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Article

Is the effect of ill health on school achievement among Swedish adolescents gendered?

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ABSTRACT

This study investigates why the relationship between health problems requiring hospitalization between the ages of 13 and 16 and school achievement (school grades in 9th grade) in Sweden was stronger for girls than for boys. We reviewed previous research on gender differences in subjective health, health care utilization and medical drug treatment to identify mechanisms responsible for this gendered effect. The relationship was analysed using retrospective observational data from several national full-population registers of individuals born in 1990 in Sweden ($n = 115\,196$), and ordinary least squares techniques were used to test hypotheses. We found that girls had longer stays when hospitalized, which mediated 15% of the interaction effect. Variability in drug treatment between boys and girls did not explain the gendered effect of hospitalization. The main mediator of the gendered effect was instead differences in diagnoses between boys and girls. Girls' hospitalizations were more commonly related to mental and behavioural diagnoses, which have particularly detrimental effects on school achievement.

1. Background

Gender differences have attracted considerable attention in the literature on school achievement and schoolchildren's health. Large-scale cross-national surveys have demonstrated gender inequality in schoolchildren's subjective health; low subjective health has long been more prevalent among girls than among boys in most industrialized countries (Torsheim et al., 2006), including Sweden (Hagquist, 2009). It is similarly well established that girls tend to obtain higher grades than boys in school, although the magnitude of this effect seems to vary (Else-Quest, Linn, & Hyde, 2010; Lindberg, Hyde, Petersen, & Linn, 2010; Voyer & Voyer, 2014).

Gender differences in health and school achievement among schoolchildren have generally been studied separately. Many studies have shown that ill health in childhood and adolescence is negatively related to school achievement (Basch, 2011; Champaloux & Young, 2015; Forrest, Bevans, Riley, Crespo, & Louis, 2011; Maslow, Haydon, McRee, Ford, & Halpern, 2011; Quach, Nguyen, O'Connor, & Wake, 2017; Suhrcke & de Paz Nieves, 2011). However, few studies have formally tested the interaction between ill health and gender, and its effects on school achievement. In addition, much of what is known about school-aged children's health derives from cross-sectional self-reported survey data (e.g. Inchley et al., 2016). Subjective data of this

kind relates primarily to mental wellbeing and psychosomatic symptoms. Conversely, this paper uses data from national full-population registers that includes information on a wide range of diseases and health-related problems classified according to the International Classification of Diseases (ICD) nosology.

In contrast to health indicators commonly used in survey-based wellbeing research (life satisfaction, general health perception and recurrent health complaints), we previously reported a population-based cohort study using a different indicator based on individual-level microdata from Swedish national registers (Bortes, Strandh, & Nilsson, 2018). Specifically, we used medical data from the Swedish National Patient Register (NPR) and hospitalizations as a measure of health problems. The use of hospitalizations is advantageous because (1) it includes many different health conditions and serves as a summarizing measure of health problems in the study population while simultaneously identifying serious health problems; and thus (2), as discussed by Ravens-Sieberer et al. (2009, p. 157), it makes it possible to "separate typical adolescents' discomfort with growing up from increased risk of serious health problems". Our previous study showed that gender was a moderator of hospitalizations' effect on school achievement in terms of overall grade points. In the Swedish cohort of children born in 1990 ($n = 115\,196$), girls with health problems that necessitated hospitalization exhibited poorer school achievement than boys

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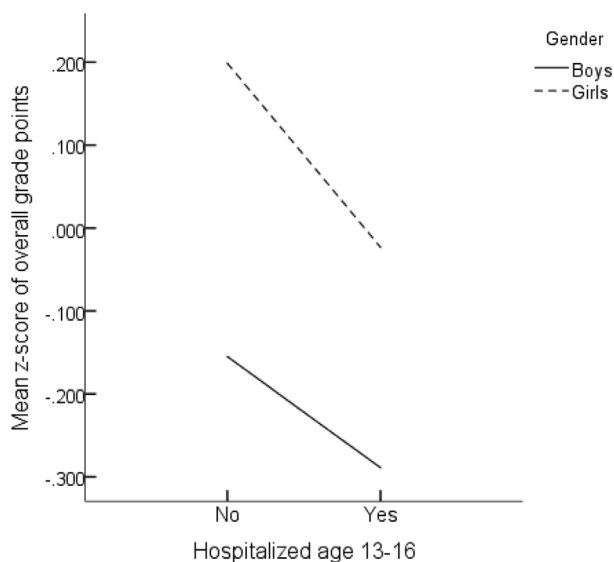


Fig. 1. The effect of the hospitalization-gender interaction on overall grade points.

who were hospitalized, especially among 13- to 16-year-olds (see Fig. 1).

The main aim of this paper is to investigate factors that could explain this gendered effect. Three such factors suggested by previous studies are considered. The first is the role of differences in diagnoses at hospital admission between boys and girls. The diagnosis specifies the reason for hospitalization and the effect of the disease itself. Mental health-related problems are the leading health burden for adolescents in high income countries, with females being overrepresented among sufferers (Collishaw, 2015; Whiteford, Ferrari, Degenhardt, Feigin, & Vos, 2015). We therefore anticipated that mental health-related diagnoses could be key to explaining this gendered effect. However, it is important not to neglect other health problems that may affect schooling. We therefore also consider the relationships between other disease types and school grades.

The second factor is differences in length of hospitalization between boys and girls. Longer hospitalizations (i.e. spending more days in hospital) would be expected to both reduce school attendance and indicate greater severity of disease. The third factor is differences in drug prescription, which could be associated with differences in the severity of both side effects and health problems.

Because previous studies indicate that mental health has important effects on school achievement, a secondary aim of this paper is to determine whether hospitalization due to mental and behavioural disorders have different effects on the school grades of boys and girls.

1.1. Previous research

We focus on three fields of research that could shed light on our finding that hospitalization affects girls' school grades more strongly than those of boys. We initially consider the existing literature on gender differences in self-rated subjective health, which is predominantly used to study schoolchildren's health. We then consider the measure of health problems used in this paper (i.e. hospitalizations). Because the NPR is a health care register rather than a register of all diseases, it was necessary to account for gender differences in health care utilization during this stage. Finally, we consider drug treatment and gender differences in drug prescriptions. Reviewing previous research in these areas enabled us to identify potential mechanisms for this gendered effect and develop testable hypotheses.

1.1.1. Self-rated subjective health

There are systematic gender differences in self-rated subjective health, which can be conceptualised as mental wellbeing and psychosomatic symptoms (Inchley et al., 2016). Compared to boys, girls report lower subjective health and multiple complaints such as headache, stomach ache and nervousness – symptoms associated with harassment, perceived stress, and recurrent pain (Alfvén et al., 2008). In the school context, worries about school work and feelings that school is too demanding are associated with self-reported symptoms, as demonstrated by both Swedish and international cross-sectional (Hjern, Alfvén, & Östberg, 2008; Murberg & Bru, 2004; Natvig, Albrektsen, Andersen, & Qvarnström, 1999; Takakura, Wake, & Kobayashi, 2005; Torsheim, Aaroe, & Wold, 2001) and longitudinal studies (Gådin & Hammarström, 2003). Girls' lower self-rated subjective health seems to be related to the fact that as a group they experience higher demands and stress in relation to school (Eriksson & Sellström, 2010; Giota & Gustafsson, 2016; Plenty, Östberg, Almquist, Augustine, & Modin, 2014; West & Sweeting, 2003; Östberg et al., 2015). While the severity of reported psychosomatic symptoms has increased over time in Sweden, this increase cannot be explained solely by changes in perceived school demands (Nygren & Hagquist, 2017). Other proposed explanations for girls' high levels of self-rated ill health suggest that perceived societal expectations of femininity and masculinity may increase willingness to report symptoms among girls while reducing it among boys, and that this effect may be especially pronounced for psychological symptoms (see e.g. Danielsson & Johansson, 2009; Maclean, Sweeting, & Hunt, 2010). Another plausible explanation that is consistent with the notion of gender socialization suggests potential gender bias in the measures of self-rated health. As noted by Inchley et al. (2016, p. 223–24), questions on self-reported health surveys often focus on reactions indicating stress that may be 'female-specific' (internalizing reactions such as headaches, stomach ache, and nervousness) and neglect aggression-based (externalizing) reactions that are more common among boys (Ruiz-Cantero et al., 2007).

Regardless of the explanatory model for this gender gap in symptom reporting, girls aged 11–15 appear to have higher levels of mental distress and stress-related symptoms than boys of the same age. It may thus be that girls are more frequently diagnosed with mental health issues when hospitalized. Since evidence suggests that mental health problems have particularly strong adverse effects on learning and school outcomes (Goodsell et al., 2017; Gustafsson et al., 2010) and that mental distress is more prevalent among girls than boys, this may partly explain the gendered effect considered here.

1.1.2. Health care utilization

Studies in high- and middle-income countries have found that women consume more health care resources than men, especially in primary care (Bertakis, Azari, Helms, Callahan, & Robbins, 2000; Carrière, 2005; Cylus, Hartman, Washington, Andrews, & Catlin, 2011; Fan et al., 2013; Kapur et al., 2005; Mackenzie, Gekoski, & Knox, 2006; Nabalamba & Millar, 2007; Pevalin, 2007; Thompson et al., 2016; Vaidya, Partha, & Karmakar, 2002; Wang, Hunt, Nazareth, Freemantle, & Petersen, 2013). However, women's overrepresentation is largely due to reproduction-related visits and childbirth, whereas men are more reluctant than women to seek care (especially mental health care), largely because of cultural norms relating to masculinity (Galdas, Cheater, & Marshall, 2005; Seidler, Dawes, Rice, Oliffe, & Dhillon, 2016). There is thus arguably a degree of inherent gender bias in medical data on hospitalizations. A recent Swedish study on sex differences in health care consumption addressed this issue by adjusting for the effects of reproductive and sex-specific morbidity (Osika Friberg, Krantz, Määttä, & Järbrink, 2016). Using a large study sample representative of the general population (including children), this work showed that the total cost for healthcare per capita was 20% higher for women than for men. After adjusting for reproductive and sex-specific morbidity, the difference in cost fell to 8%. The remaining cost

difference was explained by costs due to mental and behavioural disorders and diseases of the musculoskeletal system in women. These studies examined adult populations but other studies suggest that the 'ecology' of children's medical care resembles that of adults (Dovey et al., 2003; Ishida et al., 2012).

Based on these reports, we expect girls to be overrepresented in the Swedish NPR, in terms of both number of days spent in hospital and diagnoses within the ICD categories 'mental and behavioural disorders' and 'diseases in the musculoskeletal system'. If girls stay longer in hospital when hospitalized, this may indicate that (i) their symptoms tend to be more serious than boys', and (ii) they are more likely to be absent from school. Both factors could adversely affect school achievement.

1.1.3. Drug prescriptions

Because health care utilization and drug prescription are closely related, they exhibit similar gender differences. Thus, women are generally prescribed more drugs than men (Anthony et al., 2008; Fernandez-Liz et al., 2008; Hofer-Dückelmann, 2012). This difference was shown to persist in Swedish population studies after adjusting for multi-morbidity (Thorell, Skoog, Zielinski, Borgquist, & Halling, 2012) and sex-related morbidity (Skoog, Midlöv, Borgquist, Sundquist, & Halling, 2014). In line with these results, an analysis of data on all drugs dispensed to the entire Swedish population in 2010 (Loikas, Wettermark, von Euler, Bergman, & Schneck-Gustafsson, 2013) found while many sex differences are explained by sex differences in morbidity or biology, other differences were "hard to explain on medical grounds and may indicate unequal treatment" (2013, p. 1). If health-care professionals prescribe more drugs to girls than to boys, this could have two implications that could relate to school achievement. First, more frequent prescriptions for girls could reflect a greater severity of symptoms and disease among girls, which could be related to a differential impact of hospitalization. Second, it may be that girls and boys with the same diseases are treated differently. Greater use of healthcare services and medication for health problems should reduce the risk of school under-achievement. However, girls as a group may receive unsuitable medical treatment resulting in overuse of medication (especially psychotropic drugs) whose side-effects negatively affect day-to-day functioning. This would be expected to adversely affect schooling (see e.g. Kubiszyn, Mire, Dutt, Papathopoulos, & Burridge, 2012). Consequently, gender differences in drug treatment may explain why the negative effects of ill health on school achievement are stronger among girls than among boys.

1.2. Hypotheses

This study tests four hypotheses based on the considerations outlined above. The **first Hypothesis** is that hospitalized girls spend longer in hospital than hospitalized boys, resulting in longer absences from school and thus greater reductions in school achievement. It is well established that school attendance strongly affects educational outcomes: attendance is required for teachers to be able to assess students' work and also stimulates student-teacher bonding, which benefits schooling (see e.g. Bond et al., 2007; Hancock, Shepherd, Lawrence, & Zubrick, 2013). Additionally, longer hospitalizations are likely to be associated with more serious symptoms, and more severe adverse effects on school achievement, thus:

Hypothesis 1. The gendered effect of hospitalization on overall grade points will be explained by *total length of stay*.

The **second Hypothesis** is based on the possibility that differences in the prescription of drugs to boys and girls could explain the effect of hospitalization \times gender on school grades. Higher levels of drug prescription among girls may indicate more severe problems. Possible cognitive side effects of drugs (particularly psychotropic agents) such as drowsiness might also impede school performance (Kubiszyn et al.,

2012). Based on previous research indicating that women/girls are prescribed more drugs than men/boys we hypothesize that:

Hypothesis 2. The gendered effect of hospitalization on overall grade points will be explained by *drug prescription*.

Third, responses to self-rated questions about feelings of nervousness and anxiety are associated with hospital admissions, premature mortality, and (especially psychiatric) morbidity in Sweden (Ringbäck Weitoft & Rosén, 2005). In a study based on Danish data, Nielsen (2013) compared self-reported health data to records of hospital admissions and mortality, revealing that self-reported health correlated with previous, current and future hospitalizations. Given that self-rated health surveys repeatedly show an excess of psychological distress symptoms among girls, it is therefore reasonable to assume that the girls in our cohort are overrepresented in the ICD category of 'mental and behavioural disorders'. Furthermore, we presume that the category '*mental and behavioural disorders*' includes the types of health problems with the most debilitating effects on school outcomes. Because girls are more prevalent in this category, we hypothesize that:

Hypothesis 3a. The gendered effect of hospitalization on overall grade points will be explained by the ICD category *mental and behavioural disorders*.

Finally, we considered the possibility that boys and girls may be affected differently by mental and behavioural disorders during their schooling and hypothesize that:

Hypothesis 3b. There will be an interaction effect between *mental and behavioural disorders* and gender such that mental and behavioural disorders are more strongly associated with lower overall grade points for girls than boys.

2. Method and materials

2.1. Data and sample

We tested our hypotheses using retrospective observational data from several national total-population registers accessed via the Umeå SIMSAM Lab data infrastructure (Lindgren, Nilsson, de Luna, & Ivarsson, 2016). The overall data include micro-level information from multiple national database sources. Individuals are linked between registers by means of unique, anonymized, personal ID numbers. Information on grades was obtained from the Swedish National Agency of Education's Pupil Register. Information on hospitalizations, length of stay during medical care events, and primary diagnosis during these events was obtained from the National Patient Register (NPR), whose use has previously been validated (Grönhagen, Nilzén, Seifert, & Throslund, 2017; Ludvigsson et al., 2011). Information on drug prescriptions was obtained from the Prescribed Drug Register (PDR), which records all prescribed drugs according to the Anatomic Therapeutic Chemical classification (ATC code) dispensed at pharmacies all around Sweden. The PDR has had national coverage since 2005, when our study cohort was in the 8th grade of compulsory school. For a review of the use of the PDR in research, see Wallerstedt, Wettermark, and Hoffman (2016). We also used information on birth health status, which was obtained from the Swedish Medical Birth Register (MBR). For details of the content, quality, and uses of the MBR, see Källén and Källén (2003), Axelsson (2003), and Odland, Haglund, Pakkanen, and Otterblad Olausson (2003).

We analysed a dataset comprising $n = 115\,196$ individuals born in 1990 in Sweden. This cohort included 56 471 individuals who had been hospitalized at some point before the age of 17: 30 913 (54.7%) boys and 25 559 (45.2%) girls. We specifically focused on the 11 847 individuals (10.3% of the original dataset) who had suffered health problems requiring hospitalization during junior high school (between the ages of 13 and 16). Data on the dependent variable *overall grade points* were unavailable for 3229 individuals (2.8% of the study

population) who received schooling in a special education facility or dropped out of school before ninth grade. The corresponding observations were excluded (automatically, by the software) from the regression models. Approval to use data from the Umeå SIMSAM Lab was granted by the Regional Ethical Vetting Board in Umeå.

2.2. Dependent variable

School achievement was quantified in terms of *overall grade points*, which has been successfully used in research as a measure of school achievement in a Swedish context (Namatovu, Strandh, Ivarsson, & Nilsson, 2018). Data on this variable were obtained from the National Agency of Education's Pupil Register. An individual's overall grade point score is the sum of their 16 best subject grades in the 9th and final grade of compulsory school, which is determined at age 15–16. Grades for individual subjects range from 0 to 20 (with 0 indicating failure and 20 being the best possible performance), so the overall grade point score for 16 subjects ranges from 0 to 320. Overall grade points is a continuous variable with an approximately normal distribution ($M = 205.6$, $SD = 64.6$). The dependent variable was standardized and converted into z-scores to facilitate interpretation of effect sizes.

2.3. Independent variables

Since this study's aim was to investigate the effect of the hospitalization \times gender interaction on overall grade points, we classified hospitalizations on the basis of (a) length of stay (in days) during a medical care event, and (b) primary diagnosis during the medical care event. The variable *hospitalization at age 13–16* was used to indicate whether an individual had undergone at least one overnight stay in hospital during this age range (no/yes). Data on this variable were obtained from the NPR, which contains information on diagnoses and dates of admission and discharge for all in-hospital care events. Data on hospital admissions and discharges have been used in conjunction with information on diagnoses in several different fields of research (e.g. Björk & Bråbäck, 2003; Eliason & Storrie, 2009; Khashan et al., 2012).

To examine differences in total length of stay (in days) in hospital each year from birth until the age of 16, we performed an independent *t*-test and obtained descriptive statistics. This revealed a consistent pattern that began in the year 2003 (ages 12–13), with the mean value for girls significantly exceeding that for boys (Appendix, Table A). This gap persisted, becoming larger year by year during junior high school (between the years 2004 and 2006) as the cohort aged from 13 to 16. Put differently, beginning in their early teens, girls spent more days in hospital than boys on average, suggesting longer absences from school due to hospitalization. Our subsequent analyses therefore focused exclusively on this age range. Another reason for focusing on this age range is that we previously identified the junior high school years as a critical period in terms of health problems and their effects on compulsory school grades.

At this point, we had: defined an age range (13–16) in which differences in length of stay (Hypothesis 1) during medical care events were consistent and significant; obtained drug prescription data (Hypothesis 2) from the PDR and coded/operationalized it in terms of having received a drug prescription (no/yes) during the years 2005 (8th grade) or 2006 (9th grade), and identified primary diagnoses (hypotheses 3a–3b) received upon hospitalization. Table 1 presents descriptive statistics for key variables.

2.4. Control variables

Research on childhood health has repeatedly demonstrated links between poor birth health status (often operationalized as low birth weight) and poor later life outcomes, including educational achievement (Bhutta, Cleves, Casey, & Anand, 2002; Stjernqvist & Svaningsson, 1999; Torche and Echevarria, 2011). To control for selection into poor

health from birth, we considered several variables obtained from the MBR. These included measures of whether the child was *small for gestational age* (no/yes) or *large for gestational age* (no/yes), *malformed* (no/yes), and the child's *apgar score 5 min after birth*. The apgar score measures a new-born's physical condition 5 min after birth (normal/low); scores below 7 are considered low, while those between 7 and 10 are considered normal (Stuart, Otterblad Olausson, & Källén, 2011). We also included the *mother's smoking habits* upon admission to maternity care; the categories for this variable were non-smoker (reference), 1–9 cigarettes/day, and 10–19 cigarettes/day. These data were obtained from the MBR and are indicative of the in-utero environment, which affects foetal health. However, because tobacco use follows a social gradient, this should primarily be seen as a reflection of social position (Osler, Holstein, Avlund, & Rasmussen, 2001; Stewart et al., 1996).

We also used *parental education* as a sociodemographic variable, which was operationalized in terms of the highest level of education attained by either parent in the year the child received their final compulsory school grades (i.e. when 15–16 years old). The categories for this variable were compulsory education (reference); two years' upper secondary education; three years' upper secondary education; and two years or more of university education, including postgraduate education. Another sociodemographic variable included in the analysis was *family type*, defined by whether the biological parents were married/cohabiting when the child received their final compulsory school grades (yes/no). We examined the effects of these two sociodemographic variables at birth, at seven years of age, and at the time of receiving final compulsory school grades. Both variables' effects on the dependent variable were strongest in the latter case, so our analysis was based on the latter timepoint. Gender was operationalized as a dummy variable (0/1), using male as the reference category. The distribution of control variables is presented in Table 2.

2.5. Analysis

Due to the outcome variable's structure, ordinary least squares (OLS) regression was used for model building. Hypotheses 1, 2, and 3a were tested by determining which variables (length of stay, type of primary diagnosis, and drug prescription) reduced the effect of the hospitalization \times gender interaction term on overall grade points by fitting a series of regression models. Table 3 presents four such models. Model 1 included the birth health variables (large or small baby for gestational age, malformation, apgar score at 5 min), sociodemographic variables (parental education level and family type), the indicator variable for at least one night of hospitalization at 13–16 (no/yes), and the interaction term hospitalization \times gender age 13–16. Model 2, which was used to test Hypothesis 1, also included the *total length of stay* variable to see how it affected the interaction term's effect on the dependent variable. Model 3, which was used to test Hypothesis 2, instead included the *drug prescription* variable. To test hypothesis 3a, each *type of primary diagnoses* was added to model 1 one at a time to determine which of them had the greatest impact on the interaction term's effect. Table 3 shows the results for all diagnosis types in a single model (Appendix Tables B–P show models with the interaction coefficients for each diagnosis individually). Hypothesis 3b was tested by including the diagnostic category *mental and behavioural disorder* and its interactions with gender in a separate model, together with birth health and sociodemographic variables as controls. All analyses were performed using SPSS version 24.

3. Results

Table 3 shows the results obtained using four models. Model 1 reproduces our previous findings, showing that poor birth health status – indicated by a baby that is large ($\beta = -0.061$, $p < 0.001$) or small ($\beta = -0.059$, $p < 0.01$) for their gestational age, or malformed ($\beta = -0.036$, $p < 0.05$) – is significantly associated with lower overall

Table 1

Descriptive statistics for key variables for boys and girls hospitalized in junior high school, age 13–16.

	Boys, n (%)	Girls, n (%)	Total, n (%)
Hospitalization age 13–16	6414 (5.6)	5433 (4.7)	11 847 (10.3)
Mean number of days hospitalized (standard deviation in parentheses)	4.48 (19.0)	7.48 (38.2)	5.95 (30.0)
Primary diagnosis received when hospitalized			
Neoplasms	18 (0.0)	20 (0.0)	38 (0.3)
Certain infectious and parasitic diseases	200 (0.2)	242 (0.2)	442 (0.4)
Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism	75 (0.1)	95 (0.1)	170 (0.1)
Endocrine, nutritional and metabolic diseases	217 (0.2)	192 (0.2)	409 (0.4)
Mental and behavioural disorders	474 (0.4)	831 (0.7)	1305 (1.1)
Diseases of the nervous system	131 (0.1)	129 (0.1)	260 (0.2)
Diseases of the circulatory system	91 (0.1)	76 (0.1)	167 (0.1)
Diseases of the respiratory system	390 (0.3)	661 (0.6)	1051 (0.9)
Diseases of the digestive system	562 (0.5)	500 (0.4)	1062 (0.9)
Certain conditions originating in the perinatal period	3 (0.0)	3 (0.0)	6 (0.0)
Injury, poisoning and certain other consequences of external causes	2397 (2.1)	1547 (1.3)	3944 (3.4)
Diseases of the musculoskeletal system and connective tissue	266 (0.2)	400 (0.3)	666 (0.6)
Diseases of the skin and subcutaneous tissue	79 (0.1)	70 (0.1)	149 (0.1)
Diseases of the genitourinary system	175 (0.1)	219 (0.1)	394 (0.3)
Diseases of the musculoskeletal system and connective tissue	266 (0.2)	400 (0.3)	666 (0.6)
Congenital malformations, deformations and chromosomal abnormalities	155 (0.1)	129 (0.1)	284 (0.2)
Symptoms and signs not elsewhere classified	569 (0.5)	895 (0.8)	1464 (1.3)
Drug prescriptions ^a	28 402 (24.7)	33 601 (29.2)	62 003 (53.8)

Note: percent (%) of the total population. ^a Drugs with the ATC code “G”, for the genitourinary system and sex hormones (i.e. contraceptive pills), are excluded.

Table 2

Distribution of control variables among boys and girls hospitalized in junior high school, age 13–16.

	Boys, n (%)	Girls, n (%)	Total, n (%)
Small for gestational age	191 (0.2)	166 (0.1)	357 (0.3)
Large for gestational age	176 (0.2)	179 (0.2)	355 (0.3)
Malformed child	340 (0.3)	240 (0.2)	580 (0.5)
Low APGAR-score 5 min	88 (0.1)	46 (0.0)	134 (0.1)
Maternal smoking habits			
No smoking	4830 (4.2)	4020 (3.5)	8850 (7.7)
1–9 cigarettes/day	995 (0.9)	856 (0.7)	1851 (1.6)
≥ 10 cigarettes/day	589 (0.5)	557 (0.5)	1146 (1.0)
Parental education			
Compulsory	457 (0.4)	449 (0.4)	906 (0.8)
Two year secondary	2697 (2.3)	2346 (2.2)	5043 (4.4)
Three year secondary	908 (0.8)	702 (0.6)	1610 (1.4)
University	2328 (2.0)	1923 (1.7)	4251 (3.7)
Family type			
Married/cohabiting parents	5071 (4.4)	4117 (3.6)	9188 (8.0)
Not Married/cohabiting parents	1343 (1.2)	1316 (1.1)	2659 (2.3)

Note: percent (%) of the total population.

grade points, as is the mother smoking upon admission to maternity care ($\beta = -0.195$, $p < 0.001$). However, no such association was observed for our operationalization of the apgar score at 5 min ($\beta = -0.025$, $p = 0.436$). Having a non-traditional nuclear family when finishing compulsory school is significantly associated with lower overall grade points ($\beta = -0.255$, $p < 0.001$). Higher parental educational achievement is significantly associated with higher overall grade points. Model 1 also shows that hospitalization at age 13–16 is significantly associated with lower overall grade points after controlling for birth health status, parental level of education and family type ($\beta = -0.115$, $p < 0.001$). Further, the hospitalization \times gender interaction term indicates a significant interaction between hospitalization at ages 13 through 16 and gender ($\beta = -0.062$, $p < 0.01$). Hospitalization is associated with significantly lower overall grade points for girls than for boys.

Models 2 to 4 were used to test hypotheses 1, 2 and 3a. In these analyses, we are primarily interested in the coefficient of the interaction term. Introducing the variable *total length of stay* in model 2 reduced the interaction term's coefficient by 15%, from 0.062 to 0.053, implying that the number of days spent in hospital has some importance. However, a significant proportion of the interaction effect persisted.

Hypothesis 1 thus received minor support. Model 3 included *drug prescription*. Having been prescribed any form of medication during the 8th or 9th grades of compulsory school is significantly associated with lower overall grade points ($\beta = -0.103$, $p < 0.001$). However, *drug prescription* has a negligible effect on the interaction term's coefficient, reducing it by only 4%. No support for **Hypothesis 2** is thus found. Model 4 shows that the interaction term's coefficient is markedly reduced (by 34%) and becomes non-significant ($\beta = -0.021$, $p = 0.239$) when the types of primary diagnoses are included in the model. As noted above, we created models in which each primary diagnostic category was entered separately to see which one had the greatest explanatory value in terms of reducing the interaction term's coefficient (see [Appendix, Table P](#)). ‘Mental and behavioural disorders’ was the only diagnostic category that by itself substantially reduced the coefficient's p-value, thus strongly supporting hypothesis 3a: ‘mental and behavioural disorders’ reduced the coefficient by 39%, whereas the diagnostic categories with the second strongest effects (‘diseases of the respiratory system’ and ‘symptoms, signs and abnormal clinical laboratory findings, not elsewhere classified’) reduced it by only 11%. As expected, ‘mental and behavioural disorders’ is thus associated with significantly lower overall grade points than other diagnostic categories.

Table 4 shows the relationship between having been hospitalized due to mental and behavioural disorders during junior high school and overall grade points, and how gender moderates this relationship. The results indicate a non-significant interaction between mental and behavioural disorders and gender with respect to grade points ($\beta = -0.053$, $p = 0.336$). No support for **Hypothesis 3b** is thus found.

4. Conclusions

This study aimed to determine why health problems necessitating hospitalization had stronger negative effects on girls' school grades than those of boys in the cohort of individuals born 1990 in Sweden. Three factors based on available data and previous research on gender differences in subjective health, health care utilization, and medical drug treatment were hypothesized as explanations and tested.

Hypothesis 1 states that the length of hospitalization during medical care events (and thus the length of absence from school) might explain the gendered effect of hospitalization on school grades. This hypothesis received minor support: the stays of hospitalized girls were 3 days longer, on average, than those of hospitalized boys ([Table 1](#)).

Table 3

Multiple linear regression models showing the relationship between birth health status and sociodemographic variables, health related problems during junior high school and grade points.

	Model 1	Model 2	Model 3	Model 4
Gender (0 = Boy, 1 = Girl)	.354 (.006)***			
Small for gestational age (n/y)	-.059 (.017)**			
Large for gestational age (n/y)	-.061 (.016)***			
Malformed child (n/y)	-.036 (.015)*			
APGAR 5 min (normal/low)	.025 (.031)			
Maternal smoking habits (ref: none)	-.195 (.005)***			
Parental education (ref: compulsory)				
Two years secondary	.279 (.011)***			
Three year secondary	.592 (.012)***			
University	.891 (.011)***			
Married/cohabiting parents (y/n)	-.255 (.007)***			
Hospitalization age 13–16 (n/y)	-.115 (.012)***			
<hr/>				
Hospitalization × gender age 13–16	-.062 (.018)**	-.053 (.018)**	-.060 (.018)**	-.021 (.018)
<hr/>				
Total length of stay		-.004 (.000)***		
Drug Prescriptions (n/y)			-.103 (.005)***	
Primary diagnosis when hospitalized				
Injury, poisonings and other consequences of external causes				-.199 (.015)***
Diseases of the musculoskeletal system and connective tissue				-.009 (.036)
Diseases of the respiratory system				-.230 (.029)***
Symptoms and signs not elsewhere classified				-.210 (.025)***
Mental and behavioural disorders				-.706 (.026)***
Endocrine, nutritional and metabolic diseases				-.272 (.046)***
Certain infectious and parasitic diseases				-.161 (.044)**
Diseases of the blood and blood-forming organs and certain conditions involving the immune mechanism				.032 (.070)
Neoplasms (malignant)				.104 (.150)
Diseases of the nervous system				-.328 (.066)***
Diseases of circulatory system				-.006 (.071)
Diseases of the digestive system				-.027 (.029)
Certain conditions originating in the perinatal period				-.183 (.368)
Diseases of the skin and subcutaneous tissue				-.199 (.076)**
Diseases of the genitourinary system				-.111 (.047)*
Congenital malformations, deformations and chromosomal abnormalities				-.154 (.058)**
Constant	-.410 (.03)***	-.410 (.03)***	-.367 (.03)***	-.405 (.03)***
N	111 967	111 967	111 967	111 967
R ²	0.180	0.181	0.182	0.188

Note: Unstandardized beta-coefficients of z-scores of overall grade points, standard error in parentheses.

*p < 0.05, **p < 0.01, ***p < 0.001.

R² = adjusted R square

Models 2, 3 & 4 are adjusted for all the variables shown in model 1.

Table 4

The relationship between mental and behavioural disorders, gender and grade points.

	Model 1	Model 2
Gender (0 = Boy, 1 = Girl)	.354 (.005)***	.355 (.005)***
Mental and behavioural disorders	-.732 (.026)***	-.698 (.044)***
Mental and behavioural disorders × Gender		-.053 (.055)
Constant	-.423 (.033)***	-.423 (.033)***
N	111 967	111 967
R ²	0.183	0.183

Note: Unstandardized beta coefficients of z-scores of overall grade points, standard errors in parentheses.

***p < 0.001. R² = adjusted R square. Both models are adjusted for birth health status and sociodemographic variables.

Accounting for this reduced the strength of the interaction effect by about 15%. No support for Hypothesis 2 was found: variability in drug prescription did not explain the gendered effect of hospitalization on school grades. Conversely, hypothesis 3a was strongly supported: the gendered effect was explained by the ICD category ‘mental and behavioural disorders’. As expected, girls were significantly overrepresented

in this diagnostic category, and the associated health problems appeared to have the most debilitating effects on compulsory school grades. Finally, hypothesis 3b received no support; the adverse effect of hospitalization for mental and behavioural disorders did not differ significantly between boys and girls. This is interesting because diagnoses of mental and behavioural disorders could be strongly gendered in a way not captured by the current data. Mental health issues are usually categorized as being either internalized (anxiety, nervousness, depression, self-harm) or externalized (hyperactivity, difficulty concentrating, behavioural disorders). Girls’ symptoms tend to cluster in the former category and boys’ in the latter (Gustafsson et al., 2010). The results presented here suggest that both problem types have comparable adverse effects on school achievement. In conclusion, the main explanation of the gendered effect of ill health on school grades is that girls in this age group are more likely to suffer from mental and behavioural disorders requiring hospitalization than boys, and that health problems of this class have particularly strong adverse effects on school achievement.

Our study has some limitations. Hospitalization as a measure “captures” individuals whose ill health necessitates in-hospital care, and is thus an indicator of severe health-related problems. However, the cohort may include individuals (both boys and girls) who suffered from mental illness or other disabilities/impairments but did not receive care involving hospitalization. Our results identify gender differences in

primary diagnoses as the main explanation for the gendered effect of hospitalization on school grades. However, primary diagnosis is a wide category, and we have not obtained information on the specificity of underlying health issues/disorders. The greatest strength of this study is the high-quality datasets on which it is based and the large sample it examines. Access to the MBR enabled us to control for health selection that might occur at birth. The Umeå SIMSAM Lab houses exceptional medical and social microdata, enabling interdisciplinary research on childhood and its relationship with lifelong health and welfare.

Conflicts of interest

The authors have no conflicting interests to report.

Financial disclosure statement

The authors confirm that all funding sources have been acknowledged and that none of them were involved in: 1) the design of the study, 2) the collection, analysis and interpretation of data or 3) writing the manuscript.

Ethics approval

The Regional Ethical Vetting Board in Umeå approved all research based on data from the Umeå SIMSAM Lab, including the present study.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ssmph.2019.100408>.

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