Class-Size Effects on Adolescents' Mental Health and Well-Being in Swedish Schools

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Abstract

This paper analyzes whether class size has an effect on the prevalence of mental health problems and well-being among adolescents in Swedish schools. We use cross-sectional data collected in year 2008 covering 2,755 Swedish adolescents in 9th grade from 40 schools and 159 classes. We utilize different econometric approaches to address potential between- and within-school endogeneity including school-fixed effects and regression discontinuity approaches. Our results indicate no robust effects of class size on the prevalence of mental health problems and well-being, and we cannot reject the hypothesis that class size has no effect on mental health and well-being at all.

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1. Introduction

When schools are under financial pressure, dismissal of teachers and/or increasing class size is a fast way to reap big savings. In the U.S., the recent economic downturn was reported to lead to relaxed or eliminated class size limits as a way to manage the situation (Rogers et al. 2010). Another example was observed in Sweden, where municipalities decreased the annual hiring of new teachers by as many as 13,000 in 2009 compared to an average year, according to the Swedish Teachers' Union – a measure predicted to lead to larger classes (STU 2009). In good economic times, hiring more teachers and/or decreasing class size is a popular policy among teachers, school principals, and parents, a common argument being that it enhances learning and improves the overall school climate.

Given the frequent use of class size as an educational policy tool, it is important to analyze the potential consequences that decreases or increases in class size may have on learning, health, and social outcomes. Previous research on class size has mainly focused on learning outcomes. Several studies indicate a positive effect of reduced class size on learning outcomes (Angrist and Lavy 1999a; Krueger 1999; Krueger and Whitmore 2001; Lindahl 2005; Fredriksson, Öckert, and Oosterbeek 2013), especially in the early grades and in poorer neighborhoods (Krueger 2003), although there are a few exceptions where no significant beneficial effect is found (Hanuschek 2003, 2008).

However, learning outcomes is not the only relevant variable of interest for students, parents, and policy-makers. Students also wish to attend a school with a good social climate and without having to be exposed to violent behavior. Parents presumably also have preferences for a school climate that is beneficial for the physical and mental

well-being of their children. Some recent analyses of class-size effects on non-cognitive skills (such as school engagement) indicate a beneficial effect of attending smaller classes (Dee and West 2011). Using a regression discontinuity approach, a recent Swedish study estimated class-size effects on cognitive and non-cognitive outcomes among a set of individuals born in 1967, 1972, and 1982 in a Swedish city. Overall, the results indicated both short-term positive effects of attending a small class on school performance and non-cognitive outcomes (self-confidence and perseverance) and long-term positive effects on wages later in life (Fredriksson, Öckert, and Oosterbeek 2013).

In this paper we add another dimension to the literature on class-size effects by examining potential relationships between variations in class size and the mental health and well-being of students. More specifically, we ask whether adolescents who attend larger classes are more likely to experience concentration problems, worrying/anxiety, sadness, dizziness, headaches, or stomachaches compared with adolescents in smaller classes.

These outcome variables are of interest because they directly affect the adolescents' well-being and quality of life. They have also gained increasing policy relevance as several studies have indicated that mental health and well-being have worsened among adolescents in recent decades. This seems particularly to be the case for problems related to anxiety and worrying among adolescent girls (SOU 2006). Analyzing time trends using the Swedish part of the Health Behaviour in School-aged Children (HBSC) study, Hagquist (2010) finds support for increased (self-reported) problems among students in 9th grade (aged 15), especially for internalizing problems among girls, but does not find an increase in problems for younger students in grade 5 (aged 10/11). Overall, the HBSC

study in 2005/06 showed that approximately 1/3 of all girls often or always had problems with sadness, worrying/anxiety, headaches, and sleep. The outcome variables are also of interest because they may indirectly be related to learning outcomes since there is a well-documented link showing that academic success is highly associated with good mental health and well-being (Gustafsson et al. 2010; Schwartz et al. 2008).

The results in this paper, based on different econometric approaches to address potential between- and within-school endogeneity, including school-fixed effects and regression discontinuity approaches, indicate no robust effects of class size on the prevalence of mental health problems and well-being among adolescents in Swedish schools. Thus, the findings by Dee and West (2011) and Fredriksson, Öckert, and Oosterbeek (2013) regarding positive effects of class size on other non-cognitive skills such as school engagement, self-confidence, and perseverance does not seem to carry over to mental health and well-being as measured in this paper. The rest of the present paper proceeds as follows. In Section 2 we discuss some theoretical mechanisms that may cause differences in class size to be related to changes in mental health and well-being. To give some institutional background, Section 3 describes the Swedish school system and issues of funding and class size rules. Section 4 describes the data used for the analysis, and the econometric models and specifications are discussed in Section 5. Section 6 contains the results and Section 7 concludes the paper with a discussion.

2. Why May Class Size Matter?

There are different potential mechanisms as to why class size may be linked to adolescents' mental health and well-being. A very obvious mechanism appears if we

consider the classroom situation (educational and social learning) as a public good with congestion effects; i.e., negative externalities are created when one student disturbs and disrupts other students (e.g., Lazear (2001)). Let p be the probability that a student is not misbehaving and creating a poor classroom climate. As an example, we can consider p as the time a student is not worsening the classroom climate by, e.g., screaming, acting out, and harassing other students. These are all actions that have negative effects and can lead to concentration problems, headaches, worrying, and anxiety for other students. This implies that the probability that every student in a class with n number of students is well-behaved is p^n, which further implies that misbehavior/worsening of the classroom climate occurs $1-p^n$ of class time. It is trivial that a larger share of well-behaved students (p), and a smaller class with a constant share of well-behaved students, will imply a lower share of time characterized by disruption and negative behavior. For example, in a class of 15 (homogenous) students with p equal to 0.99, there is some sort of disruption and negative behavior 14 percent of the time, i.e., an average of over 8 minutes for every one-hour class. If the class instead has 30 students, this implies that there is some sort of negative behavior 26 percent of the time, i.e., approx. 15.5 minutes for every one-hour class.

Another argument for why class size may affect mental health and well-being is that in smaller classes it may be easier for teachers to socialize the students to function in the class-room context and setting, and to foster proper student behavior. This concerns the learning of skills that make it easier for the student to cope with the requirements of school life (Biddle and Berliner 2002). Further, if smaller classes improve the learning climate, they may also be beneficial for mental health considering that several studies

have shown that better school results are associated with better mental health (Gustafsson et al. 2010).

On the other hand, it may be argued that smaller classes also make it less likely to find a matching peer, and peer relationships have also been shown to be important for mental health and well-being (Gustafsson et al. 2010). It has for example been found that difficulty in the school social and academic domains is a predictor of depressive symptoms during childhood (Schwartz et al. 2008). Moreover, having smaller classes implies hiring more teachers, which could result in recruiting less qualified teachers who are less able to create a good, healthy school climate. In Sweden the acceptance score for the marginal entrant admitted to teaching colleges dropped from 4.5 to 3.4 on a 1-5 scale from 1980 to 2000 (Björklund et al. 2005). In sum, there are mechanisms that may go in either direction, and hence it becomes an empirical exercise to identify whether some mechanisms are stronger and crowd out others.

3. Institutional Background

The Swedish educational system is divided between the national government and parliament and the municipalities (290 in total). The national government and parliament set the national guidelines for educational policy in, e.g., the Education Act, curricula, and the compulsory school regulations. At the local level, the 290 municipalities are responsible for financing and provision of compulsory schooling. There are nine years of compulsory schooling, starting with first grade in the calendar year the child turns seven

years old and consequently ending with 9th grade.[1] Schools can either be publicly or independently operated. A voucher-based system is used, so that also independent schools are publicly funded. Students typically attend the school closest to their homes, yet they do have the freedom to choose, together with their parents, other public or independent schools in their municipality. If the student chooses another school, he/she is admitted only if a place is available, and acceptance is based on the date of application only (schools are not allowed to "cream-skim" among applicants). In a U.S. perspective, the Swedish independent schools with their public funding are similar to charter schools (Björklund et al., 2005), but with the difference that the Swedish independent schools may be for-profit.

The voucher-based system implies that each school receives a fixed sum of funding per year for each enrolled student ("funding per pupil"). The amount varies with observable socio-economic and -demographic characteristics of the students, with a higher amount per student allocated to schools with more socio-economically disadvantaged students. However, the exact design and specific variables used to define "disadvantaged" students vary across municipalities, with some municipalities not using any resource compensation scheme at all. At the school level, these funds may then be used rather freely, and there are no formal regulations regarding a maximum class size. Before the decentralization of the Swedish school system in the early 1990s, which made the local municipalities responsible for both funding and provision of compulsory education, there were rules on class size such that a maximum cap was set at 25 (grades 1-3) and 30 (grades 4 and above) (Fredriksson, Öckert, and Oosterbeek 2013). Despite

[1] It should be noted though that almost all children also attend "grade 0" (the calendar year they turn 6), which is seen as a preparatory year for first grade, albeit it is not compulsory.

the absence of formal rules for a maximum class size, there are clearly some informal norms regarding appropriate class size. We will use this fact as part of our empirical approach in a fuzzy regression discontinuity design. In discussions with school leaders in the region where our data was collected, we see a norm stipulating that a class is considered to be large (with discussions about splitting it into multiple classes) when exceeding a size of 25 students, which is roughly half a standard deviation larger than the mean class. We will use this in an approach where we predict actual class size based on the school enrollment in the specific grade (see further in Section 5).

4. Data

The paper is based on cross-sectional data collected in April 2008 among students/adolescents in the 9th grade of compulsory school in the county of Värmland, Sweden.[2] The county has 274,000 inhabitants and is situated close to the Norwegian border 250 kilometers west of the capital Stockholm. The data was collected in schools by researchers at the Centre for Research on Child and Adolescent Mental Health (Karlstad University, Sweden) via a questionnaire, which was completed anonymously in the classroom and returned in a sealed envelope. The same type of questionnaire has been used for data collection in this region every three years since 1988, but was linked to class size only in the 2008 wave. Except for one small private boarding school, all schools in the county were included. The data collection was carried out in accordance with the principles of research ethics in the humanities and social sciences stipulated by

[2] In Sweden, students in 9th grade are 15-16 years old.

the Swedish Research Council. The data covers 159 classes in 40 schools in the region. There are only two independent schools in the sample; the rest are public.[3]

A total of 3,109 students completed the questionnaire, which implies a response rate of 84.3%. The non-response of 15.7% includes questionnaires that were handed in blank, answered in an obviously false way or miscoded in the coding process.[4] The response rates of boys and girls were within 1% of each other. We also exclude all observations with missing data on any of the dependent or independent variables. All in all, our analyses are based on a final sample of 2,755 students. Table 1 summarizes the outcome and explanatory variables used in the paper.

[Table 1 about here]

The outcome variables on mental health and well-being are all based on the question, *"How often during the current school year have you had any of the following problems?"*, with the response alternatives (i) never, (ii) seldom, (iii) sometimes, (iv) often, and (v) every/almost every day. As seen in Table 1, we include six different aspects of mental health and well-being. Even though they are not directly indicative of mental disorder, studies indicate that adolescents who have (self-reported) problems with worrying, anxiety, and nervousness are more likely to also develop severe and longstanding mental disorders (Ringbäck Weitoft and Rosén 2005). As shown in Table 1,

[3] Independent schools are more common in urban areas of Sweden and among high schools.
[4] There were 45 blank, false, and miscoded questionnaires in 2008.

having difficulties concentrating is the most prevalent of the six outcome variables with a mean of 0.27.

Regarding the explanatory variable of interest, class size, there is substantial variation in the sample, from a minimum of 12 students in a class to a maximum of 33. The average 9th grade class size in the county of Värmland is 23.8 students, which is close to the average class size in OECD countries of 23.9 for the academic/school year 2007/08.[5] The nations with the lowest average class size in the OECD are Iceland (19.8) and Denmark (19.9), while those with the highest average class size are Korea (35.6) and Japan (33.2) (OECD 2009).

5. Empirical Approach

We set out to address the question of whether (and how) class size affects mental health and well-being as measured by six different outcome variables. The main empirical problem in addressing the issue of class-size effects is that there is no guarantee that comparable groups of students have been "assigned" to small and large classes. Hence, class-size variation may very well become mixed up with important pre-existing differences between the student groups. We divide this problem into between-school endogeneity and within-school endogeneity. Between-school endogeneity refers to sorting where, e.g., well-educated high-income parents sort into particular areas with relatively better schools and school environments. If these schools have the financial means to have smaller classes, and the children of well-educated high-income parents are already more likely to have better mental health, we may find a spurious correlation

[5] Since 1994 no data has been collected on class size at the national level in Sweden.

between small class size and good mental health. On the other hand, if compensating resource allocation is practiced (as is the case in the municipalities in our data), i.e., municipalities allocate more economic resources per student to schools where students come from families with less favorable socioeconomic circumstances, these schools have the means to employ more teachers and have smaller classes. This may create the spurious correlation of smaller classes being associated with more mental health problems (if we believe that adolescents from families with social adversities are more likely to have mental health problems).

Within-school endogeneity could arise if school principals and teachers are able to place problematic students in smaller classes where the teacher can spend more time with them individually, i.e., p in the simple model in Section 2 would be higher if n is low. This could potentially create the spurious relationship of smaller classes showing worse mental health or worse well-being. We may also face a similar problem if school principals assign high-quality teachers to larger classes.

We address the difficulties outlined above in some different ways in this paper. In Section 5.1 we describe our baseline models using observable characteristics as well as a school fixed effects approach. In Section 5.2 we run some analyses trying to detect endogeneity problems in our data (without identifying such problems), and in Section 5.3 we describe our regression discontinuity approach.

5.1 Baseline models

The empirical specification for our initial baseline model is shown in equation (1) below:

$$Y^{*}_{ics} = \alpha + \beta CS_{cs} + \delta X_{ics} + \varepsilon_{ics}, \quad (1)$$

where Y^{*}_{ics} is a latent variable measuring the mental health or well-being outcome for student *i* in class *c* at school *s* during the academic year 2007/8. Considering that the underlying response variable Y^{*}_{ics} is not observable, we have defined dummy variables, Y_{ics}, (as listed in Table 1 for mental health and well-being) that takes the value 1 if $Y^{*}_{ics} > 0$ and 0 otherwise and we estimate equation (1) using probit models. Further, in equation (1), CS_{cs} is the specific size of the class that the student attended this academic year, and X_{ics} is a vector containing the student-specific controls/characteristics as listed in Table 1. We also have an error term (ε) and a constant (α).

This "naive" baseline setup controls for potential between- and within-school endogeneity by including individual control variables (X_{ics}). The compensating resource allocation in the municipalities where our data was collected is mainly based (at school level) on the share of non-Swedish students, the share of students with unemployed parents and the share of students with parents without higher (university level) education. We can control for two out of three of these factors (all but the share of parents without higher education). Yet, it is still likely that there is sorting between schools that may affect both class size and our outcome variables but that we cannot observe in our data. Hence, in a second step to further control for between-school sorting, we estimate a school-fixed effects (SFE) model, where the class-size effect is estimated based on within-school variation in class size. Thus, we specify the following, also estimated using probit models:

$$Y^{*}_{ics} = \alpha + \beta CS_{cs} + \delta X_{ics} + \gamma D_{cs} + \varepsilon_{ics}. \quad (2)$$

Controlling for between-school sorting obviously also restricts the class-size variation on which β is estimated. However, there is still considerable within-school variation with the average class-size difference at 2.15 students, a minimum of within-school difference of 0, and a maximum of 7 students, which is a variation that is in the relevant range for policy-makers within each school and municipality.[6]

What is not addressed in equation (2) is the potential problem of within-school endogeneity, e.g., a principal allocating a "trouble-maker" to a smaller class where he/she may be more easily supervised. However, we argue that this is not very likely to happen in the Swedish school system, since there is a strong norm and policy not to move students across classes or schools as an instrument to deal with classroom problems. For example, a survey showed that only 6 out of 290 Swedish municipalities have actually made use of a new discrimination law introduced in 2006 (SFS 2006:67) that explicitly specifies that schools are allowed to move a violent/bullying student (even against the will of the parents/guardians) from one class or school to another (DN 2008). Even though this law generally applies to more severe cases of negative and antisocial behavior among students, we argue that it also indicates a general social norm and often invoked policy that it is not a preferred policy to move disturbing/violent/bullying students from a class. Another possible conflicting causal mechanism is that higher quality teachers may be assigned to larger classes within schools, i.e., if teachers with high skills in handling classroom misbehavior are assigned to large classes and teachers with low skills in handling classroom misbehavior are assigned to small classes. We know that teacher quality can be important for student achievement (Hanushek and Rivkin 2010; Rivkin,

[6] Schools with no within-school variation in class size will obviously fall out of the school fixed effects estimations.

Hanushek, and Kain 2005), and thus it may also be important for mental health and well-being among the students. However, as 9th grade classes in Sweden have different teachers in different subjects, this problem should at least be smaller at this age than in lower grades. Furthermore, in our regression discontinuity design we handle the problem by not using within-school variation in class size as the source of identification.

5.2 A regression discontinuity approach

As an additional test of whether class size affects mental health and well-being, we will exploit a norm that potentially generates exogenous variation in class size in Värmland. As the class size exceeds 25 students, schools generally start thinking about dividing the class into two. This implies that class size should (to some extent) fall discretely at enrollment intervals of 25 students. Other studies have used the same identification strategy to study the effect of class size on test scores (Angrist and Lavy 1999b; Asadullah 2005; Hoxby 2000; Urquiola 2006; Urquiola and Verhoogen 2009). The norm is not the only factor that determines class size, and we have classes larger than 25 in our sample, but using this norm as an instrumental variable is (as demonstrated below) nevertheless meaningful. In practice we implement this "fuzzy" regression discontinuity design by using the 25-in-a-class norm as an instrument for actual class size, while also controlling for enrollment (see Angrist and Lavy (1999b) for a very similar application).

Since the discontinuity at 25 students is the source of identifying information, we will not only conduct the IV analyses on the full sample but also on different bandwidths that include schools with enrollments close to the discontinuities (at 25, 50, 75, 100, 125, 150, 175, and 200). For all our estimations, the first stage F-value for excluded

instruments is well above the rule of thumb (which is 10), the F-value varies between 17 and 55 (not shown). This is in the same magnitude as in Fredriksson, Öckert, and Oosterbeek (2013), and implies that the class size stipulated by the 25 students per class norm is a good predictor of the actual class size and that it has enough variation to be used as an instrument. Since we use the regression discontinuity design with the 25 student norm and not a strict rule, we also constructed instruments with the dividing lines at 26, 27, 28, 29, and 30. However, the first stage F-values indicates that the 25-rule is the best instrument for actual class size.

5.3 (Non)-evidence of endogeneity problems

As a check of potential endogeneity problems, we perform a tentative test of systematic differences of class size and our individual controls/characteristics. As has been argued elsewhere (Altonji, Elder, and Tabor 2005; Bifulco, Fletcher, and Ross 2011), using the degree of selection on observables as an indicator of the degree of selection on unobservables, null results or no significant relationships between class size and our individual controls/characteristics support our argument that our empirical specification is not significantly plagued by endogeneity problems. Hence, we run a regression with class size as outcome variable and the individual level variables listed in Table 1 as explanatory variables. We run this regression both without and with school fixed effects, the former taking class-size variation both between and within schools into account and the latter only taking class-size variation within schools into account. Table 2 shows the results.

[Table 2 about here]

The results show that there are no statistically significant associations between class size and any of our independent variables. Further, joint F tests show that we cannot reject the hypothesis that all characteristics have no joint effect on actual class size. This is comforting given that any significant associations would be tentative evidence of systematic correlations between student background variables and class size. This may indicate (but of course does not prove) that endogeneity is not a serious problem for our analyses.

6. Results

In Section 6.1 we estimate the baseline model (equation 1) and then the SFE model (equation 2), while in section 6.2 we report the results from our RD approach.

6.1 Results from baseline models

Table 3 shows the results in terms of the marginal effects based on the model as outlined in equation (1) estimated using probit models. Class size does not seem to be associated with any statistically significant effect on any of the six outcome variables, i.e., class size does not seem to matter for the mental health and well-being of adolescents.[7] Further,

[7] We also tested creating an outcome variable summing all six binary outcome variables into one aggregate mental health/well-being outcome variable (with 0 indicating no problems with any of the outcome variables and the maximum value of 6, which indicates a problem with all binary outcome variables). We find no effects when using this outcome variable either (treating the outcome variable as continuous using OLS or an ordinal regression). We also tested creating dummy variables based on in which class-size quartile a specific class is located.

there is no substantial "economic magnitude" of the class-size variable and non-rejection is hardly driven by very large standard errors.

A result of interest is that girls show a significantly higher likelihood of experiencing (often or always) worrying/anxiety, sadness, dizziness, headaches, or concentration difficulties, with rather large marginal effects; e.g., a girl is 15 percentage points more likely than a boy to report worrying/anxiety. Adolescents who live with a single parent are more likely to experience concentration difficulties, worrying/anxiety, sadness, dizziness, headaches, and stomachaches. Having a non-working father and/or a non-working mother is associated with concentration difficulties, worrying/anxiety, headaches, and stomachaches.[8]

[Table 3 about here]

Moving on to the SFE estimation in Table 4, where we control for between-school endogeneity and results are based on within-school variation in class size, the results are in most aspects very similar to those reported in Table 3. We cannot reject the null hypothesis of no relationship between class size and the six different outcome variables.

[Table 4 about here]

[8] The estimations in Tables 3 and 4 are shown using robust standard errors clustered at the school level (40 clusters in Table 3 and 35 clusters in Table 4). When using a small number of clusters there is a risk for over-rejection. However, no non-significant results turn significant when we run the regressions without clustering (which creates "too small" standard errors). Also, if clusters are at least above 30, we may be reasonably confidents that they do not over-reject (Cameron, Gelbach, and Miller 2008).

The other results of interest in Table 4 are similar to those reported in Table 3 as well. Girls are more likely to report problems in all domains, and living with a single parent is a risk factor as well.[9]

6.2 Regression discontinuity results

We conduct the analysis for the full sample (Table 5) and for several bandwidths, i.e., schools with enrollments in a range close to the discontinuity.[10] The Akaike Information Criterion (AIC) suggests that not including higher order polynomials of enrollment is preferred; the findings do however not change if higher order polynomials are included. Table 6 presents the results for the bandwidth +/-3, i.e., schools with enrollments in the set of intervals [22,28], [57,63], [72,78] and so on. As can be seen in Table 5, there are indications of positive effects of class size on headaches and dizziness; however, the results from the discontinuity sample (Table 6) point to a negative effect on dizziness and no statistically significant effect on headaches. Estimations with other bandwidths as well as including municipality fixed effects show that the results are very fragile (the results are available upon request). These results are well in line with the previous findings in the present paper, indicating that class size does not robustly affect mental health and well-being.

[9] We also conducted the school fixed effects regressions using only boys and girls in the sample, respectively, but found no significant or robust effect of class size in such regressions either. Full results from these regressions are available upon request from the authors.

[10] We run the regression discontinuity regressions treating outcome variables both as continuous (ivreg) and binary (ivprobit in Stata), with no qualitative differences in interpretation. The results shown in the Table is, for simplicity, based on treating the outcome variables as continuous.

[Table 7 & 8 about here]

7. Conclusion

In conclusion, the results in this paper indicate that it is not more likely for 9th grade adolescents in Sweden who attend larger classes to have more mental health problems or less well-being. Hence, the main conclusion that can be drawn here is that the analyses do not support the claim that smaller classes are beneficial for the mental health of adolescents in this age group.

That there are generally no robust statistically significant associations between class size and the outcome variables may be because class size is not an important variable, or that there are conflicting causal mechanisms that work against each other. For example, in a larger group the likelihood of finding a peer with matching interests, attitudes etc. increases, and this may be a protective factor against mental health problems (Schwartz et al. 2008) counteracting the potential negative consequences of larger classes. Further, as has been discussed in the literature on class size and learning outcomes, smaller classes require more teachers, which may imply that schools have to hire less qualified and motivated teachers. Another possible conflicting causal mechanism is that higher quality teachers may be assigned to larger classes, i.e., if teachers with high skills in handling classroom misbehavior are assigned to large classes and teachers with low skills in handling classroom misbehavior are assigned to small classes. However, since Swedish 9th grade classes have different teachers in different subjects, this problem should be smaller at this age than in lower grades.

There are several limitations in our analyses that should be pointed out. First, we have data on 9th grade, while the literature on class size and learning outcomes indicates that the positive effects of reducing class size on learning are mainly found in the lower grades. We believe that it is important for future research to examine this issue. Finally, we have used self-reported measures of mental health problems and well-being, which imply uncertainty regarding the reliability of the data. Still, we believe that we have reduced some potential bias by guaranteeing the anonymity of the survey participants and not allowing them to communicate before completion of the questionnaire.

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Tables

Table 1 Summary statistics

Variable name	Description	Mean (std. dev)
Outcome variables: mental health and well-being		
Concentration problems	= 1 if often or almost every day problems concentrating; 0 otherwise	0.26 (0.44)
Worrying/anxiety	= 1 if often or almost every day worrying/feeling anxiety; 0 otherwise	0.20 (0.40)
Sadness	= 1 if often or almost every day feeling sad; 0 otherwise	0.21 (0.40)
Dizziness	= 1 if often or almost every day feeling dizzy, 0 otherwise	0.12 (0.33)
Headaches	= 1 if often or almost every day problems with headache, 0 otherwise	0.23 (0.42)
Stomachache	= 1 if often or almost every day problems with stomachaches; 0 otherwise	0.15 (0.35)
Explanatory variables		
Class size	Number of students in class	23.82 (3.96)
Girl	=1 if girl	0.49 (0.50)
Living with single parent	=1 if living with a single parent	0.33 (0.47)
1st generation immigrant	=1 if first generation immigrant	0.05 (0.22)
2nd generation immigrant	=1 if second generation immigrant	0.14 (0.35)
Non-working mother	=1 if mother is not working	0.16 (0.36)
Non-working father	=1 if father is not working	0.08 (0.27)

Note: Number of observations is 2,755 (individuals with missing data on any of the variables were deleted).

Table 2 OLS regression with class size as dependent variable

	Class size	Class size
Girl	-0.07	0.10
	(0.15)	(0.07)
Living with single parent	-0.14	-0.10
	(0.16)	(0.08)
1st gen. Immigrants	-0.12	-0.11
	(0.40)	(0.19)
2nd gen. Immigrants	0.28	-0.08
	(0.25)	(0.12)
Non-working mother	-0.22	-6.24E-04
	(0.22)	(0.11)
Non-working father	-0.001	0.08
	(0.29)	(0.14)
Constant	23.90***	15.00
	(0.12)	(0.52)
School fixed-effects	No	Yes
N	2755	2755
R^2	0.001	0.76

Notes: *** p<0.01, ** p<0.05, * p <0.10. Robust standard errors correcting for clustering at school level.

Table 3 Baseline results on class size and mental health/well-being: marginal effects from probit model

	Concentration problems	Worrying/anxiety	Sadness	Dizziness	Headaches	Stomachaches
Class size	0.002	-0.001	-0.003	0.001	-5.98E-04	-0.003
	(0.003)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)
Girl	0.07***	0.15***	0.24***	0.07***	0.17***	0.14***
	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)
Single parent	0.08***	0.01	0.08***	0.03**	0.07***	0.05**
	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)	(0.01)
1st gen. immigrants	-0.06	-0.07*	0.001	-0.04	-0.08*	-0.05*
	(0.04)	(0.04)	(0.04)	(0.03)	(0.04)	(0.03)
2nd gen. immigrants	0.02	0.05	0.07*	0.05**	0.01	0.03
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)
Non-working mother	0.04*	0.05***	0.02	0.01	0.04*	0.04
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Non-working father	0.06**	0.04*	0.03	0.01	0.04	0.04**
	(0.03)	(0.03)	(0.02)	(0.02)	(0.03)	(0.03)
N	2,755	2,755	2,755	2,755	2,755	2,755
Schools	40	40	40	40	40	40
Pseduo R-squared	0.02	0.04	0.11	0.02	0.05	0.04

Notes: *** p<0.01, ** p<0.05, * p <0.10. Robust standard errors correcting for clustering at the school level. Constant significant in all models but results not reported in table.

Table 4 School fixed effects estimations on class size and mental health/well-being: marginal effects from probit model

	Concentration problems	Worrying/anxiety	Sadness	Dizziness	Headaches	Stomachaches
Class size	-0.005	-0.001	-1.71E-05	-0.001	-4.31E-05	-5.84E-04
	(0.005)	(0.002)	(0.004)	(0.004)	(0.005)	(0.005)
Girl	0.08***	0.15***	0.24***	0.06***	0.17***	0.14***
	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)
Single parent	0.08***	0.01	0.08***	0.03**	0.08***	0.05***
	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)
1st gen. Immigrants	-0.08*	-0.09**	-0.02	-0.05**	-0.09**	-0.07***
	(0.05)	(0.04)	(0.04)	(0.02)	(0.04)	(0.02)
2nd gen. Immigrants	0.03	0.06*	0.08**	0.05**	0.02	0.03
	(0.03)	(0.03)	(0.04)	(0.03)	(0.03)	(0.02)
Non-working mother	0.05**	0.06***	0.02	0.01	0.04*	0.04**
	(0.03)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)
Non-working father	0.05*	0.05*	0.03	0.02	0.04	0.04**
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
N	2,662	2,662	2,662	2,662	2,662	2,662
Schools	35	35	35	35	35	35
Pseduo R-squared	0.04	0.07	0.13	0.04	0.07	0.08

Notes: *** p<0.01, ** p<0.05, * p <0.10. Robust standard errors correcting for clustering at school level. Constant significant in all models but results not reported in table.

Table 5 Class size and mental health/well-being: instrumental variable regressions

	Concentration problems	Headache	Stomachaches	Worrying/anxiety	Sadness	Dizziness
Class size	-0.006	0.028*	0.006	0.022	-0.003	0.027**
	(0.016)	(0.016)	(0.012)	(0.015)	(0.014)	(0.012)
Enrollment	0.000	-0.000	-0.000	0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Girl	0.074***	0.171***	0.143***	0.150***	0.240***	0.067***
	(0.017)	(0.016)	(0.013)	(0.015)	(0.015)	(0.013)
Single parent	0.081***	0.077***	0.048***	0.013	0.081***	0.035**
	(0.019)	(0.018)	(0.014)	(0.017)	(0.016)	(0.015)
1st gen. immigrants	-0.068	-0.073*	-0.062*	-0.074*	-0.0002	-0.046
	(0.043)	(0.039)	(0.034)	(0.039)	(0.042)	(0.034)
2nd gen. immigrants	0.028	0.005	0.029	0.043	0.062**	0.044*
	(0.029)	(0.028)	(0.024)	(0.027)	(0.027)	(0.025)
Non-working mother	0.041*	0.044*	0.042**	0.059**	0.016	0.016
	(0.025)	(0.024)	(0.021)	(0.023)	(0.022)	(0.020)
Non-working father	0.061*	0.041	0.045	0.039	0.032	0.014
	(0.034)	(0.033)	(0.027)	(0.031)	(0.030)	(0.027)
Constant	0.327	-0.539	-0.093	-0.432	0.133	-0.554*
	(0.363)	(0.360)	(0.279)	(0.360)	(0.331)	(0.284)
N	2,755	2,755	2,755	2,755	2,755	2,755

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All estimations use the predicted class size as an instrument for actual class size. The Akaike Information Criterion (AIC) suggests that not including higher order polynomials of enrollment is preferred; the findings do however not change if higher order polynomials are included. Note that models are based on treating outcome variables as continuous, but as noted in footnote 10, results are qualitatively similar if treating outcome variables as binary.

Table 6 Class size and mental health/well-being: instrumental variable regressions, discontinuity sample (+/-3)

	Concentration problems	Headache	Stomachache	Worry/anxious	Sad	Dizziness
Class size	-0.025	-0.030	-0.017	-0.010	0.013	-0.047**
	(0.028)	(0.030)	(0.020)	(0.024)	(0.024)	(0.023)
Enrollment	0.000	0.001**	0.000	0.000	-0.000	0.000
	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
Girl	0.128***	0.209***	0.149***	0.145***	0.249***	0.098***
	(0.035)	(0.034)	(0.028)	(0.030)	(0.031)	(0.030)
Single parent	0.118***	0.064*	0.079***	0.011	0.101***	0.063*
	(0.039)	(0.039)	(0.030)	(0.032)	(0.034)	(0.033)
1st gen. immigrants	-0.081	-0.104	-0.044	-0.013	-0.011	0.043
	(0.069)	(0.068)	(0.056)	(0.072)	(0.066)	(0.066)
2nd gen. immigrants	-0.055	-0.017	-0.003	0.059	0.028	-0.003
	(0.056)	(0.054)	(0.042)	(0.052)	(0.047)	(0.050)
Non-working mother	0.084	0.154***	0.030	0.069	0.058	0.018
	(0.053)	(0.056)	(0.041)	(0.050)	(0.048)	(0.048)
Non-working father	-0.008	0.067	-0.049	-0.003	-0.010	0.016
	(0.064)	(0.071)	(0.046)	(0.060)	(0.059)	(0.060)
Constant	0.754	0.702	0.451	0.288	-0.260	1.167**
	(0.642)	(0.678)	(0.450)	(0.548)	(0.532)	(0.514)
N	622	622	622	622	622	622

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All estimations use the predicted class size as an instrument for actual class size. The Akaike Information Criterion (AIC) suggests that not including higher order polynomials of enrollment is preferred; the findings do however not change if higher order polynomials are included. Note that models are based on treating outcome variables as continuous, but as noted in footnote 10, results are qualitatively similar if treating outcome variables as binary.