychosomatic symptoms among adolescents overall (that is, both genders combined (Karvonen et al., 2005)), or, more specifically, in the increase in symptoms among girls, and the consequent widening gender gap (West and Sweeting, 2003). This study investigates both phenomena. With regard to the first – the overall increase in symptoms – educational stressors can contribute to this through two mechanisms, or pathways. If educational stressors become more prevalent over time, and their effect on psychosomatic symptoms is stable, this will, all else being equal, lead to more symptoms. This is called the exposure-mechanism, since it refers to an increase in the exposure to a stressor. However, even if the prevalence of educational stressors remains stable over time, they can still contribute to more symptoms if their effect becomes stronger over time. This is called the vulnerability-mechanism, since it refers to an increase in the vulnerability to a given exposure (Sweeting et al., 2010).

Analysing the second trend, the widening gender gap, is slightly more complex, since this requires a consideration of the interactions between gender differences in exposure and vulnerability. A given stressor can contribute to a widening gender gap through four potential sub-mechanisms (cf. Kim, 2010; Smith and Welch, 1989). Firstly, if the prevalence of (i.e. exposure to) a stressor increases more among girls than among boys, girls will experience a greater increase in symptoms, and the gender gap will widen. This corresponds to the exposure-mechanism, but in relation to the gender gap. Secondly, if the effect of a stressor becomes stronger for girls compared to boys over time, girls will also experience a greater increase in symptoms. This second sub-mechanism corresponds to the vulnerability mechanism, but again, in relation to the gender gap. Thirdly, if girls are initially more exposed to the stressor (i.e. a greater initial prevalence among girls), and the vulnerability to the stressor increases over time (the effect of the stressor becomes stronger) for *both* girls and boys, girls will experience a relatively greater increase in symptoms, since more girls are affected by this shared increased vulnerability. This third sub-mechanism is called a time-interaction effect. Fourthly, if girls are initially more vulnerable to the stressor (i.e. a stronger initial effect for girls), and *both* girls and boys become more exposed to the stressor (i.e. the prevalence of the stressor increases for both), girls will also experience a relatively greater increase in symptoms, since the shared increased exposure is more harmful for girls. This fourth sub-mechanism is called a gender-interaction effect (race-interaction effect in the words of Smith and Welch (1989), who studied racial disparities in income).

2.2. Previous research on educational stressors and trends in adolescent health

Three studies have in one way or another tested the educational stressors hypothesis, with varying methods. Karvonen et al. (2005) examined if increased psychosomatic symptoms in Finland between 1996 and 2000 could be accounted for by school-related factors, health-behaviours, and family characteristics (that is, the exposure-mechanism). They found that school-related factors accounted for only a minor share of the increase in symptoms, and that most of the increase could not be explained by any observed characteristic. Karvonen et al. (2005) did, however, not look at the gender gap, nor at changes in vulnerability over time.

Nygren and Hagquist (2017) investigated whether the effect of school demands on psychosomatic symptoms in Sweden had changed between 1988 and 2011 (that is, the vulnerability-mechanism), but found that the effect remained fairly stable over time. Sweeting et al. (2010), in a study of trends in psychological distress among Scottish adolescents, from 1987 to 2006, found that much of the increase in distress was accounted for by school disengagement, and worries about school (the exposure mechanism), and the effects of these on distress were stronger in 2006, generally, than in 1987 (the vulnerability mechanism).

In addition to the above-mentioned studies, that focused on school factors, other studies have investigated further possible determinants of trends in adolescent health. We will return to them in the data and methods-section.

Following this research background, the present study has two objectives:

Objective 1: To investigate the role of school stress in regard to trends in psychosomatic symptoms among Swedish adolescents between 1993 and 2017.

Objective 2: To investigate the role of school stress in the changing gender gap in psychosomatic symptoms among Swedish adolescents between 1993 and 2017.

3. Data and methods

3.1. Data

We use Swedish data from the Health Behaviours of School-aged Children (HBSC) survey. HBSC is conducted every four years, and we use the surveys from 1993/1994, 1997/1998, 2001/2002, 2005/2006, 2009/2010, 2013/2014 and 2017/2018. Swedish HBSC data go back to 1985/1986, but we use 1993/1994 as the year of comparison, since the indicator of school stress is only available from that year onwards. The total sample size, for the years 1993–2017, is 29,199 respondents.

HBSC is a repeated cross-sectional survey, conducted in selected countries in collaboration with the World Health Organization (WHO). The Swedish HBSC data are collected by Statistics Sweden, via a two-stage cluster design, with schools as the primary sampling unit. In stage one, three random samples of Swedish schools are selected, one for each school grade (grades 5, 7, and 9, when pupils are between 11 and 16 years old). In stage two, one school class is selected at random from each school, and all pupils in that class may participate in the survey if they choose. The survey is then completed in the classroom, under the supervision of the teacher.

A key issue when studying health trends is ensuring that the sample is representative of the adolescent population, and that this has not changed over time (Collishaw, 2015). Since almost all Swedish adolescents attend school until grade 9, and the sample is a random sample of the population attending school, the sample should, in principle, reflect the population of Swedish adolescents aged 11 to 16. Non-response rates, at the level of pupils, have been consistently around 10–15%, and stable over time. Non-response rates at the school level have been rather stable over time, around 20% or less, though with a slightly increasing trend. The exception is 2017, when around half of the sampled schools did not participate, most probably because Statistics Sweden was no longer allowed to send reminders to non-responding schools. Given increasing school segregation, the results for 2017 should be viewed with more caution, an issue that we will return to later.

3.2. Dependent variable

Psychosomatic symptoms are conceptualized in this study as reflecting a mixture of psychological or mental, and physical or somatic, health complaints (cf. Potrebny et al., 2017). Since the concept refers to symptoms relating to mental states or feelings of pain, it is at least partly subjective. As an indicator of psychosomatic symptoms, we use the Health Behaviour of School-Aged Children symptoms checklist (HBSC-SCL). Pupils are asked about the frequency of eight different symptoms over the last six months. The symptoms are headache, stomach-ache, dizziness, backache, sleeping difficulties, feeling low, nervous, and irritable or bad tempered, and response categories range from 'about every day' (coded 4) to 'rarely or never' (coded 0). The exact same questions have been asked in all surveys, which is essential for establishing time trends (Collishaw, 2015). A study based on Nordic samples demonstrated satisfying reliability and validity of the HBSC-SCL as a measure of adolescent psychosomatic health, given some post hoc revisions of the original scale (see below), (Hagquist et al., 2019).

The HBSC-SCL can be analysed as a one-factor (i.e. all items included in one construct) or as a two-factor construct, distinguishing between psychological and somatic symptoms (Hagquist et al., 2019). Confirmatory factor analysis on the present data shows that a two-factor model fits the data better, which is in line with previous research (Dey et al., 2015). However, the one-factor model shows acceptable fit, and somatic and psychological symptoms are highly correlated in the two-factor model. Moreover, the factor structure has remained stable over time. In order to simplify the analyses, we use a unidimensional construct, in line with Hagquist et al. (2019). The unidimensional construct used in the analyses is an additive index based on the eight items, ranging from 0 to 32.

3.3. Explanatory variables

Time is measured by the year of the survey, ranging from 1993/1994 (henceforth 1993) to 2017/2018 (henceforth 2017). Gender is measured by a dummy variable for girl, with boy as reference. The main explanatory variable is school stress. The question asked is "How stressed do you feel by your school work?“, with possible answers ranging from 'Not at all' (0) to 'Very' (3). With a slight change of one response category in 1997 ("Somewhat" changed to "Fairly much"), the wording of the questions and responses has not changed since 1993.

Several factors have been mentioned as contributing to trends in psychosomatic symptoms. Among those factors that have been reported in previous research, and that we can measure, we include indicators of parental employment, and the consumption level of the household, to control for changes in socioeconomic conditions over time (Kim and Hagquist, 2018). Among family-related factors, we also control for the quality of child-parent relationships, measured by the perceived ease with which the respondent can discuss important matters with their mother or father (Collishaw et al., 2012; Sweeting et al., 2010). We include one indicator measuring the respondent's opinion of his/her body to control for issues related to body image and appearance, one indicator for the number of times the respondent has been drunk (von Soest; Wichstrøm, 2014), and one indicator measuring frequency of physical activity. In addition, we control for the age of the respondent.

Moreover, we include one indicator measuring how often the respondent has been bullied in school, and one indicator of perceived social relations in school. These two directly school-related indicators can partly be seen as potential confounders of the stress-symptoms association, but also as indicators testing the educational stressors hypothesis in their own right.

Non-binary variables have been mean-centred in the analyses. Measurements and descriptive statistics for all variables are presented in Table S1 in the online appendix.

3.4. Analysis

We use two analytical strategies. The first strategy utilizes a regression framework to analyse to what extent stress functions as a mediator and/or moderator of the trend in psychosomatic symptoms (cf. Sweeting et al., 2010). We capture the trend in symptoms (the dependent variable) with a set of dummy variables for each survey year, and investigate if school stress mediates and/or moderates this trend by entering the stress variable first as a mediator, and then as a moderator (the latter through interacting stress with time) (Collishaw et al., 2012; Karvonen et al., 2005; von Soest; Wichstrøm, 2014). The mediation model addresses the exposure-mechanism, while the moderation model addresses the vulnerability-mechanism. We use an equivalent approach to investigate trends in the gender gap, but then interact gender with time, as well as with stress.

Mediation and moderation analyses in a regression framework enable us to address the exposure and vulnerability-mechanisms, respectively. However, it only provides evidence of the *presence* of the respective mechanisms, but not on their relative importance. In order to disentangle and quantify the contributions of each mechanism, we also employ decomposition analysis, using the Blinder-Oaxaca decomposition method (Jann, 2008; Kim, 2010; Smith and Welch, 1989). The Blinder-Oaxaca decomposition method was originally developed to study determinants of wage differences across groups, but, in principle, it can be used to account for any type of difference across groups or categories.

In decomposition analysis, two regression models are estimated, one for each of the two groups being compared. Both models include the same dependent and explanatory variables, although, since they are estimated separately for the two groups, the distribution and effects of these explanatory variables are allowed to vary between the models. The difference in a dependent variable between the groups is then decomposed into the endowment and the coefficient effects, respectively. The endowment effect is the share of the difference between the groups accounted for by differences in the distribution (prevalence) of the explanatory variables across the groups, and thereby captures the exposure mechanism. The coefficient effect sums up the share of the difference that is due to differing effects of the explanatory variables across the groups, and thereby captures the vulnerability-mechanism. In research on wage differentials, the coefficient effect is often termed "unexplained", since it is thought to reflect discrimination (e.g. that men gain more than women from higher education). However, this is not the case when measures of health are used as outcomes. The share of the difference that is not accounted for by the explanatory variables is reflected by differences in intercepts across the groups.

In this study, we want to decompose time trends, in other words, how much of the *changes* in symptoms that can be accounted for by stress. The first objective, concerning the overall time trend, is addressed by estimating separate regression models in 1993 and 2017, and decomposing the difference in average levels of symptoms between the respective years into the endowment and coefficient effects. The second objective is addressed by estimating separate regressions for girls and boys, in both 1993 and 2017, decomposing the gender gap *within* the respective years as described above, and then comparing the respective two decompositions to see if the share of the gender gap that is accounted for by stress has changed over time.

This type of decomposition can only disentangle the exposure and vulnerability mechanisms, but it does identify the time and gender-interaction effects described previously (Smith and Welch, 1989). In the decomposition analysis presented in this study, the exposure mechanism (endowment effect) subsumes the time-interaction effect, that is, the increase in the gender gap resulting from a shared increase, for both girls and boys, in the effect of a stressor of which the prevalence initially differed between the groups. The vulnerability mechanism subsumes the gender-interaction effect, that is, the change in the gender gap resulting from a shared increase for both girls and boys in the prevalence of a stressor of which the effect initially differed between the groups.

4. Results

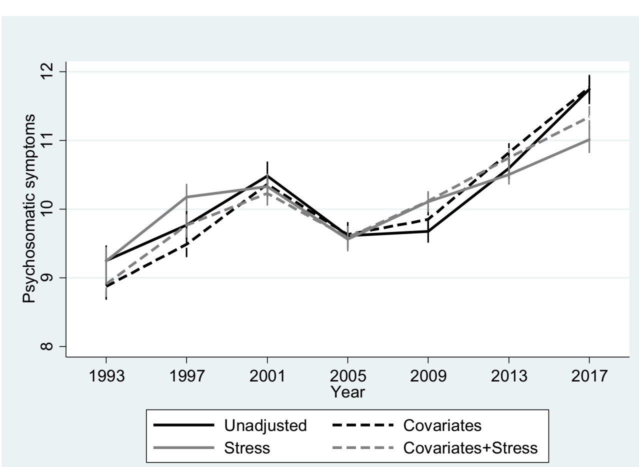
The average age of the sample is 13.02 years, with 49.83% boys and 50.17% girls. The number of observations per survey ranges from 3230 (in 1993) to 6748 (in 2013).

4.1. Regression results

We present the results of the regression analyses graphically, since this facilitates interpretation of the results. Full tables, including standard errors, are provided in the online appendix (Tables S2–S4). Unless otherwise stated so, all differences that we comment upon are statistically significant at the 5% level.

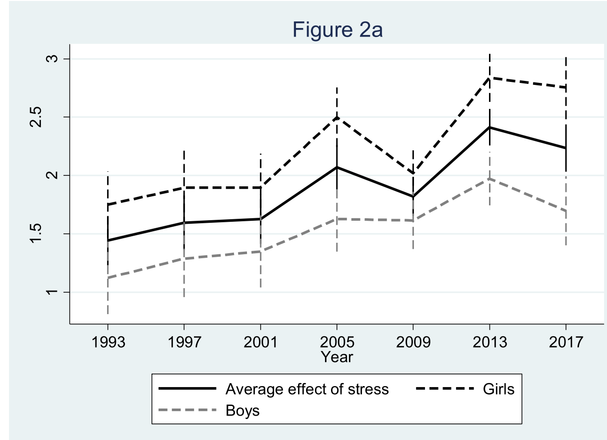
Objective 1 is addressed in Fig. 1, estimated from mediation models. The vertical y-axis shows average scores on the psychosomatic symptoms scale, and the horizontal x-axis shows how this changes over time. The solid, black line ('Unadjusted') shows the baseline results for the time trend, estimated from a regression model with no covariates. There has been a clear, though not linear, increase in psychosomatic symptoms, especially from 2009 onwards. The dashed black line shows the trend after adjusting for all covariates, save for school stress. The line is largely parallel to the unadjusted time trend, indicating that the covariates combined cannot account for the time trend.

The grey solid line shows the time trend after adjusting only for school stress, thereby addressing the exposure mechanism. The line is again largely parallel to the unadjusted time trend, with the exception of a reduction in excess symptoms in 2017. In other words, had average stress levels been constant over time, the increase in symptoms would have been roughly the same in all years save for 2017. The grey dashed line shows the time trend when adjusting for stress and the other covariates simultaneously. Again, the line is largely parallel to the unadjusted line. In sum, it appears that neither school stress, nor the other covariates, mediates the increase in symptoms except in 2017, meaning

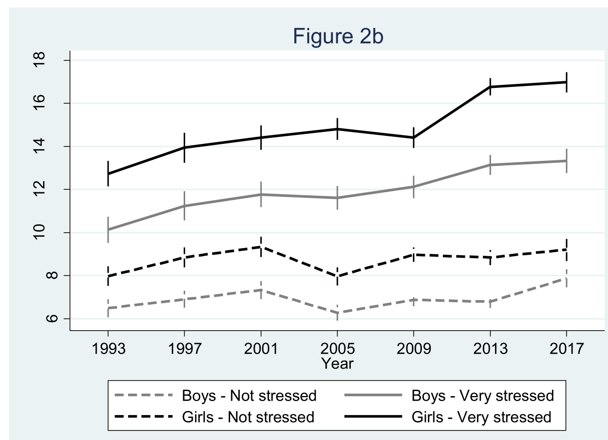


Note: spikes show 95 % confidence intervals.

Fig. 1. Predicted levels of psychosomatic symptoms, both genders. 1993–2017.



Note: Line shows the effect of a one unit increase in school stress. Spikes show 95 % confidence intervals.



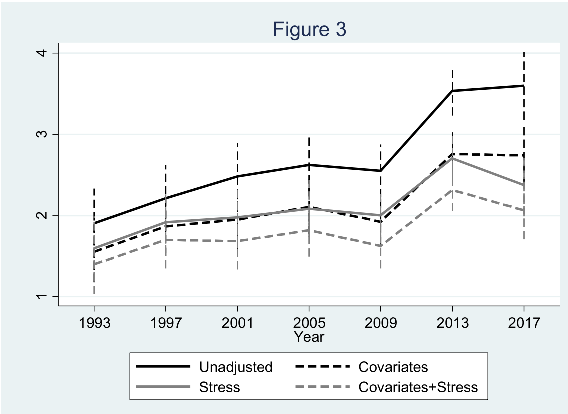
Note: spikes show 95 % confidence intervals.

Fig. 2. a – Predicted effect of stress on psychosomatic symptoms. 1993–2017. b – Predicted levels of psychosomatic symptoms for different levels of stress. 1993–2017.

that we find weak evidence for the exposure mechanism in relation to the overall trend in symptoms.

Fig. 2a and b address the vulnerability-mechanism from different perspectives, with both figures estimated from moderation models in which stress is interacted with time, as well as with gender (we present results for girls and boys separately since this is of relevance for objective 2). Fig. 2a shows how the effect of stress on symptoms has changed since 1993, controlling for the covariates. The effect of stress has become stronger over time, for both genders. In 1993, a one scale point higher level of stress was, on average for both genders (black, solid line), associated with around a 1.4 scale point higher level of symptoms, with the corresponding effect in 2017 around 2.2 scale points. Fig. 2b shows trends in average levels of symptoms conditional on stress, for girls and boys separately. The solid lines show predicted levels for the most stressed ("Very stressed"), and the dashed lines are the equivalent for the least stressed ("Not stressed"), with black lines showing results for girls, and grey lines the equivalent for boys. For both girls and boys, symptom levels have barely increased for the least stressed pupils, but grown steadily for the most stressed ones. In sum, we find evidence for the vulnerability mechanism in relation to the overall trend in symptoms.

We next turn to objective 2, concerning the gender gap in symptoms. Fig. 3 displays changes in the gender gap, with the vertical y-axis showing average levels of excess symptoms for girls compared to boys.



Note: Lines show average levels of excess symptoms for girls compared to boys. Spikes show 95 % confidence intervals.

Fig. 3. Predicted gender gap in psychosomatic symptoms. 1993–2017.

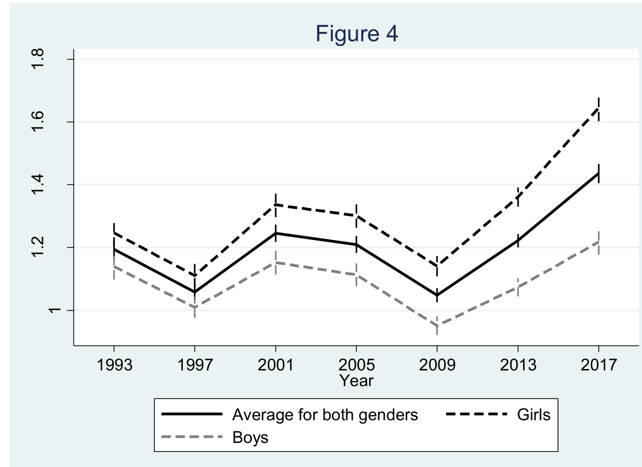
The solid, black line ('Unadjusted') shows the baseline results for the time trend. In line with results from other national contexts (e.g. Ross et al., 2017), the increase in symptoms has been stronger for girls, as is evident from the almost linear growth of the gender gap. In 1993, the gender gap was less than 2 scale points, while in 2017 it had grown to more than 3.5 scale points.

When the covariates are adjusted for (black dashed line), the gender gap is reduced, as is the rate of growth in the gap. When school stress is adjusted for separately (grey solid line), the reduction of the gap is similar, though slightly larger in 2017. The gender gap is further reduced when stress is included simultaneously with the other covariates (grey dashed line). In sum, school stress can account for a large portion – a share equal to all other covariates combined – of the widening gender gap through the exposure mechanism.

Fig. 2a and b also provide evidence of the vulnerability mechanism in relation to the gender gap. From the perspective of objective 2, two things stand out in Fig. 2a. First, stress has a stronger effect for girls, as is evident from the fact that the line for girls (black, dashed line) is above that for boys (grey, dashed line) throughout the time-period. Second, there is a tendency for a larger gender difference in the effect of stress in recent years. In 1993, a one scale point higher level of stress was associated with about 0.6 scale points more symptoms for girls relative to boys, while in 2017, the corresponding effect was around one scale point. However, the change in the gender difference in the effect of stress is not statistically significant (as tested by three-way interaction terms between time, gender, and stress). In line with this, Fig. 2b shows that the polarization between the least and most stressed pupils has been slightly stronger for girls compared to boys. The difference in average symptoms between the least and most stressed girls increased from around 4.8 scale points in 1993 to 7.8 scale points in 2017, with the corresponding differences among boys being around 3.6 in 1993 and 5.5 in 2017. In sum, this suggests that the vulnerability mechanism might also be present with regard to the widening gender gap, but the non-significant three-way interaction terms preclude any strong conclusions.

We next turn to school stress itself. Fig. 4 shows average levels of stress (y-axis) for both genders combined (solid black line), as well as for girls (dashed black line) and boys (dashed grey line) separately. The trend in levels of stress is less clear-cut than the trend for psychosomatic symptoms: only in 2017 were average stress levels significantly higher than in 1993. However, the trend of a widening gender gap in stress is rather distinct: in 1993, the gender gap was around 0.1 scale points, but it had grown to 0.4 scale points in 2017, a statistically significant increase.

Fig. 4 provides some new information regarding the mechanisms through which stress affects trends in psychosomatic symptoms. From Fig. 4, we know that the effect of stress on symptoms was already stronger for girls in 1993, or, in other words, that girls were initially more vulnerable to stress. Fig. 4 reveals that the shared (for both boys and girls) exposure to stress has increased, but only (significantly) in 2017. This provides weak evidence for the gender-interaction effect, and only for 2017. Likewise, Fig. 4 shows that girls where more exposed to stress already in 1993. Since we know from Fig. 2a that the effect of stress on symptoms has increased for both girls and boys (the shared increased vulnerability), this provides evidence for the time-interaction effect. However, the initially greater exposure to, and stronger effect of, stress for girls was rather small, and neither the time-interaction nor the gender-interaction effect is likely to have contributed more than marginally to the widening gap.



Note: spikes show 95 % confidence intervals.

Fig. 4. Predicted levels of school stress, for girls and boys separately. 1993–2017.

4.2. Decomposition results

As stated, the regression analyses only provide evidence of the *presence* of the respective mechanisms, but do not allow us to quantify the contributions of each. The following subsection presents results for the decomposition analysis. Results are presented in tables since the focus is now on the contribution of each explanatory variable.

We begin with the overall time trend (objective 1), in Table 1. The results are presented on the psychosomatic symptoms scale metric, that is, how much of the change in absolute values of the dependent variable that can be accounted for by each explanatory variable. The top rows show that average symptom levels increased by around 2.5 scale points between 1993 and 2017. The decomposition shows that, of these, slightly more than 0.5 can be accounted for by stress. Specifically, the positive value of 0.49 indicates the contribution through the exposure mechanism, and means that the higher levels of stress in 2017 account for 0.49 scale points of the total increase in symptoms compared to 1993. Likewise, the value 0.08 indicates the contribution through the vulnerability mechanism, and means that the stronger effect of stress in 2017 accounts for 0.08 scale points of the increase in symptoms. Of the remaining variables, none contributed notably to the increase in symptoms, and communication with parents and drinking behaviours have actually counteracted the trend (as indicated by the negative coefficients). Overall, however, the bulk of the increase in symptoms remains unexplained, and the minor contributions of most variables go in different directions.

Table 2 presents results for the gender gap. The top rows show that the gap in symptoms almost doubled over the period, from 1.9 scale points in 1993 to 3.6 in 2017. The bottom rows show the decompositions of these two gaps. Positive coefficients contribute to greater, and

Table 1
Decomposition of the overall time trend in psychosomatic symptoms.

Average level of symptoms 1993	9.25		
Average level of symptoms 2017	11.74		
Change 2017–1993	2.49		
Decomposition of the change 2017–1993	**Exposure-mechanism**	**Vulnerability-mechanism**	**Total**
Stress	0.49	0.08	0.57
Communication with parents	−0.23	−0.04	−0.27
Body image	−0.08	−0.00	−0.08
Accepted by students	0.05	0.03	0.08
Bullied	0.04	0.00	0.04
Binge drinking	−0.21	−0.04	−0.25
Physical activity	0.00	0.01	0.01
Parental employment	−0.04	0.02	−0.02
Household consumption	0.03	−0.01	0.02
Age	−0.02	0.01	−0.01
Total	0.03	0.05	0.09
Intercept effect (unexplained)	2.41		
N (total)	6489		

Note: The exposure-mechanism corresponds to what in decomposition analysis is typically referred to as the endowment effect, while the vulnerability-mechanism corresponds to the coefficient effect. Due to rounding, the numbers may not add up precisely.
Data from the Health Behaviors of Schools-aged Children (HBSC) survey, 1993 and 2017.

negative to smaller, gaps. Thus, the results for stress means that in 1993, stress accounted for 0.18 scale points of the gap, while in 2017, the corresponding number was around 1 scale point (through both mechanisms combined). Most of the growth of the importance of stress was through the exposure mechanism, which grew from 0.17 in 1993 to 0.90 in 2017.

Note that in Table 2, the exposure mechanism subsumes both the “pure” exposure mechanism (the greater increase in stress for girls) and the time-interaction effect (the shared stronger effect of stress for both genders, combined with an initially greater exposure for girls in 1993). The vulnerability mechanism subsumes both the “pure” vulnerability mechanism (the greater increase in the effect of stress for girls) and the gender-interaction effect (the shared increased exposure to stress for both genders, combined with an initially stronger effect for girls in 1993). Since the effect of stress has only become marginally, and not significantly, stronger for girls compared to boys (“pure” vulnerability mechanism; Fig. 4), and since the shared increase in stress has been smaller than the widening of the gender gap in stress (gender-interaction effect; Fig. 4), the vulnerability mechanism is less prominent.

The contributions of most other variables to the gap were minor in both years, and none grew substantially over time. While the contributions of stress, communication with parents, and body image, were roughly equal in 1993, stress had surpassed the others in importance by 2017, by far. The rightmost column shows the contributions of each variable to the *increase* in the gender gap. As is evident, only stress has made a noticeable contribution, accounting for around half (0.84/1.70 = 0.49, or 49%) of the increase. Accordingly, when the decomposition analysis of the change between 1993 and 2017 (corresponding to the results in Table 1) is performed on girls and boys separately, the results (not shown) demonstrate that stress can account for a rather substantial share (29%) of the increase in symptoms for girls, but only a minor share (7%) of the corresponding increase for boys.

4.3. Supplementary and sensitivity analyses

Previous studies among Swedish adolescents indicate that the growth in symptoms has been strongest among older adolescents (Hagquist, 2010; Hagquist et al., 2019). We have therefore re-estimated the decomposition analyses using only the grade 9 sample (aged 15–16 years). A comparison of the results for the grade 9 pupils with the results for the full sample showed that a greater share of the overall increase in symptoms was accounted for by stress. Furthermore, a larger share of the gender gaps in the respective years (1993 and 2017), but a lesser share of the *widening* of the gender gap over time, was accounted for by stress for the grade 9 pupils. This was mainly because, already in

Table 2
Decomposition of the gender gap in psychosomatic symptoms.

Year	**1993**			**2017**			**Difference in gender gap 2017–1993**
Average level of symptoms - Boys	8.29			9.90			
Average level of symptoms - Girls	10.19			13.50			
Gender gap: Girls - boys	1.90			3.60			1.70
Decomposition of gender gap	**Exposure-mechanism**	**Vulnerability-mechanism**	**Total**	**Exposure-mechanism**	**Vulnerability-mechanism**	**Total**	
Stress	0.17	0.00	0.17	0.90	0.11	1.01	0.84
Communication with parents	0.16	0.01	0.16	0.44	−0.09	0.35	0.19
Body image	0.21	0.02	0.22	0.18	−0.01	0.17	−0.05
Accepted by students	−0.01	0.02	0.01	0.16	−0.03	0.13	0.12
Bullied	−0.04	−0.01	−0.05	0.02	0.04	0.06	0.11
Binge drinking	−0.06	0.00	−0.06	0.02	0.04	0.06	0.12
Physical activity	−0.12	0.01	−0.11	0.03	0.01	0.04	0.15
Parental employment	−0.00	0.01	0.01	−0.00	0.03	0.03	0.02
Household consumption	0.00	−0.01	−0.01	−0.01	0.01	0.00	0.01
Age	0.00	0.00	0.00	−0.00	0.12	0.12	0.12
Total	0.29	0.05	0.35	1.73	0.23	1.96	1.62
Intercept effect (unexplained)	1.55			1.64			
N	3138			3328			

Note: The exposure-mechanism corresponds to what in decomposition analysis is typically referred to as the endowment effect, while the vulnerability-mechanism corresponds to the coefficient effect. Due to rounding, the numbers may not add up precisely.
Data from the Health Behaviors of Schools-aged Children (HBSC) survey, 1993 and 2017.

1993, stress accounted for more of the gap for the grade 9 pupils (Tables S5–S6 in the online appendix).

As stated in the methods-section, a two-factor construct, distinguishing between psychological and somatic symptoms, fitted the data better than the one-factor construct used in the main analyses. When we re-estimated the decomposition models separately for the two subconstructs, results showed that the overall increase in symptoms was larger for psychological symptoms, but the share of the increase accounted for by stress was very similar. Similarly, the increase in the gender gap was larger for psychological symptoms, but the share of the increased gap that could be explained by stress was larger for somatic symptoms (results not shown). Future studies are needed to disentangle the differential trends for psychological and somatic symptoms.

We have moreover performed additional analyses to probe how sensitive the reported results are to the properties of the psychosomatic symptoms scale, and to different model specifications. First, to deal with potential problems with the symptoms scale, we have analysed this using Rasch Measurement Theory (Hagquist, 2019; Hagquist et al., 2019). The Rasch analysis showed evidence of Differential Item Functioning (DIF), in particular for the items stomach-ache and feeling low across genders. Therefore the DIF for these two items was resolved by splitting them into gender specific items. The problem with disordered thresholds was addressed by collapsing two pairs of response categories ('About every day'& 'More than once a week' and 'About once a week' & 'About once a month'), which reduced the number of response categories to three for all items. Using a variable of logit values generated by this Rasch analysis as the outcome, the results of the regression models were qualitatively similar, although the contribution of the vulnerability mechanism to the widening gender gap was reduced (Figs. S1–S4 and Tables S7–S8 in the online appendix).

Second, we have re-estimated the decomposition models, but using 2013 as year of comparison instead of 2017. The contribution of stress with 2017 as comparison year was smaller than with 2013 as comparison year, and the more minor contributions of the other covariates were largely in the opposite direction (i.e. counteracting the trend). The contribution of stress to the widening gender gap was also smaller, but remained substantial and far larger than the contribution of any other variable (Tables S9–S10 in the online appendix).

5. Discussion

Motivated by the educational stressors hypothesis, this study had two objectives: To investigate the role of school stress in the overall trend (objective 1), as well as in the gender gap (objective 2), in psychosomatic symptoms among Swedish adolescents from 1993 to 2017. In line with previous Swedish research (van Geelen; Hagquist, 2016), the analysis showed a marked increase in symptoms, especially since 2009, as well as a growing gender gap in symptoms. As regards objective 1, two results stand out. First, while the exposure to stress has only increased in the most recent years, the effect of stress on symptoms has become clearly stronger over time. Stress has, in that sense, contributed to a polarization in symptoms, with almost no increase in symptoms for the less stressed adolescents, but a marked increase for the more stressed ones. However, and second, the decomposition analysis showed that neither the greater exposure to, nor the stronger effect of, stress can explain more than a minor share of the overall increase in symptoms. In sum, we found weak evidence for the educational stressors hypothesis in relation to the overall trend in symptoms.

As regards objective 2, two results should be highlighted. First, the gender gap in school stress has widened in tandem with the corresponding gap in psychosomatic symptoms (contributing to the exposure mechanism), and the effect of stress on symptoms is stronger, and possibly increasingly so, for girls (contributing to the vulnerability-mechanism). Second, the decomposition analysis showed that these mechanisms together can explain about half of the growth of the gender gap in symptoms since 1993. In sum, we found strong evidence for the educational stressors hypothesis in relation to the widening gender gap.

With regard to objective 1, the analysis showed that most of the increase in overall psychosomatic symptoms cannot be accounted for by any measured characteristic. Thus, none of the factors typically mentioned in discussions about troubling adolescent health trends – poor parent-child relationships, worries about appearance, economic distress – can explain the increase in symptoms in Sweden. This might reflect that the measurement of the explanatory variables was not ideal, or that potentially important factors were not included as explanatory variables due to lack of data.

However, the failure to explain the overall trend also raises the question of whether the trends in self-reported symptoms reflect trends in the actual symptom burden, and not merely changes in reporting behaviour. International reviews of the field have concluded that the growth of psychosomatic symptoms is probably not primarily driven by changes in reporting behaviour, although firm conclusions are not possible (Bor et al., 2014; Collishaw, 2015; Jorm et al., 2017; see also Calling et al., 2017). For instance, the increase in symptoms has been accompanied by a concomitant increase in diagnosed psychiatric disorders (Collishaw, 2015), also in Sweden (National Board of Health and Welfare, 2017, 2019). Moreover, van Geelen & Hagquist (2016), in a Swedish study, found that the trends in psychosomatic symptoms and functional impairment were largely congruent, and that symptoms were strongly correlated with impairment at the individual level.

Although an explanation for the trend in school stress itself is beyond the scope of this study, the rise in stress coincides with a major school reform implemented in 2011/2012. The reform aimed to strengthen the focus on goal-attainment and grading, and implied an increased use of summative assessments and standardized testing. A recent study suggests that this led to more stress, and mental health problems, among, especially, girls (Högberg et al., 2019). Such negative consequences would be consistent with the educational stressors hypothesis and its emphasis on stressors related to the school environment. Furthermore, from the perspective of the educational stressors hypothesis, additional societal factors, not directly tied to institutional features of the education system, might also contribute to stress. For instance, in modern knowledge societies, success in the labour market is increasingly dependent on educational credentials, thus making school performance more important for the overall life chances of individuals.

Moreover, different societal changes may affect the mental health trends at different time periods. For example, Kim and Hagquist (2018) found that worries about family finances significantly explained increasing rates of adolescents' psychosomatic problems during the 1990's recession in Sweden.

5.1. Limitations

Studies of trends in adolescent health need to consider several issues related to the data and methodology (Collishaw, 2015; von Soest; Wichstrøm, 2014). Collishaw (2015) lists eight criteria that can be used to evaluate time trend studies, and the conclusions drawn from them. (1) The sampling of cohorts should be representative, and not change over time. This is satisfied by the use of HBSC data, in which the sample frame includes all Swedish pupils in the relevant age range. (2) Response rates should not change over time. This is not fully satisfied, since response rates have shown a slightly declining trend, especially in 2017 (see below). (3) Health measurements should be equivalent over time. This is largely satisfied since equivalent questions were asked in all surveys, although we cannot rule out that the meaning of the questions might have changed. (4) Multiple data sources should indicate similar results. This is partly satisfied, since other data sources show similar trends with regard to school stress (National Agency for Education, 2019), as well as diagnosed depression and anxiety disorders (National Board of Health and Welfare, 2019). However, it would be desirable to have additional health measures that are not based on self-reports from adolescents themselves, such as reports from parents or other third parties. (5) Data should include information on functional impairments. This is not satisfied, since HBSC largely lacks such data. (6) Health should be measured contemporaneously and not retrospectively. This is satisfied by HBSC data, which asks about symptoms during the last six months. (7) Data on explanatory risk factors should be equivalent over time. This is satisfied, since we only include covariates where the same question was asked in the different surveys. However, it should be acknowledged that the focal independent variable in this study, school stress, is a rather crude summary measure, and that a more comprehensive set of measures would give a more nuanced understanding of the role of educational stressors. Such measures are only available in the later survey rounds. (8) Data should be longitudinal at the individual level. This is not satisfied, as HBSC is a cross-sectional survey.

The non-response rate at the school-level increased in the last survey, in 2017, which raises questions about potential non-response bias. Unfortunately, the identities of the non-participating schools are not known, and an analysis of their characteristics is not possible. However, there are reasons to believe that the non-response is not a substantial source of bias. First, previous analyses have not found any systematic differences between participating and non-participating schools, with regard to reasons for non-participation, geographical location, or public or private management (a strong proxy for socioeconomic composition) (Public Health Agency of Sweden, 2018). Secondly, the 2017 results, in terms of the levels of symptoms and stress, are basically a linear continuation of the trend between 2009 and 2013, and there is no indication of a "kink" in the trends between 2013 and 2017 (Figs. 1 and 4). Third, the trends in school stress reported here are consistent with those reported in a similar repeated survey conducted by the Swedish National Agency for Education (2019). Also, the trends, including trends in the gender gap, in psychosomatic symptoms are also similar to trends for youth, aged 16–29, reported in a survey by the government Agency for Youth and Civil Society (2019). Fourth, the increase in symptoms between 2013 and 2017 mirrors the trend in diagnosed depression and anxiety disorders (based on administrative population registers) in this age group for the same period (National Board of Health and Welfare, 2019).

In addition to those limitations already mentioned, one major limitation is the cross-sectional and observational data at the individual level. Decomposition analysis in itself only accounts for differences across groups in a statistical sense, but in order for the decomposition results to have a causal interpretation, the explanatory variables must have causal effects. This is difficult to ensure with cross-sectional and observational data. Moreover, we did not have data on several potential explanatory variables, such as electronic media usage, which has increased dramatically among adolescents over the past few decades, or parental divorce and changes in household composition (cf. Collishaw, 2015). Official statistics show that divorce rates in Sweden have fluctuated over time, but with an overall increase from the late 1980s, reaching a peak in 2013. However, the share of parents with joint physical custody of their children has increased dramatically during the period, thus reducing the number of children in vulnerable single-parent households (Fransson et al., 2018). The strong increase in school stress and psychosomatic symptoms after 2013 also coincided with a decline in divorce rates.

One must also consider that the baseline year of investigation (1993) coincided with the peak of the 1990's recession in Sweden. In sum, the empirical results should be interpreted with the above discussed caveats in mind. While the data are arguably among the more suitable that are available for this type of analysis in Sweden, they also exhibit several limitations.

5.2. Implications and concluding remarks

The overall conclusion of this study is that educational stressors, specifically stress related to schoolwork, have become more prevalent among Swedish adolescents, and simultaneously more harmful for their psychosomatic health, especially for girls. This has made a modest contribution to the overall increased prevalence of psychosomatic symptoms, but it has made a significant contribution to the increase among girls, thereby having a substantial contribution to the widening gender gap in symptoms.

The implication of this should be that policymakers pay careful attention to potential negative health effects of education policies, especially those that are likely to generate stress. Insofar as academically successful education policies do have negative health consequences, policymakers must find ways to counter these through compensatory measures, which would in turn have implications for school-based health work, and bring the importance of school nurses, school social workers, and counsellors to the foreground.

Author contributions

BH developed the research idea and the overall design of the study. BH wrote most of the manuscript, with CH and MS providing comments and revisions. BH conducted most of the data analysis. CH conducted the Rasch analysis and wrote the sections concerning the Rasch analysis. BH, CH, and MS together discussed and worked on the drafts as well as the revision.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2020.112890.

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