Smartphone Bans, Student Outcomes and Mental Health

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Abstract

How smartphone usage affects well-being and learning among children and adolescents is a concern for schools, parents, and policymakers. Combining detailed administrative data with survey data on middle schools' smartphone policies, together with an event-study design, I show that banning smartphones significantly decreases the health care take-up for psychological symptoms and diseases among girls. Post-ban bullying among both genders decreases. Additionally, girls' GPA improves, and their likelihood of attending an academic high school track increases. These effects are larger for girls from low socio-economic backgrounds. Hence, banning smartphones from school could be a low-cost policy tool to improve student outcomes.

JEL classification: I12, I21, I31, J24, O33
Keyword: Smartphones, mental health, grade point average, bullying, test scores

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1 Introduction

The increasing use of technology, particularly the growing smartphone usage, by children and adolescents has led to concerns about the effects on young people's cognitive, physical, and socioemotional development. Across the OECD countries, more than 90% of teenagers report owning a smartphone or having access to one (OECD, 2018). On average, teenagers spend 3 hours online per day outside of school (OECD, 2019; Smahel et al., 2020). Over 20% report spending more than 6 hours online outside school hours (Bakken, 2022).

Of particular concern is whether screen-based activities are harmful to children and adolescents learning and well-being (Kardefelt-Winther, 2017). Screen time, and particularly the use of social media, has increased since the mid-2000s. At the same time, the mental health of teenagers has worsened and is today one of the leading causes of illness among adolescents (WHO, 2021). For instance, in 2019, 29% teenage girls and 10% teenage boys in Norway reported having issues with depression or anxiety (Bakken, 2019). In the public debate, many argue that exposure to social media is one of the major contributing factors to the increase in mental health issues among teenagers, as social media are addictive and harmful and fuel an experience of inadequacy about your personal life or appearance. In 2023, UNESCO called for a global smartphone ban in schools to tackle disruption by smartphones in classroom and protect children from cyberbullying (UNESCO, 2023). Concurrently, proponents argue that smartphones and tablets could be used as teaching tools in classrooms, as they are part of modern society (Røsvik, 2010).

The experience of mental health problems and bullying among adolescents is a serious concern as it has been linked to several costly long-term issues, such as adult health problems, including increased risk of suicide, and lower labor market productivity (Currie et al., 2010; Gini and Pozzoli, 2009; Goodman et al., 2011; Lundborg et al., 2014; Van Geel et al., 2014; Wolke et al., 2013). Yet, the impact of smartphone use in schools on student outcomes and well-being is ambiguous (Amez and Baert, 2020; OECD, 2019). Both the behavioral and psychology literature have found multitasking to be detrimental not only to attention but also more specifically to learning (see, e.g., Abouk and Adams, 2013; Glass and Kang, 2019; Mendoza et al., 2018; Rana et al., 2019; Smith et al., 2011). Moreover, several papers report a negative correlation between screen time, and mental health issues (Kardefelt-Winther, 2017; Twenge, 2019). Almost 6% of adolescents in Norway report experiencing bullying or harassment at school or online by other students at their school (Bakken, 2019). Easy access to smartphones and social media platforms could potentially lower the cost of bullying by making it less salient for teachers and adults. Hence, banning smartphones from schools could lower the incidence of bullying and thereby indirectly enhance human capital accumulation.

This paper contributes to the debate about the consequences of new technology such as smartphones on students' mental health, their educational outcomes, and the incidence of bullying, by studying the effects of banning smartphones from Norwegian middle schools. I leverage quasi-experimental variations in Norwegian middle schools introducing smartphone bans that limited usage among students. I employ a nonparametric event-study design to identify causally the time-varying impact of banning smartphones from the classroom on students' mental health, educational outcomes, and bullying.

There are no national guidelines on smartphone use in Norwegian schools. Instead, schools make autonomous decisions on whether to allow or ban smartphones. Over the last 10 years, this has resulted in variations in the timing of smartphone bans being implemented across schools. As there is no centrally collected information on smartphone bans in schools, I used a survey to collect data from Norwegian middle schools on their smartphone policies, and whether and when they had introduced any smartphone regulations. Then, I matched schools' responses from the survey to Norwegian Registry data, which include information on each individual's educational institution, health care take-up at specialist care, including psychologists, and general practitioners (GPs), middle-school grades set by students' teachers and externally corrected exams, student's overall GPA, and individuals' choices of academic or vocational high schools. A bullying measurement is available from the Norwegian Pupil Survey, implemented yearly since 2007 by the Norwegian Directorate for Education and Training.

The validity of my research design rests on the assumption that the timing of a school adopting a smartphone ban is uncorrelated with other determinants of student outcomes. I provide different pieces of evidence that the main identification assumption is likely to hold. First, I show that school, student, and teacher baseline characteristics cannot predict the timing of when a school implements a ban. Second, I show that schools that implemented smartphone bans in different years did not experience changes in baseline characteristics before to the introduction of the bans. Moreover, the event-study framework demonstrates that both pre- and post-policy, school, teacher, and student characteristics do not change. This suggests that endogenous compositional changes are not driving my results.

I present five key findings. First, I show that banning smartphones reduces the number of consultations for psychological symptoms and diseases at specialist care, by about 2–3 visits during middle school years when exposed for full-time in middle school. Relative to pretreatment this is a significant decline by almost 60% in the number of visits. In addition, girls have fewer consultations with their GP due to issues related to psychological symptoms and diseases – a decline by 0.22 visits – or 29% decline relative to the pretreatment mean. However, I find no effect on students' likelihood (extensive margin) of being diagnosed or treated by specialists or GPs for a psychological symptom and diseases. The decline in the number of consultations for psychological symptoms and diseases shows that after a ban is implemented, girls are in less need of care related to mental health issues. Second, my results show that banning smartphones lowers the incidence of bullying for both girls and boys when they are exposed from the start of their middle school years to a ban.

Third, the findings show that post-ban, girls exposed to a smartphone ban from the start of middle school make gains in GPA, average grades set by teachers, and externally graded mathematics exams. Post-ban girls gain 0.08 standard deviations in GPA, and 0.09 standard deviations in teacher-awarded grades and have 0.22 standard deviations higher mathematics test scores compared to girls not exposed to a ban. As a point of comparison, literature in economics studying the effect of decreasing class size by one student shows effect sizes between 0.00–0.05 standard deviation in test scores (Jepsen, 2015). On average, I find that the effect of banning smartphones from the classroom is larger than reducing the class size by one student, highlighting the distracting effect smartphones have on learning. Additionally, girls are 4-7 percentage points more likely to attend an academic high school track after experiencing a ban. This effect amounts to an 8–14% point increase in the probability of attending an academic high school track relative to the pre-ban years. These effects are only significant for girls who are exposed to a smartphone ban for at least 2 years or more in middle school.

I find no effect on the boys' mental health, GPA, their average grades set by teachers, or on the probability of them attending an academic high school track. The heterogeneity in the patterns between girls and boys could result from the substantially higher phone usage among girls. More than 70% of girls of middle-school age in Norway report that they spend more than 2 hours a day on their phones, whereas only 54% of boys say the same. Additionally, almost 60% of girls report that they spend 2 or more hours on social media, whereas, by comparison, only 32% of boys do the same (Medietilsynet, 2018).

My fourth set of results shows important heterogeneity by socioeconomic status. These results suggest that health care take-up for psychological symptoms and diseases, GPA, teacher-awarded grades, and the probability of attending an academic high school track is larger for girls from low socioeconomic backgrounds. These important differences suggest that unstructured technology is especially distracting for students from low socioeconomic families, whereas students from high socioeconomic families do not experience any negative externalities.

Lastly, the effect on grades, GPA, and test scores is largest among girls attending middle schools that ban students from bringing their phones to school or schools where students must hand their phones in before classes start. Schools with a more lenient policy only require students to have their phones on silent mood during lectures. Behavioral experiments have shown that just having your phone nearby, but in a silent mood, could even increase phone usage, especially for people with increased "Fear-Of-Missing-Out" (FoMo) (Liao and Sundar, 2022). For specialist and GP consultations related to psychological symptoms and diseases, the effect by type of ban is less distinguishable.

I contribute to the literature in several important ways by providing a comprehensive overview of the causal effect of banning smartphones along several previously under-studied dimensions of student outcomes: mental health, progression into high school, and the experience of bullying. Braghieri et al. (2022) provide quasi-experimental evidence that the staggered adoption of Facebook across US colleges harmed students' mental health, mainly by contributing to increased social comparison among students. Donati et al. (2022) shows that following the rollout of high-speed internet, mental disorders among young adults increased in Italy. I complement this literature on social media, internet, and mental health by investigating another margin and evaluating if banning access to smartphones, that restrict easy access to social media platforms and the internet during school hours, impacts students' mental health. I find positive effects at the intensive margin. There is no effect on mental health at the extensive margin. This is most likely because although students are restricted during school hours after a ban is implemented, phone usage after school hours is most likely not impacted, which represents the majority of time spent on social media.[1] Moreover, this paper complements the growing literature about the determinants of mental illness and bullying during school-aged years. For instance, Bütikofer et al. (2020) have investigated how school selectivity affects mental health and shows that eligibility for a more selective high school improves enrollment in higher education and decreases the risk for treatment for a psychological disease. Rees et al. (2022) show that when state-level anti-bullying laws become introduced, suicide rates declined and mental health among adolescents in middle and high school improved, especially among females.

A second novel contribution of this paper lies in providing causal evidence that banning smartphones lowers the incidence of bullying among middle school students. Bullying has been found to have severe physical and emotional long-term consequences for students (Drydakis, 2014). Beneito and Vicente-Chirivella (2022), show that after two regions in Spain introduced a ban against mobile phones, bullying decreased in both regions and PISA scores increased in one of the regions.[2] The large individual and societal cost has increasingly led teachers, parents, policymakers, and the media to draw attention to bullying and methods

[1] See Appendix Figure A1.

[2] As the authors use regional-level data, in combination with only two treated regions, mental health or important heterogeneity differences are not being analyzed.

to stop it. Despite this, there has been a lack of credible causal evidence on how to tackle bullying. My results suggest that a low-cost intervention such as banning smartphones from schools might be an effective policy tool to reduce bullying and improve adolescents' mental health.

For students' educational outcomes, a handful of studies investigates phone use and its association with students' higher education outcomes (see, e.g., Amez and Baert, 2020) but the majority of these are descriptive, with the exceptions of Beland and Murphy (2016) and Kessel et al. (2020). Similar to this paper, these two studies investigate how mobile phone bans affect students' test scores in the UK and Sweden, respectively. Beland and Murphy (2016) document that banning mobile phones has a positive effect on test scores, especially for disadvantaged and underachieving pupils. As Beland and Murphy (2016) study student outcomes between 2001–2011, their results largely cover a period when mobile phone ownership was much lower, smartphones barely existed, and phones had little value as a teaching tool. Today, this situation is very different. Additionally, my study provides novel evidence not only on test scores but also on how banning smartphones affects several dimensions of student outcomes and their health. Kessel et al. (2020) study the effect of banning mobile phones on test scores in a much more recent period; 1997–2018. They find no effect of banning mobile phones on students' test scores. However, their data are aggregated at the school level, restricting them from examining heterogeneous effects across different individuals. The data I use allow for an in-depth heterogeneity analysis throughout the student's schooling.

Lastly, this study contributes to the literature on technology in the classroom and its impact on students' achievements. Most previous studies focus on the impact of introducing or having access to technology, such as introducing computers in the classroom, and the impact on student achievement. However, the resulting evidence is mixed (Hall et al., 2019; Escueta et al., 2017; Barrow et al., 2009; Banerjee et al., 2007; Angrist and Lavy, 2002). Unlike these studies, I consider a type of technology that is highly accessible to teenagers but, in contrast with the computers in the classroom, is not necessarily considered a teaching tool.

2 Institutional Background

2.1 The Norwegian Educational System

Norwegian compulsory education starts at 6 years of age and lasts for 10 years. There are two levels of compulsory education: primary school (grades 1–7) and middle school (grades

8–10). Usually, students commence middle school in the year in which they turn 13 and finish compulsory schooling in the year that they turn 16 years old.

Compulsory education is financed by grants from the central government as well as local income taxes. The syllabuses are centrally determined by the Norwegian Directorate for Education and Training. There is no streaming by ability in compulsory education. In primary school, children are not graded. In middle school, grades are set according to national standardized learning goals and students take standardized national tests in grades 5, 8, and 9. In most counties, the scores from the exit exams in middle school and grades from teachers are crucial for admission into different high schools.[3]

Most students attend public schools. In 2019, only 4% of children attended a private or independent school. Municipalities are responsible for organizing compulsory schooling in public schools. To receive public funding, schools are not allowed to charge any tuition fee. School assignment in public primary schools is based on fixed school catchment areas within municipalities through a distance-from-home rule.

Despite the clear rules on educational content, the Norwegian Directorate for Education and Training gives school principals the discretion to determine how to allocate funds, what teachers to hire, and what detailed rules are imposed on school grounds. By law, each school must have a stated code of conduct following the Norwegian Education Act, §9 A-10. However, it is up to each school to decide what kind of rules and regulations to include, as long as they are within the framework of the Education Act, the Human Rights Act, and private school laws. Each school's code of conduct should state the rights and obligations of the students and include rules about conduct and the measures that can be used against students who violate the rules. Each municipality is responsible for ensuring that each school has elaborated its code of conduct.

Smartphone bans are one rule that each school can determine. As there are no national guidelines or recommendations for students' phone usage in school, schools are free to decide their policy. That is, schools are free to regulate students' phone usage within the framework of the school regulations by, for example, prohibiting the use of smartphones during class time. However, schools cannot forbid students from bringing their smartphones to school, as schools cannot regulate the leisure time of the students, i.e., their use on their way to and from school. If students do not comply with the rules, the schools may take measures against the students. In regard, to smartphone usage, for instance, a teacher may seize a student's phone during school hours if they use it in a manner against the school rules. However, schools are not allowed to keep students' phones after the school day ends (Utdanningsdirektoratet,

[3]Assignment to high schools varies across counties. Twelve of the 19 counties in Norway had a free school choice system in 2016. In rural counties, geographic criteria still largely determine student high school choice.

2020b).

After middle school, students may enroll in high school (grades 11–13). High schools are organized at the county level. All students aged 16 to 23 years in Norway have a statutory right to enrollment at high school. This right is at the county level and does not ensure enrollment in a specific school or program. About 98% of students enroll in high school in Norway in the first year. About 50% of the students enroll in general studies, 45% in vocational programs, and 3% in alternative training plans (Utdanningsdirektoratet, 2023).[4]

2.2 The Norwegian Health Care System

All Norwegian citizens have universal access to publicly financed health services in Norway. The first level of care, primary care, is organized at the municipality level and includes GPs, emergency rooms (ERs), infant and child health care centers, school health services, and elderly care. Specialist care is organized in the four health regions and includes somatic specialist care, psychiatric health services, and private referral specialists.

All Norwegian citizens are entitled to a specific GP's list, who are responsible for providing primary health care. The GP's tasks include setting the correct diagnosis, certifying sick leave, prescribing treatment, or referring to specialist care if needed. Specialized care is provided through public hospitals, but certain private specialists can be contracted. Patients have to be referred to specialist care via GPs or ERs to access specialist treatment (Helfo, 2023).

School children between age 5-20 additionally have access to a free school health care service during school hours. The school health service offers for instance vaccinations, medical examinations, education, and drop-in services. School nurses are employed by the municipality and therefore often provide service to more than one school. School health services can also put students in touch with GPs, dentists, physiotherapists, psychologists, or other specialists (The Norwegian Directorate of Health, 2023). There is no registry over the use of school health services, but 39% of students in middle school report that they have used the school health care during the last year (Bakken, 2019).

3 Data

For this study, I link three primary data sources: a compilation of Norwegian administrative data sets, including the national educational registers, family registers, tax registries, and

[4]Note that only 80% of students initially enrolled in general studies programs graduate and that graduation rates for vocational programs are even lower.

health registers; a nationwide pupil survey; and survey data on middle schools' smartphone policies. I study a sample of students who completed grade 10 between 2010 and 2018. The combined data sources allow me to explore how smartphone policy affects students' health outcomes, educational outcomes, and bullying, using a dynamic event-study design together with a host of robustness checks.

3.1 Individual Level Data

The Norwegian Registry data cover the entire population in Norway up to 2018 and are a collection of different administrative registers, including the central population registry, the family register, the education register, and the earnings and tax register. From these registers, I obtain detailed background information about children and their parents on demographic variables, including gender, date and place of birth, residency, educational attainment, earnings, and immigration status. The parental identifier enables me to match children to their parents. Earnings are not top-coded and include all pension-qualifying income, that is, labor earnings, taxable sickness and unemployment benefits, and parental leave payments.

Importantly, the registry data allow me to test whether the introduction of a smartphone ban changes the composition of the school intake in terms of student, school, and teacher characteristics. By linking the employer-employee registry with the education registry, I construct teacher and principal characteristics at the school level, including type of education, years of experience, and gender ratio.

3.2 Health Data

All visits to GPs and ERs are available from the from the Control and Payment of Health Refunds database (KUHR). KUHR is available between the years 2006–2019. To receive payments, GPs and ERs, report all consultations using International Classification of Primary Care (ICPC-2) codes. ICPC codes provide information about the GPs' assessment of the patient's health problems and the type of care provided.

As many teenagers might seek help through the school health service, via school nurses, instead of their GP, I additionally use the Norwegian Patient Registry (NPR), which contains information on everyone who has received specialized healthcare at a hospital, outpatient clinic, or from contract specialists. School nurses can directly put students in contact with for instance specialists in psychology. NPR is available for the years 2009–2019. Specialists report all consultations using the International Classification of Diseases (ICD-10).

Using this information, I construct variables indicating both whether and how many times each student has visited a GP or ER during middle school. Similarly, for specialist care, I construct measures on whether and how many times a student visited a specialist during middle school years. Specifically, I evaluate ICPC-2 codes starting with "P" for GP visits, containing diagnoses for psychological symptoms, and ICD-10 codes starting with "F" for specialist care related to diagnoses of mental and behavioral disorders. For the health outcomes, I consider academic rather than calendar years to measure the in-school effect. Below, will refer to these outcomes as consultations related to students' "mental health".

3.3 Educational Data

Schools report student grades directly to Statistics of Norway, and grades are available for cohorts born between 1986 and 2002. This includes grades set by the teacher and those from externally graded exams. From grade 8, students begin to receive teacher-awarded grades in each subject. In the final year of middle school, students take written and oral exams. Three days before the exams, students are informed which subjects their exams will cover. Their written exam could be in mathematics, Norwegian, or English, and with the exam subject being decided at the school level. Oral exams are quasi-randomly selected at the student level and, in addition to mathematics, English, and Norwegian, could cover a second language, social science, religion, or natural science. Both written and oral exams are externally graded, with the grades ranging from 1 (the lowest grade) to 6 (the highest grade).

At the end of grade 10, all students obtain a diploma with a total GPA that represents the weighted total of all teacher-awarded grades combined with the exam grades. The middle-school GPA ranges from 0 to 60, where 60 is the best possible grade. These grades are used when applying for high schools and high school programs in a majority of counties. As such, these are high-stakes tests because the scores have long-run impacts on educational possibilities.

Additionally, the education registry contains national exam test scores for cohorts born between 1997–2002. National exams are nationally organized and externally graded. Students take national exams in mathematics, reading, and English in grades 5 and 8. In grade 9, students take a national exam in mathematics and reading. Information from the national exams forms the basis for undergraduate assessment and quality development at all levels of the school system. I use the test scores from grade 5 to condition students' achievements before they enter middle school.[5] High school programs are generally divided between academic and vocational tracks. The data allows me to identify what type of high school

[5]In contrast to the test in grade 10, these national exams involve smaller stakes for students.

program students enroll in the first year.

In my analysis, I use four measurements of student performance as outcome variables. Two of my main outcome variables are middle school GPA and average grades set by teachers at the end of middle school.[6] I then separately look at externally graded test scores from exams in mathematics, Norwegian, and English. While middle-school grades, GPA, and test scores focus on short-term impacts, I also study students' progression into high school education. Specifically, I investigate whether a ban on smartphones in schools affects the type of high school track in which students enroll. For this, I construct a measure for whether students attend an academic or vocational program. High school program choice is associated with long-term human capital enhancements in education and labor market outcomes (Hanushek et al., 2017) and thus captures a broader set of skills and aspirations compared with test scores.

3.4 Pupil Survey

The Norwegian Education Act, §9 A-9, states that each school is responsible for providing a safe environment for children. Thus, strict measures must be taken against any form of bullying at school, such as physical or mental harassment, regardless of whether it occurs online or in person. The Norwegian Directorate for Education and Training administrates an annual national Pupil Survey in which students are asked about bullying, learning, and social well-being in school. The answers are generally used by the schools, the municipality, and the central government to improve the schools. Participation in the survey is compulsory for all schools. The survey is conducted in grades 7, 10 and 13, the last year of high school (Utdanningsdirektoratet, 2020a). As the Pupil Survey contains unique school identifiers for each school, I can link the survey data to the registry data as well as other school-level data.

The data from the Pupil Survey are aggregated at the school level and are available for the years 2007–2019. The exact questions vary across years, but whether students have experienced bullying is measured consistently over the years. Additionally, bullying is the only measure based on a standardized questionnaire (Olweus questionnaire on bullying for pupils). The responses are measured on a scale from 1 to 5 for bullying, with a value close to one being desirable as it represents low levels of reported bullying.

Bullying is defined as repeated negative actions by one or more person/s, against a student who may have difficulty defending him- or herself. It can be calling another person mean names and teasing them, holding a person off, talking behind their backs, pushing, or hitting. The measurement of bullying is based on students' answers to several specific questions

[6] All grades standardized by cohort, with a mean of zero and standard deviation of one.

concerning whether they have been exposed to these kinds of actions, with responses varying from "not at all" (1) to "several times a week" (5). I use the measurement of whether students have experienced any of these kinds of actions by other pupils at their school to measure "incidents of bullying". This variable is reported as the mean among students in grade 10 at school and by gender. Answers from grade 10 students are selected because this is the year in which the middle-school GPA is also measured. To assist interpretation, I standardize the bullying variable to have a mean of zero and a standard deviation of one at the yearly level.

3.5 School Smartphone Policy Data

The identification strategy that I use relies on comparing the outcomes of cohorts with variations in treatment exposure to smartphone bans at different schools. This requires knowing the exact year in which each school implemented a ban regulating smartphone usage during school hours. As noted above, schools are free to set their policy regarding smartphones and other electronic devices in the classroom. As there is no centrally collected data on school policies regarding electronic devices, I collected data on mobile phone policies by sending out a short online survey to all middle schools in Norway in 2019. In total 1,187 middle schools received the survey via an email directed to the principal of each school. The survey contained questions about the school's current policy regulating students' phone usage and the year in which any smartphone policy was introduced. The full questionnaire is provided in the Appendix. Questions regarding the type of policy and how strict it is were also included in the survey. A total of 529 schools had answered the survey by March 2020, for a response rate of 45%, and I can link 477, 40%, of these schools to the registry data.[7] For the bullying outcome 431 schools could be linked from my survey to the pupil survey. This equals 36% of all middle schools.[8] Below I evaluate the representativeness of my sample.

3.6 Descriptive Statistics

Figure 1 plots the number of schools introducing a ban against smartphones in a given year. The figure documents that bans against smartphones in middle schools were unusual before 2010. After 2010, bans were introduced at an increasing rate, with the number of implemented bans peaking in 2016, when 119 middle schools implemented a ban. I define

[7] 52 schools could not be linked, either because they answered that they did not know which year a ban was implemented, in addition, a few schools cannot be linked due to errors in school name or organization number.

[8] The results on health and education are not affected by only including the 431 schools that I can link to the pupil survey.

middle schools as having a strict phone policy if they either (1) ask students not to bring their phones to school or (2) collect phones before classes and store them in a "mobile phone hotel". On average, 45% of the schools that implemented a ban have strict smartphone policies. As shown in Figure 2, it is most common for schools to allow students to use their phones under certain conditions, as long as it does not distract the class.

The left-hand y-axis of Figure 1 shows that the ownership of smartphones/mobile phones is very common among adolescents in Norway. The average ownership rate is above 95% for adolescents aged 12–16 years. In comparison, computer ownership among adolescents is much lower, with only 70% having their own computer (Medietilsynet, 2020). Survey evidence from Norway indicates that more than 60% of all teenagers in grade 10 spend 2 or more hours on their phones each day. However, the difference by gender is large. More than 70% of girls answered that they spend 2 or more hours on their phone each day, compared with only 54% of boys. The gender difference for social media use is even larger; 60% of girls spend 2 or more hours on social media per day, compared with only 32% of boys (Medietilsynet, 2018). Appendix Figure A1 shows that the most common time for teenagers to use their phone is between 7–9 p.m., followed by 4–7 p.m.

The high ownership rate of smartphones among Norwegian adolescents is not surprising given that Norway is one of the most advanced countries in the world in terms of consumers adopting digital media and technological implementation. Despite its many remote areas and the mountainous landscape, as early as 2007, 90% of the Norwegian population had access to 3G coverage. This is documented in Appendix Figure A2. By 2015, 4G coverage was fully available for the Norwegian population. Despite not having individual-level data on smartphone usage, these aggregated numbers show that school regulations targeting smartphones affect most adolescents and impact individuals' smartphone usage during school hours. The geographical coverage of schools implementing a smartphone ban is well spread out across the country. Figure A3, in the Appendix, presents Norwegian municipalities with at least one school implementing a smartphone ban. In total, the data on smartphone bans covers 77% of all municipalities; 328 of the 425 municipalities. 57% of these municipalities are rural areas and 43% urban areas.

My baseline data set contains 161,371 observations. 49% of the sample are girls, and 51% are boys. For the quasi-random and externally graded exams, there are 53,484 observations in mathematics (51% boys and 49% girls), 49,657 observations in Norwegian (50% boys and 50% girls), and 52,820 observations for English exams (50% boys and 50% girls). I do not make any sample restrictions except that I include only individuals who attend a middle school with a known smartphone policy and individuals for whom I can observe health outcomes, teachers' grades, GPA, and national test score data in grade 5.

Table 1 shows the representativeness of the schools in my sample compared to Norway as a whole and to untreated schools. Column 1 illustrates the average characteristics and outcomes of all schools in Norway, Column 2 shows the schools where I was able to obtain information on their smartphone policy, Column 3 non-responding schools, and Column 4 illustrates non-responding schools, but in municipalities where there is at least one responding school. Columns 5–6 show the difference between these samples. Most importantly, average test scores in grade 5, and parents' income and education, measured before starting middle school, show no difference between responding and non-responding schools (Column 6). There is no difference in gender balance, teacher characteristics, such as experience or share of teachers with a teaching degree, and only small differences in the share of students with foreign-born parents, or share of students with married or cohabiting parents.

Comparing the number of students, it is apparent see that sampled schools are on average larger, both compared to the national average and compared to schools in municipalities with at least one responding school. Sampled schools do have slightly higher parental earnings and education compared to the national average (Column 5). While this limits the external validity of my results, these differences pose no threat to my identification strategy that focuses on schools participating in the survey.

4 Empirical Strategy

To investigate how students' mental health, educational outcomes, and bullying are affected by a ban on smartphones, I rely on a difference-in-difference approach. I exploit variations within-school and cross-cohort differences in exposure to smartphone bans induced by the timing of schools' autonomous phone regulation decisions. Although a smartphone ban might have an immediate impact on student outcomes, its effect on students' educational outcomes and experience of bullying could vary over time for two main reasons. First, some cohorts of students are only exposed to a ban for part of their middle school years. This might generate time-varying treatment effects based on the length of exposure to the policy. Second, the ban itself might have time-varying impacts on local school conditions, norms over phone usage, and resources allocated to students, such as teachers' time and effort. Therefore, the effect of a ban might be different in the first, second, or third year after its introduction. To allow for such time patterns, my main empirical strategy is an event-study model that nonparametrically traces out these time-varying treatment effects.

To estimate unbiased effects, the timing of a school adopting a smartphone ban needs to be uncorrelated with other determinants of student outcomes. I start by presenting evidence from an empirical test to support this key identification assumption. To test for this, I study whether school, student, and teacher characteristics can predict the implementation of a smartphone ban. Table 2 presents estimates for η in the following equation:

$$Year_s = \eta X_{s,t0} + \pi_m + \chi_s \tag{1}$$

where $Year_s$ is the year of implementation of a ban of school s, or a dummy variable whether the school implemented a ban before 2016, which is the mean year of implementation for my estimation sample. $X_{s,c0}$ is a vector of pre-ban school-level characteristics for schools, students, and teachers measured in 2008; 2008 was before the introduction of smartphone bans for the vast majority of schools. 2008 also allowed me to measure changes in school-level characteristics before my first cohort started school in 2010. π_m are municipality fixed effects. Column (1) in Table 2 shows the mean for each variable. Column (2) shows estimates of Equation 1 and shows that student characteristics during the period of interest fail to predict when a smartphone ban will be introduced. Column (3) shows that these characteristics fail to predict if a school implemented a ban early versus late. Importantly, neither students' mental health consultancy, performance, the share of students later attending an academic high school track, or bullying can predict when a school implements a smartphone ban. Moreover, the results do not indicate that teacher characteristics, such as gender ratio, education, and experience predict an early implementation of a smartphone ban. What instead is important is that across schools, earlier implementation of a ban took place in schools located in cities, as seen in Column (2). In a robustness check, I therefore drop the two largest cities in Norway; Oslo and Bergen. This robustness check has little effect on my results.

Second, I examine whether the timing of the introduction of the smartphone ban was correlated with changes in student, school, and teacher characteristics using Equation 1. This could be the case if, for instance, smartphone bans were implemented earlier in schools that had experienced an increase in mental health issues among their students, declining average GPA, or increased bullying levels. The results are presented in Column (4) and Column (5) in Table 2. There does not appear to be a significant correlation between the timing of the implementation of a smartphone ban and changes in student, school, and teacher characteristics from 2008 to 2010. Altogether, there seems to be a lack of systematic correlation between when schools implement a ban for both the level of and changes in students' socioeconomic, school, and teacher characteristics.

4.1 Event-Study Specification

My empirical strategy exploits the staggered adoption of smartphone bans between schools within a flexible event-study framework in a manner similar to Bailey and Goodman-Bacon (2015). The event-study framework allows me to directly evaluate the parallel trends assumption. Formally, for individual i, who is in cohort c and attending middle school s:

$$Y_{ics} = \alpha + \sum_{s=-4, s\neq -1}^{5} \psi_y D1(c - T_s^* = y) + \lambda_s + \theta_c + \gamma X_{ics} + \varepsilon_{ics} \tag{2}$$

where Y_{ics} is the reduced form outcome of interest (consultations related to mental health, teacher-awarded grades, GPA, various test score measures, or the probability of attending an academic high school track). λ_s is a set of school-fixed effects that absorb time-invariant differences between schools. This allows for consistent estimates of ψ even in the presence of unobserved differences between schools. The cohort fixed effect, θ, controls for common time-specific shocks within cohorts that might be correlated with the introduction of a smartphone ban or educational outcomes.

X_{ics} is a set of individual and family characteristics, including the individual's gender, parental background characteristics, such as the mother's education and income, mother's age, mother's immigration status, parent's marital status at birth, father's education and income, father's age at birth, father's immigration status, the individual's birth order, a dummy for whether individual i is 1 year older than his or her peers, and a dummy for whether individual i is 1 year younger than his or her peers. The inclusion of these factors has little effect on my results. I additionally control for previous test scores in grade 5 and account for ability, family, and school investment up to grade 5. The interpretation for Y_{ics} when measuring GPA and test scores, should thus be interpreted as the gain in test scores after smartphones were banned.

D_s is a binary indicator for treatment that is equal to 1 from year T_s^*, which is when a school implements a ban. The event-year dummy, $1(c - T_s^* = y)$, is equal to the number of years of exposure that a cohort has to a smartphone ban, with c being the cohort and T_s^* being the implementation year of the smartphone ban at school s. For example, a cohort that finishes middle school in 2018 and is attending a middle school that adopted a smartphone ban in 2017 will have an exposure time of 1. On the other hand, a cohort that finishes middle school in 2015 and is attending a middle school that adopts a smartphone ban in 2018 will have an exposure time of –3. As middle school is 3 years, cohorts with an exposure time of 3 are the first cohorts to be fully exposed to a smartphone ban at middle school s.

The ψ estimates measure the intention-to-treat (ITT) effects of the smartphone ban on students' educational outcomes. In the regression, ψ_{-1} is omitted such that all ψ estimates are relative to the year prior to the smartphone ban adoption. Observations more than 4 years before or 5 years after the mobile phone ban is implemented are captured by dummies $1(c - T_s^* = -4)$ and $1(c - T_s^* = 5)$.[9] Standard errors are clustered at the school level.

The ψ coefficient nonparametrically captures pretreatment relative trends (ψ_{-4} to ψ_{-1}) before a smartphone ban was implemented, as well as time-varying treatment effects (ψ_0 to ψ_5). ψ_{-4} to ψ_{-1} allow for a direct evaluation of the assumption that cohorts at schools implementing a smartphone ban would have had the same outcomes as other cohorts at schools without a smartphone ban in the absence of the ban. If there are any pretreatment trends before the introduction of a smartphone ban, this would suggest a deviation from the secular trends. In other words, the design allows me to evaluate directly whether the timing of the ban is uncorrelated with other determinants of student outcomes.

Conditional on the control variables, the variations arise from two sources. The first is within-school differences in exposure of different cohorts driven by the schools' decision and implementation of a ban. The second source of variation comes from cross-school differences in the timing of adopting smartphone bans.

In contrast to the educational outcomes, bullying is measured at the school level. I use the same event-study model as in Equation 2 but on the school level to estimate the effect of banning smartphones on incidents of bullying. Formally, I regress the following equation for school s and year t:

$$Y_{st} = \alpha + \sum_{s=-4, s\neq -1}^{5} \psi_y D1(c - T_s^* = y) + \lambda_s + \theta_t + \gamma X_{st} + \varepsilon_{st} \tag{3}$$

where Y_{st} is a standardized indicator for bullying. For the school-level analysis, I include the average test scores for students in grade 5, together with the average income, education, age, and marital status of mothers and fathers, the share of students with an immigrant background, and the share of one-year older and one-year younger students in X_{ics}. The estimates are weighted by the number of pupils, and standard errors are clustered at the school level.

Another identification problem is the existence of alternative school-cohort-specific policies or events, such as changes in leadership at school, that were implemented concurrently with the smartphone ban and might impact student outcomes. To address this issue, I added

[9] I choose this event-year window because the sample size is small beyond these values. Note that the binned endpoints are –4 and +5 and that I show estimates from –3 to +4. Endpoint results are not shown in the graphs as they are a combination of several event years and as such, should not be interpreted as treatment effects (Bailey and Goodman-Bacon, 2015). However, my results are invariant to not binning the endpoints.

a dummy variable controlling whether an individual is exposed to a leadership change during the middle school years. This allows me to account for the time-varying characteristics of the school.[10] Additionally, as the previous literature has shown, peer effects appear to be an important determinant of students' achievements (Burke and Sass, 2013). Therefore, I control for peers' previous achievements measured by peers' test scores in grade 5.

Moreover, if the characteristics of new students change post-ban, even though students are assigned to middle schools based on fixed catchment areas, this might change the school environment and alter student outcomes. Even though the estimated effects could be interpreted as the total policy impact in partial equilibrium, this paper aims to estimate the effect of a phone ban on students' educational outcomes and bullying. Therefore, I test whether the characteristics of students or teachers change relative to the introduction of a smartphone ban. The results of this exercise are shown in the Appendix Figure A16. Conditional on school and cohort fixed effects these figures show that there is little evidence that student intake or student and teachers' characteristics changed post-ban.

Note that I do not use estimators discussed in (Roth et al., 2023) here as I do not have a group of schools that never introduced a smartphone ban and could serve as a control group. In addition, the relatively short period during which smartphone bans are implemented does not leave me enough years to use late-adopting schools as a control group for a long enough period.

5 Empirical Results

5.1 Health Outcomes

I start by analyzing the impact of banning smartphones from the classroom on student's mental health during middle school. The year before the event, (-1), corresponds to the omitted category and is always zero by construction. I divide the results between visits for psychological symptoms and diseases at the hospital (specialist treatment) or to the GP. I show results for both the extensive and the intensive margin (number of consultations during middle school). Analysis of the full sample indicates no effect of banning smartphones on student's likelihood of being treated, or on the intensity of treatment, related to psychological symptoms and diseases, as shown in Figure 3.

[10] To my knowledge, there were two countrywide policies implemented during the period considered; the teachers' norm and a homework policy. The teachers' norm was a policy implemented in 2018 to restrict the student-to-teacher ratio to 20 (Utdanningsdirektoratet, 2019b). The homework policy was implemented in 2014 for grades 1–10. In particular, it required that each school provides 8 hours a week for homework assistance, with this time divided between grades 1–10 (Utdanningsdirektoratet, 2019a). As both policies were nationwide, they were absorbed by the cohort fixed effects.

However, the effect of smartphone bans might not be the same for different groups of students. Phone usage is significantly higher among girls than among boys (Medietilsynet, 2018). Hence, girls could be more intensely affected by the ban and, therefore, the potential effect could be larger for girls. In addition, it has been shown that girls and boys react differently to resources in the classroom (Fredriksson et al., 2013; Pekkarinen, 2012), and girls have, on average, increased levels of mental health issues during the adolescent years (Campbell et al., 2021). Despite this, in recent decades, girls have on average outperformed boys in school (Machin and Pekkarinen, 2008), except in mathematics (Bharadwaj et al., 2015).

Figure 4 shows results by gender, both at the extensive margin and the intensive margin for specialist and GP care. Post-ban, girls experience a significant reduction in the number of visits for psychological symptoms and diseases, especially for consultations at specialist care. This result implies that, while girls are still covered by care, they are much less in need of it. Already the same year as the introduction, girls have significantly less need for specialist care. One year of exposure to a smartphone ban reduces the number of consultations by 0.98 visits (p-value 0.044), and three and four years of exposure lead to a reduction of 2–2.7 visits (p-value 0.011 and 0.008 respectively). Girls visit specialist care on average 3.4 times pretreatment, hence this is a significant reduction by almost 60% fewer specialist consultations three years post-ban. Moreover, girls exposed full-time in middle school to the smartphone ban have 0.22 (p-value 0.076) fewer consultations for psychological symptoms and diseases at their GP. This corresponds to a decline of about 29% in number of visits compared to pretreatment mean. There is no effect on girls who are partially exposed to a smartphone ban in middle school for consultations related to psychological symptoms and diseases at the GP level. For specialist care, the effects between girls and boys are statistically different three- and four years post-ban. Although I cannot statistically distinguish the effect between the genders for the number of GP visits, the effect is largely driven by girls.

5.2 Bullying

Another important dimension of students' mental health is the experience of bullying at school. Bullying has been shown in previous research to be predictive of several long-term health, educational, and labor market consequences (Drydakis, 2014). The data for bullying is aggregated at the school level, but the cohorts are the same as for the estimates at the individual level.

When examining the full sample, the estimates show a significant decline in the incidents of bullying after two years of exposure. Bullying incidents decline by 0.25–0.35 standard deviation two to four years after a smartphone ban is implemented (p-values of 0.067 and 0.094), as documented by Figure 5 Panel A. Separating the results by gender, in Panel B, shows that both girls and boys experience a decline in bullying after a ban is implemented. For girls bullying declines by 0.30 standard deviations two years after a smartphone ban is introduced (p-value 0.058). Girls exposed to a full-time, smartphone ban for three years in middle school instead experienced a decline in reporting bullying incidents by 0.42 standard deviations (p-value 0.039) compared to unaffected girls. This corresponds to a 46% reduction compared to the pretreatment mean in reporting the experience of being bullied by other students over the last months. Four years post-ban boys experience a decline in bullying by 0.39 standard deviations or a 43% reduction compared to the pretreatment mean.

Rees et al. (2022) shows that in states where anti-bullying laws were implemented, female students in middle and high school report an 8% reduction in the probability of having been a victim of bullying. Beneitoa and Vicente-Chirivellab (2020) find that after a mobile phone ban was implemented in two regions in Spain, average cases of bullying declined by 15-18% for 12-14 years old and 9-18% for 15-17 years old. Rees et al. (2022) looks at the likelihood of being a victim of bullying (extensive margin). I can only look at the average effect at the school level of students reporting being bullied by other students over the last couple of months as the pupil survey only reports the average number by the school. As such, my findings are comparable and in line with Beneitoa and Vicente-Chirivellab (2020) effects on bullying.

5.3 Educational Performance

Figure 6 shows results on students educational performance by gender.[11] Panel A and B of Figure 6 illustrates the results on GPA and teacher awarded grades. In the years before the ban, the coefficients between girls' and boys' GPAs and grades set by teachers are similar, confirming that female and male students share the same trends prior to the smartphone ban. Girls who started middle school one year after a ban was established gain on average 0.08 standard deviations in GPA, and 0.09 standard deviations in average grades set by teachers (p-values 0.064 and 0.05, respectively). There is no effect on girls who are partially exposed to a smartphone ban in middle school for GPA or teacher average grades.

Previous literature has evaluated much more monetarily expensive policies, such as introducing computers in classrooms or reducing the number of students in a class. There is

[11]The analysis based on the full sample indicates that there is no effect on students' GPA, their average grades set by teachers, or probability of attending an academic high school track. As such, these grades and GPA results are similar to the findings of Kessel et al. (2020). Externally corrected exams in mathematics show some positive effects post-ban for the full sample. These results are presented in Appendix Figure A4.

a large literature on the reduction of class size (Jepsen, 2015; Krueger, 2002). Fredriksson et al. (2013) study class size effects in Sweden, a country with a similar education system to Norway. They show that reducing class size among primary school students in Sweden increases test scores in middle school by 0.02 standard deviations, and increases wages in adulthood by 0.7%. I estimate the increase in GPA and teacher-awarded grades following a smartphone ban to be around 0.08–0.09 standard deviations, a much larger effect size than reducing class size by one student. While I cannot say anything about long-term effects, such as wages, I estimate the effect on the choice of high school track that later could influence the type of university degree and earnings in adulthood (Joensen and Nielsen, 2009). First, I will evaluate the effect on externally graded exams.

The existing literature has found indications that teachers can be biased toward their students (Terrier, 2020; Carlana, 2019; Lavy, 2008). If students behave better after a smartphone policy is in place, a teacher could potentially award students with a higher grade even if they have made no actual improvement in grades. As the Norwegian Registry data contain not only grades set by the teachers but also externally graded exams, I test whether there is an improvement in blind test scores. Blind test scores are reported for the subjects mathematics, Norwegian, and English. Figure 6, Panel C, documents the results on mathematics. Girls have significantly higher test scores in mathematics already one-year post-ban. The gain in mathematics is 0.07 standard deviations (p-value 0.067) one year post-ban and increases to 0.22 standard deviations four years post-ban (p-value 0.014). The substantial increase in externally graded test scores in mathematics for girls suggests that the ban improved human capital accumulation.[12] Barrow et al. (2009) study the effect of a randomized control trial involving the introduction of an instructional computer program for algebra. They find that test scores are 0.25 standard deviations higher among students who use computer-aided instructions. Hence, introducing instructional computer algebra programs and banning smartphones appear to have similar effects. Dahl and Lochner (2012) finds that a rise by $1000 in family annual income increases math and reading test scores by about 0.6 standard deviations. An increase by 0.22 standard deviation is almost 40% of this increase, or $400, assuming linearity.

Survey evidence indicates that girls feel more anxious about mathematics compared with boys (OECD, 2013), and while girls outperform boys in almost all subjects, boys perform generally better in mathematics (Guiso et al., 2008; Fryer Jr and Levitt, 2010; Bharadwaj et al., 2015). One could speculate that during mathematics classes girls are more likely to turn to non-study-related activities on their phones if they struggle with the task and start feeling anxious. When phone usage is prohibited, they are required to focus on the

[12] There is no effect on externally corrected exams in Norwegian or English, as shown in Appendix Figure A5

subject. The increased performance in mathematics among girls is important, since test scores influence the choice of the program at high school track, and subsequently can influence the type of program enrollment at university (Buser et al., 2014; Ceci et al., 2009), and ultimately affect gender differences in earnings as women often shy away from STEM fields with higher earnings (Blau and Kahn, 2000; Joensen and Nielsen, 2009).

Figure 6, Panel D, shows the result for students' likelihood of progressing into an academic high school track. This variable enables me to study whether banning smartphones not only improved short-term outcomes such as grades and test scores but also improved middle-term outcomes such as enrollment into an academic high school track.[13] For girls exposed to a smartphone ban for at least 2 or more years when they are in middle school, the probability of attending an academic high school track increases by 4–7 percentage points. This result shows that banning smartphones increases the probability of them entering a more challenging high school track which thus prepares them for further higher education. These estimates are significant at the 5% level. An alternative way of illustrating this magnitude is to compare it with the pretreatment mean of 49%: The estimated effect suggests there is an 8–14% increase in the number of girls attending an academic high school track compared with the average number of girls who attended an academic high school track relative to pre-ban years. Although, I observe that after a ban has been introduced, girls' educational performance improves I cannot reject the null hypothesis that the coefficients between girls and boys are equal, in any of these results.[14]

Albeit endogenous, controlling for the decline in students' number of specialist consultations for psychological symptoms in Appendix Figure A6, does not alter the positive impact on the measured educational outcomes. The takeaway from this exercise is that the increase in performance in GPA, test scores, and the likelihood of choosing an academic high school track cannot be explained by the orthogonal decline in the number of consultations for mental health issues.

6 Robustness Checks

The results presented in Section 5 imply that girls being exposed to a smartphone ban, since their start of middle school, experienced a significant reduction in their number of consultations at both specialist and GP care for psychological causes and symptoms, improved their GPA, average grades set by their teacher and their test scores in externally corrected

[13] The last year in the education registry is 2018. As such, these results include individuals who finished middle school during or before 2017.

[14] Note that the positive effect on attending an academic high school track three years prior to the introduction of a smartphone ban is driven by boys, for whom there is no effect post-ban.

exams in mathematics. After a ban, girls also become more likely to start an academic track at high school compared to a vocational track and experienced less bullying by other students at their school. These effects are not driven by differential pre-trends, which is the main testable identifying assumption. In this section, I present several additional robustness checks. My main findings are robust to excluding parental background characteristics and excluding observations from the larger cities.

First, I show that my results are not sensitive to including parental background characteristics. Excluding parental background characteristics does not affect non of my outcomes, as shown in Appendix Figure A7, Figure A8 and Figure A9.

Second, the results are not sensitive to dropping schools situated in the two largest cities, Oslo and Bergen. This provides suggestive evidence regarding the external validity of my results across cities. Appendix Figure A10, Figure A11 and Figure A12 show the results when Oslo and Bergen are dropped for mental health, bullying, and educational outcomes. None of my results are affected by dropping the two largest cities in Norway. The top panel of Figure A12 illustrated the results for GPA and teacher awarded grades are stronger when excluding Oslo and Bergen; the positive effect on girls performance is visible already three years post-ban compared to four years as in the main results showed in Figure 6.

Less than 0.4% of the schools in my sample are private schools (545 observations). Private schools might be very different from public schools in many dimensions, and parents must apply to these schools for their children to attend. Dropping private schools from the estimates has no impact on my main results, as shown in Appendix Figure A13, Figure A14 and Figure A15.

Lastly, I also investigate whether students or teachers are endogenously sorting in response to the introduction of smartphone bans using changes in the observed composition of those in a given cohort and attending a certain school in Appendix Figure A16. I find little evidence of any systematic change in the composition of students or teachers that would suggest that parents or teachers are systematically sorting between schools due to a smartphone ban.

7 Heterogeneity

A large literature suggests that family background and school environment characteristics are important traits for both adolescents mental health and student achievement (Björklund and Salvanes, 2011; Reiss, 2013). To disentangle the effect between students of low and high socioeconomic status, I separately examine individuals whose fathers have an academic or vocational high school education.[15] Another important dimension is the type of ban implemented by the school. In my survey, 45% of schools responded that phones are prohibited at school or that phones are collected before class and stored in “mobile phone hotels”. I define these schools as having a strict smartphone policy. Schools that allow phone use during the breaks are defined as schools with lenient policies. To disentangle the effect between these schools, I separately examine students' outcomes by type of policy.

7.1 Socioeconomic Background

Panel A and B in Figure 7 show that girls with low-educated fathers experience a decline in the likelihood of being treated for psychological symptoms and diseases by a specialist by 2–6 percentage points two and three years post-ban (p-values 0.065 and 0.003). Contrary, girls with highly educated fathers, experience an increase in the likelihood of getting specialist care for psychological symptoms and diseases, two and three years post-ban by about 3 percentage points.[16]

Panel C and D in Figure 7 instead show that the decline in the number of consultations related to psychological symptoms and diseases, both for specialist care and GP visits, is driven by girls with a low-educated father. Girls with low-educated fathers experience a decline in the number of consultations by specialists already the first year when a ban is implemented by 1.5 visits (p-value 0.003). For fully exposed girls the number of visits declines by 2.4–3.3 visits (p-values 0.022 and 0.019). Moreover, already two years post-ban there is a clear decline in the number of consultations and treatment by a GP for a psychological cause. Girls having a father with vocational education experience a statistically significant decline by 0.26–0.41 visits two to four years post-ban (p-values 0.064 and 0.081). There is no effect on the intensive margin for girls with academically educated fathers, as shown in Panel C and D in Figure 7. There is no effect on boys post-ban by socioeconomic status.

As the bullying data are on the school level, I cannot study differences by socioeconomic status at the individual level. Nevertheless, I divide schools at the mean based on students with fathers educated at academic high schools. The results are shown in Figure 8. Girls attending low socioeconomic schools experience a decline in bullying by 0.58 standard deviations (p-value 0.046) already one year of exposure and 0.99 standard deviations when they are exposed for full time in middle school (p-value 0.074). There is no significant effect on bullying dependent on the socioeconomic status of the school for boys.

[15] Fathers with less than high school education are grouped together with fathers with vocational education. Fathers with academic education have attended an academic high school track or have attained higher education.

[16] There seems to be slightly more of a pretreatment trend for girls with highly educated fathers. Hence, these results should be interpreted with more caution.

Figure 9, Panel A and B, shows the results for GPA and average grades set by teachers by socioeconomic status. Girls whose fathers have a vocational education experience an increase in both GPA and average grades set by teachers. GPA increases by 0-0.09–0.14 standard deviations post-ban (p-values 0.029 and 0.009), and average grades by 0.09–0.15 standard deviations (p-values 0.032 and 0.006) three and four years post-ban. The improvement in externally corrected mathematics test scores for girls whose fathers have an academic or vocational education is equal. Panel D in Figure 9 presents results for the likelihood of enrolling in an academic high school track. Girls with vocationally educated fathers are 5 percentage points more likely to attend an academic high school track three years post-ban and 6 percentage points more likely four years post-ban (p-values of 0.051 and 0.069). There is no effect on boys' GPA, average grades, test scores, or their probability of attending an academic high school track.

These important differences suggest that unstructured technology is especially distracting for learning and impacts mental health to a larger extent for students from low socioeconomic families, whereas students from high socioeconomic families do not experience any large negative externalities. Between girls, this means that the gap in mental health and educational performance declined along the socioeconomic spectrum, while the insignificant effect for boys also suggests that the gender gap in especially education might increase following the introduction of bans against smartphones in middle school.

7.2 Type of Ban

To disentangle the effect between schools with a strict and more lenient policy against smartphones, I separately examine the students' outcomes by type of policy. Schools where students are required to hand in their phones in the morning, and therefore cannot access them during breaks, are considered to have a strict policy against smartphones. Schools where students are allowed to access their phones during breaks but are required to have them on for instance silent mood during lectures are classified as having a lenient policy toward smartphones.

For mental health, the effect between schools with a more lenient and strict policy is relatively similar, as shown in Figure 10.[17] Four years post-ban, girls experience 3.48 and 2.3 fewer visits for specialist care related to psychological symptoms and diseases at schools with a lenient and strict policy respectively (p-values 0.036 and 0.068).[18] For bullying, there is not much difference dependent on the type of policy implemented when it comes

[17] Although the effect is more visible and direct at schools with a more lenient policy there is also slightly more of a pretreatment trend at these schools.

[18] Results for boys by type of ban are shown in Appendix Figure A20.

to bullying, neither for girls as documented in Figure 11, or boys as shown in Appendix Figure A21.

However, girls attending a middle school introducing a strict policy against smartphones, experience an increase by 0.12 standard deviations in GPA. This estimate is significant four years post-ban at the 5% level (p-value 0.032). Additionally, girls attending a middle school with a strict policy have significantly higher teacher-awarded test scores by 0.08 and 0.14 standard deviations, three and four years post-ban (p-values 0.075 and 0.011). These results, shown in Panel A and B in Figure 12, show that both GPA and average grades set by teachers for girls improve after strict smartphone bans in schools are implemented.

Panel C in Figure 12 shows that for externally graded test scores in mathematics, girls already make improvements one-year post-ban when they attend a school with a strict smartphone policy. One-year post-ban girls experience a gain of 0.09 standard deviation (p-value 0.080) and four years post-ban girls gain 0.25 of a standard deviation (p-value 0.028) in externally corrected mathematics exams. However, there are no detectable differences in the likelihood of attending an academic high school track between schools with strict compared to more lenient policies.[19]

These results by type of policy, suggest that at schools with a strict policy, students experienced a larger increase in their educational performance, when it comes to GPA and test scores. This is in line with several behavioral experiments showing that having the phone nearby but in a silent mood, is still distracting and could potentially even increase phone usage, especially among persons with phone addiction having increased FoMO (Liao and Sundar, 2022). For high school track, mental health, and bullying the results are less pronounced by type of ban.[20]

8 Conclusion

In this paper, I evaluate the effect of banning smartphones from school on students' outcomes. Specifically, I focus on how banning smartphones impacts students' mental health, incidents of bullying, and several measures of educational performance, including GPA, externally corrected exams, and their likelihood of attending an academic high school track. I combine self-administered survey data on the timing at which smartphone bans were implemented with Norwegian Registry data and a pupil survey on bullying. My identification strategy is based on the staggered adoption of smartphone bans across schools and time. Importantly

[19]Boys GPA, test scores, and choice of track at high school is not affected as seen in Appendix Figure A22.

[20]There is no effect on externally corrected exams in Norwegian and English, either by strictness of the ban or by socioeconomic status for boys and girls. Results provided on request.

for the identification strategy, student, teacher, and school characteristics cannot predict when a school implements a smartphone ban.

My results show that banning smartphones leads to a significant decline at the intensive margin for the number of consultations related to diagnosis and treatment for psychological symptoms and diseases, both for specialist and GP care, by 60% and 29% relative to pretreatment mean, respectively. Thus, banning smartphones leads to a reduction in girls' need for care related to mental health issues. Additionally, girls' educational performance improves as their GPA increases by 0.08 and their teacher-awarded grades increase by 0.09 standard deviations. Post-ban girls' externally graded exams in mathematics improved by 0.22 standard deviations, suggesting that the human capital accumulation of girls is improved post-ban. Girls are also 4–7 percentage points more likely to attend an academic high school track post-ban, suggesting that banning smartphones leads to an improvement in girls' mid-term educational outcomes. Further, I provide evidence that bullying decreases by 0.42 and 0.39 of a standard deviation for girls and boys, respectively, when they are exposed full-time in middle school.

The magnitudes of all my estimates are larger among girls from low socioeconomic backgrounds, suggesting that this particular group of students is distracted by unstructured technology in the classroom. There are no negative effects of banning smartphones on students from high socioeconomic families, or on boys.

My results are mostly robust to several specification checks. Although this paper shows robust evidence of the impact of smartphone bans on student outcomes, because the policy is quite recent, I cannot yet analyze students' likelihood of completing high school, nor follow their outcomes in terms of adult health, higher education, or labor market returns. Nevertheless, banning smartphones from the classroom is an inexpensive tool with sizable effects on student's mental health and educational outcomes.

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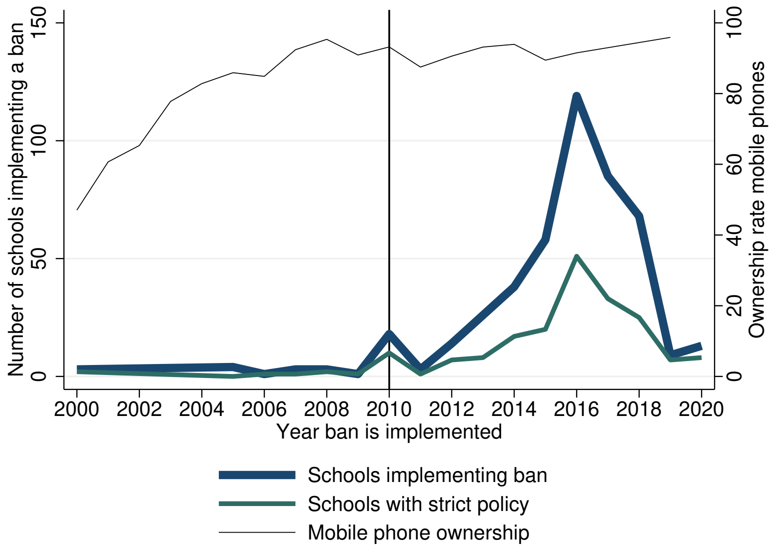
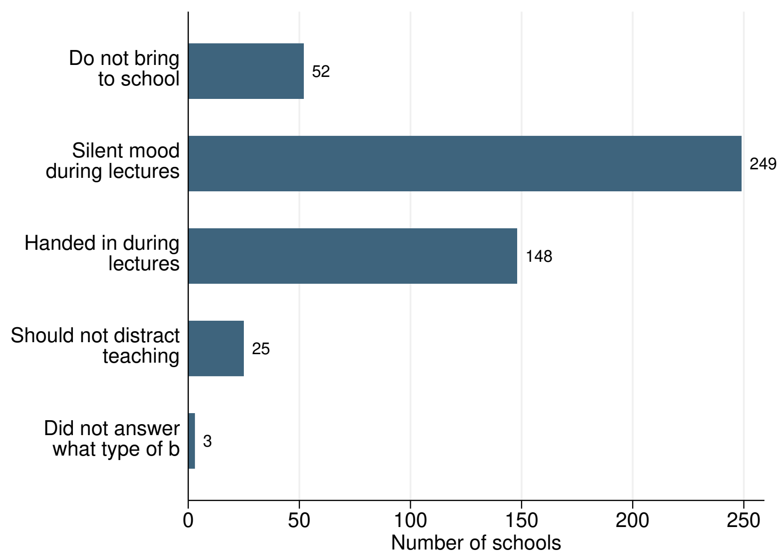
9 Figures and Tables

Figure 1: Introduction of Smartphone Bans Over Time at Middle Schools



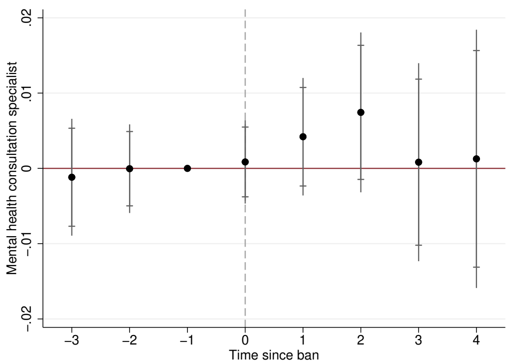
Notes: The number of schools implementing a smartphone ban each year. Strict bans against phones are defined as: (1) students are not allowed to bring phones to school, or (2) phones must be handed in before the class starts and stored in a "mobile phone hotel". Lenient bans allow phone usage during breaks. The vertical line in 2010 indicates the first year that a cohort in my sample starts middle school. The ownership rate of mobile phones is defined for 12–16-year-olds. Source data ownership rate: Culture and Media Use Survey, Statistics Norway.

Figure 2: Type of Smartphone Ban

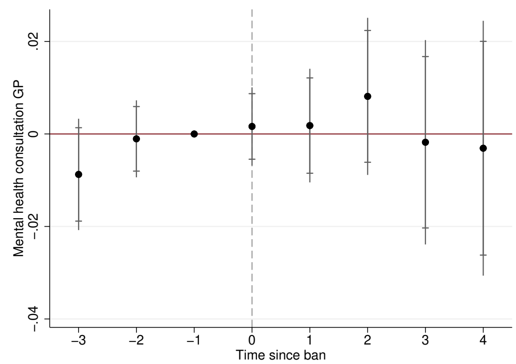


Notes: Distribution by type of ban implemented at schools. Survey answers from school principals. Three schools did not answer what type of policy they had implemented.

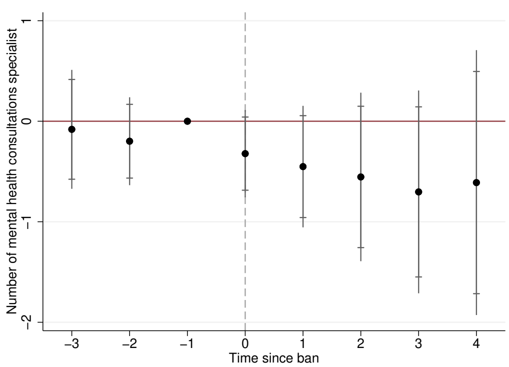
Figure 3: Effect of Smartphone Ban on Diagnosis and Treatment by Specialist and GPs for Psychological Symptoms and Diseases



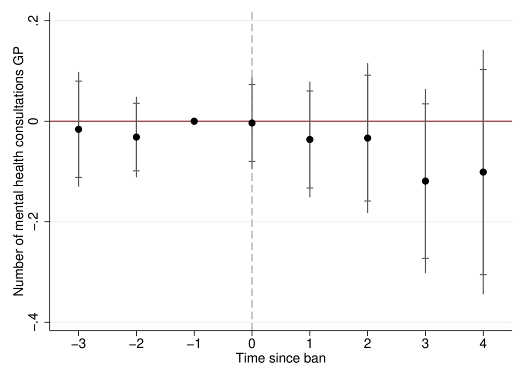
(a) P(Specialist consultation=1)



(b) P(GP consultation=1)



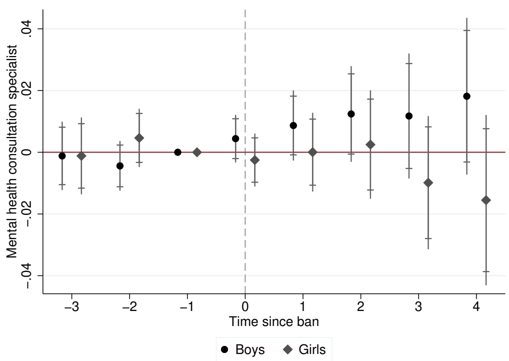
(c) Number of specialist consultations



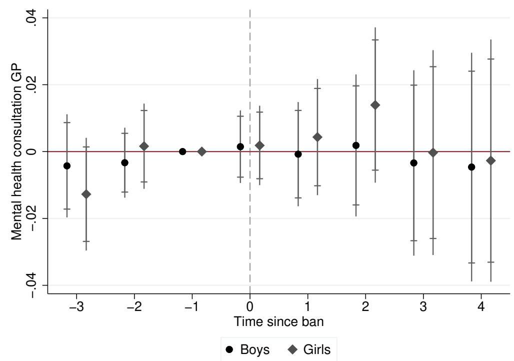
(d) Number of Gp consultations

Notes: Each graph is from a separate regression. All specifications include a full set of cohort and school fixed effects. Robust standard errors are clustered at the school level. Additional control variables are a dummy variable for gender, the mother's education and mother's age at the birth of the child, mother's marital status at the birth of the child, father's education and father's age at birth of the child, a dummy for having foreign-born parents, a dummy for being 1 year older than classmates, a dummy for being 1 year younger than classmates, test score in grade 5, peer's grade from grade 5, a dummy for whether there was a change in leadership during the individual's middle-school years, and the individual's birth order. The reference year is 1 year prior to the introduction of a smartphone ban. Error bars show 95% and 90% confidence intervals.

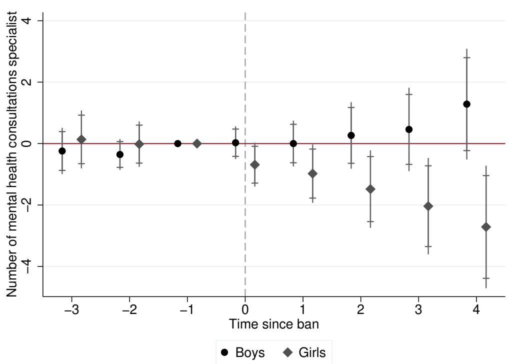
Figure 4: Effect of Smartphone Ban on Diagnosis and Treatment by Specialist and GPs for Psychological Symptoms and Diseases by Gender



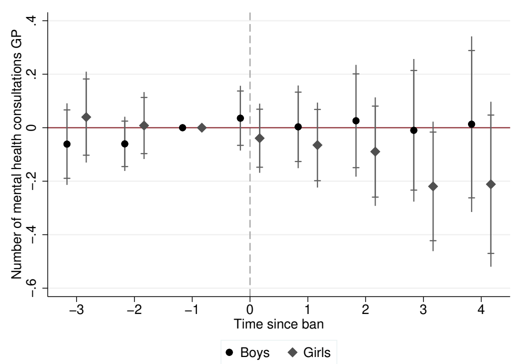
(a) P(Specialist consultation=1)



(b) P(GP consultation=1)



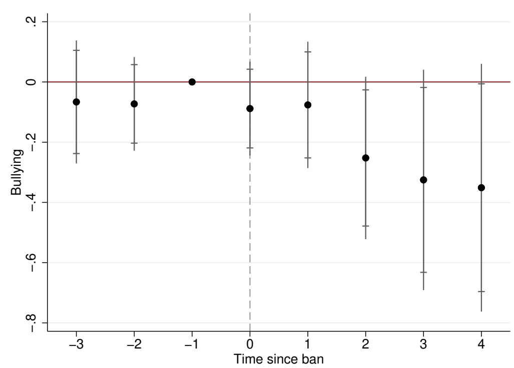
(c) Number of specialist consultations



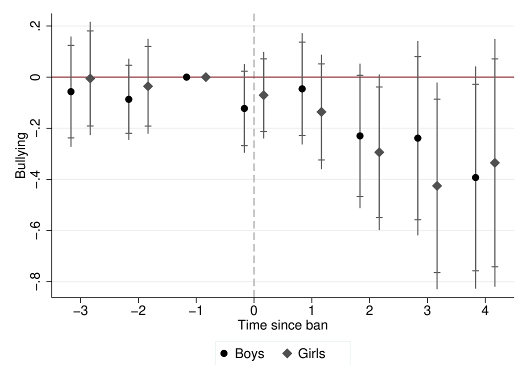
(d) Number of GP consultations

Notes: Each graph is from a separate regression. All specifications include a full set of cohort and school fixed effects. Robust standard errors are clustered at the school level. Additional control variables are a dummy variable for gender, the mother's education and mother's age at the birth of the child, mother's marital status at the birth of the child, father's education and father's age at birth of the child, a dummy for having foreign-born parents, a dummy for being 1 year older than classmates, a dummy for being 1 year younger than classmates, test score in grade 5, peer's grade from grade 5, a dummy for whether there was a change in leadership during the individual's middle-school years, and the individual's birth order. The reference year is 1 year prior to the introduction of a smartphone ban. Error bars show 95% and 90% confidence intervals.

Figure 5: Effect of Smartphone Ban on Bullying by Full Sample and by Gender



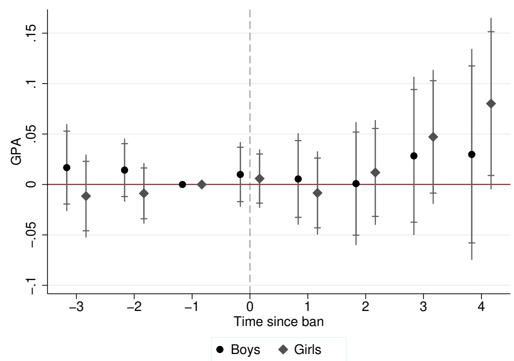
(a) Bullying



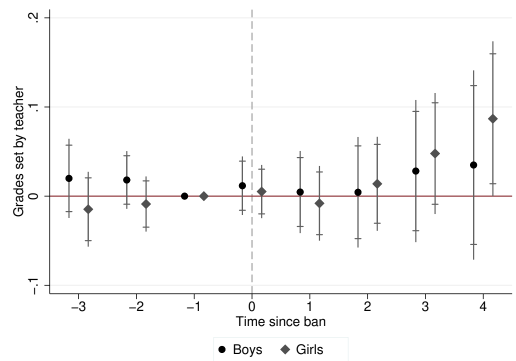
(b) Bullying

Notes: Each graph is from a separate regression. All specifications include a full set of cohort and school fixed effects. Robust standard errors are clustered at the school level. Additional control variables are the mean of mothers' education and the mean of mothers' age at the birth of the child, share of students with married parents at birth, the mean of fathers' education, the mean of fathers' age at birth, share of students being 1 year older than classmates, share of students being 1 year younger than classmates, mean of birth order, share of students with foreign-born parents, mean of students' test scores in grade 5, and a dummy controlling for leadership change. The reference year is 1 year prior to the introduction of a smartphone ban. Error bars show 95% and 90% confidence intervals.

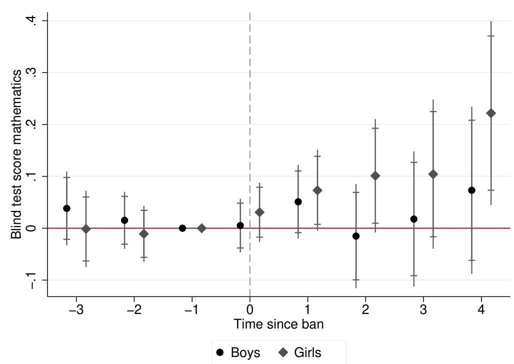
Figure 6: Effect of Smartphone Ban on GPA, Test Scores and Likelihood of Attending an Academic High School Track by Gender



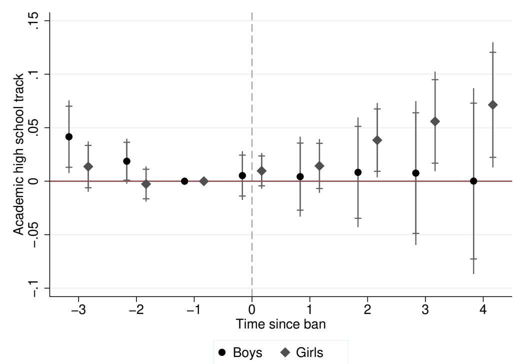
(a) GPA



(b) Teacher's grades



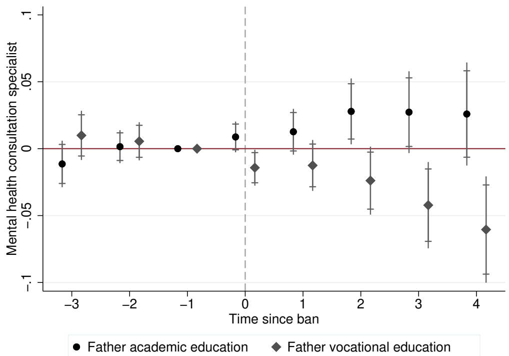
(c) Externally corrected mathematics exam



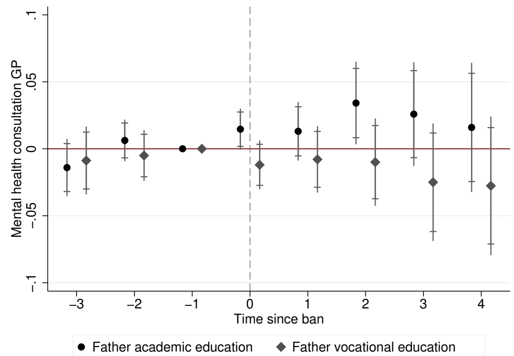
(d) P(Academic track=1)

Notes: Each graph is from a separate regression. All specifications include a full set of cohort and school fixed effects. Robust standard errors are clustered at the school level. Additional control variables are a dummy variable for gender, the mother's education and mother's age at the birth of the child, mother's marital status at the birth of the child, father's education and father's age at birth of the child, a dummy for having foreign-born parents, a dummy for being 1 year older than classmates, a dummy for being 1 year younger than classmates, test score in grade 5, peer's grade from grade 5, a dummy for whether there was a change in leadership during the individual's middle-school years, and the individual's birth order. The reference year is 1 year prior to the introduction of a smartphone ban. Error bars show 95% and 90% confidence intervals.

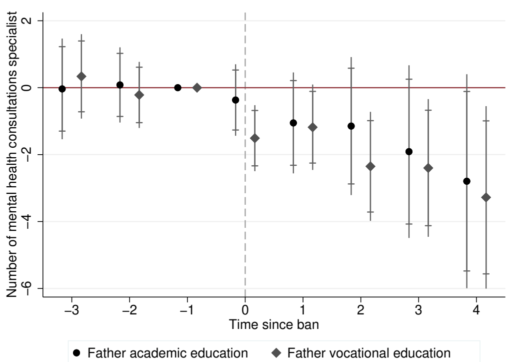
Figure 7: Effect of Smartphone Ban on Diagnosis and Treatment by Specialist and GPs for Psychological Symptoms and Diseases by Father's Education for Girls



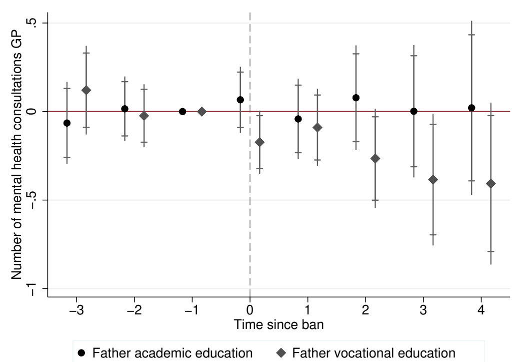
(a) P(Specialist consultation=1)



(b) P(GP consultation=1)



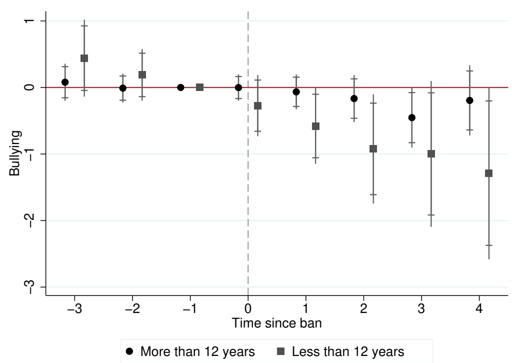
(c) Number of specialist consultations



(d) Number of GP consultations

Notes: Each graph is from a separate regression. All specifications include a full set of cohort and school fixed effects. Robust standard errors are clustered at the school level. Additional control variables are a dummy variable for gender, the mother's education and mother's age at the birth of the child, mother's marital status at the birth of the child, father's education and father's age at birth of the child, a dummy for having foreign-born parents, a dummy for being 1 year older than classmates, a dummy for being 1 year younger than classmates, test score in grade 5, peer's grade from grade 5, a dummy for whether there was a change in leadership during the individual's middle-school years, and the individual's birth order. The reference year is 1 year prior to the introduction of a smartphone ban. Error bars show 95% and 90% confidence intervals.

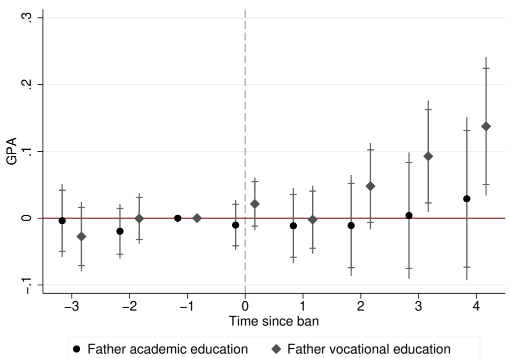
Figure 8: Effect of Smartphone Ban on Bullying by Father's Education for Girls



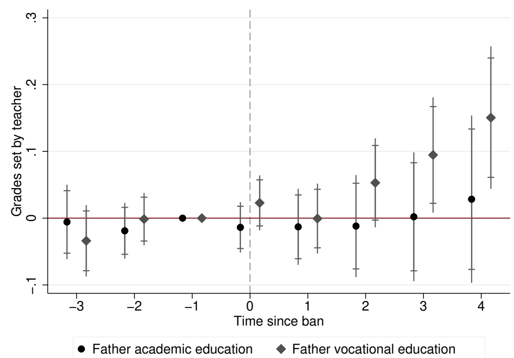
(a) Bullying

Notes: Each graph is from a separate regression. All specifications include a full set of cohort and school fixed effects. Robust standard errors are clustered at the school level. Additional control variables are the mean of mothers' education, the mean of mothers' age at the birth of the child, share of students with married parents at birth, the mean of fathers' education, the mean of fathers' age at birth, share of students being 1 year older than classmates, share of students being 1 year younger than classmates, mean of birth order, share of students with foreign-born parents, mean of students' test scores in grade 5, and a dummy controlling for leadership change. The reference year is 1 year prior to the introduction of a smartphone ban. Error bars show 95% and 90% confidence intervals.

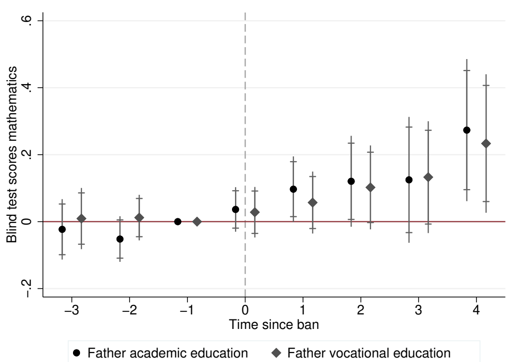
Figure 9: Effect of Smartphone Ban on GPA, Test Scores and Likelihood of Attending an Academic High School Track by Father's Education for Girls



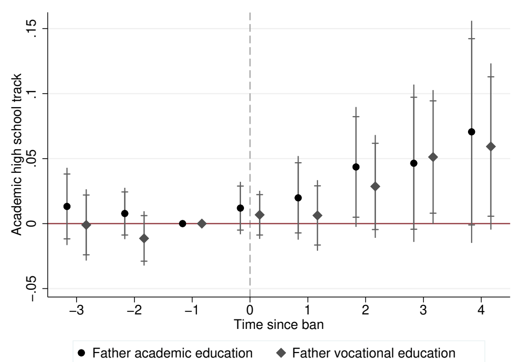
(a) GPA



(b) Teacher's grades



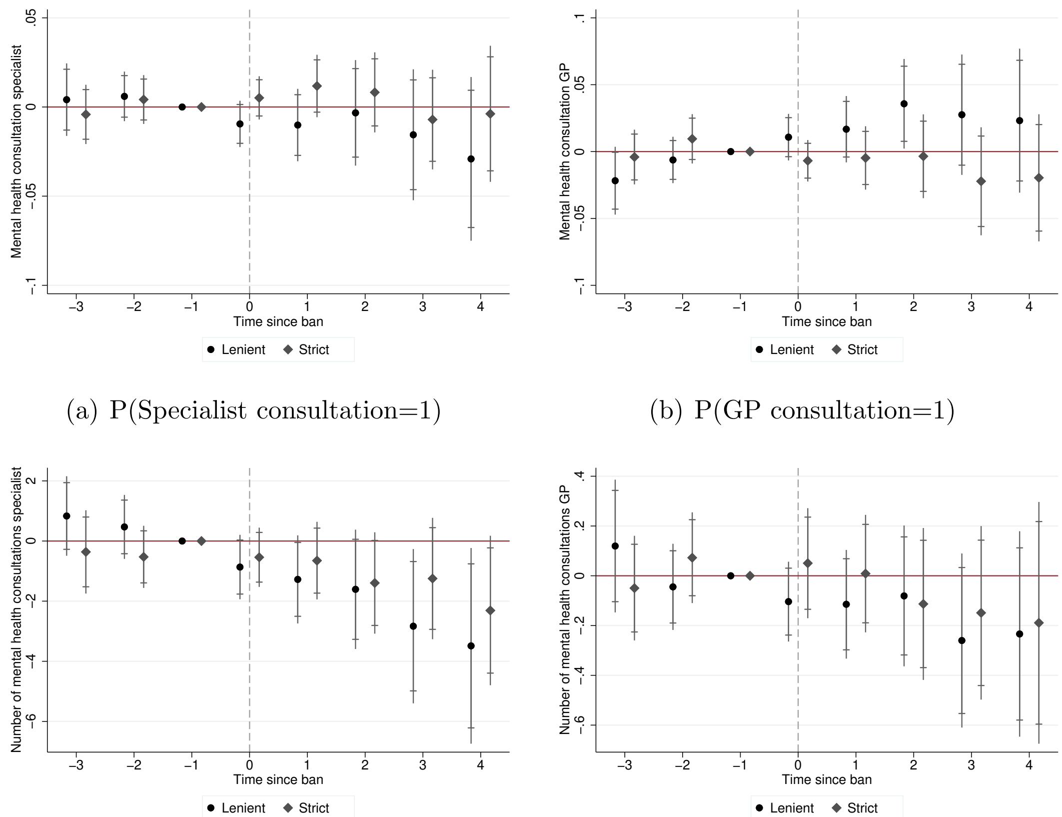
(c) Externally corrected mathematics exam



(d) P(Academic track=1)

Notes:Each graph is from a separate regression. All specifications include a full set of cohort and school fixed effects. Robust standard errors are clustered at the school level. Additional control variables are a dummy variable for gender, the mother's education and mother's age at the birth of the child, mother's marital status at the birth of the child, father's education and father's age at birth of the child, a dummy for having foreign-born parents, a dummy for being 1 year older than classmates, a dummy for being 1 year younger than classmates, test score in grade 5, peer's grade from grade 5, a dummy for whether there was a change in leadership during the individual's middle-school years, and the individual's birth order. The reference year is 1 year prior to the introduction of a smartphone ban. Error bars show 95% and 90% confidence intervals.

Figure 10: Effect of Smartphone Ban on Diagnosis and Treatment by Specialist and GPs for Psychological Symptoms and Diseases by Type of Ban for Girls



(a) P(Specialist consultation=1)

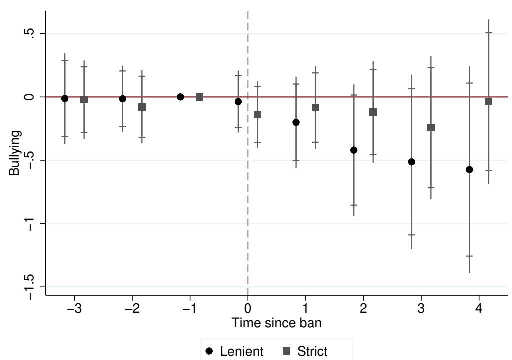
(b) P(GP consultation=1)

(c) Number of specialist consultations

(d) Number of GP consultations

Notes: Each graph is from a separate regression. All specifications include a full set of cohort and school fixed effects. Robust standard errors are clustered at the school level. Additional control variables are a dummy variable for gender, the mother's education and mother's age at the birth of the child, mother's marital status at the birth of the child, father's education and father's age at birth of the child, a dummy for having foreign-born parents, a dummy for being 1 year older than classmates, a dummy for being 1 year younger than classmates, test score in grade 5, peer's grade from grade 5, a dummy for whether there was a change in leadership during the individual's middle-school years, and the individual's birth order. The reference year is 1 year prior to the introduction of a smartphone ban. Error bars show 95% and 90% confidence intervals.

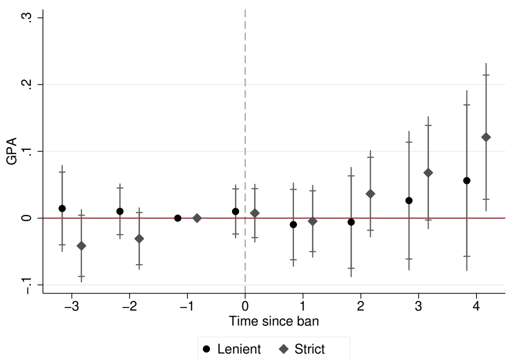
Figure 11: Effect of Smartphone Ban on Bullying by Type of Ban for Girls



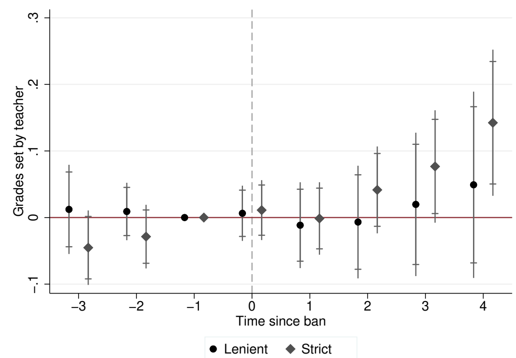
(a) Bullying

Notes: Each graph is from a separate regression. All specifications include a full set of cohort and school fixed effects. Robust standard errors are clustered at the school level. Additional control variables are the mean of mothers' education, the mean of mothers' age at the birth of the child, share of students with married parents at birth, the mean of fathers' education, the mean of fathers' age at birth, share of students being 1 year older than classmates, share of students being 1 year younger than classmates, mean of birth order, share of students with foreign-born parents, mean of students' test scores in grade 5, and a dummy controlling for leadership change. The reference year is 1 year prior to the introduction of a smartphone ban. Error bars show 95% and 90% confidence intervals.

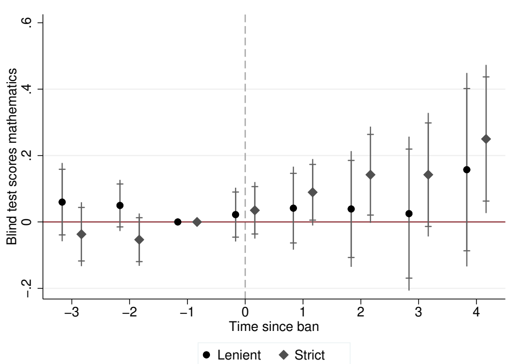
Figure 12: Effect of Smartphone Ban on GPA, Test Scores and Likelihood of Attending an Academic High School Track by Type of Ban for Girls



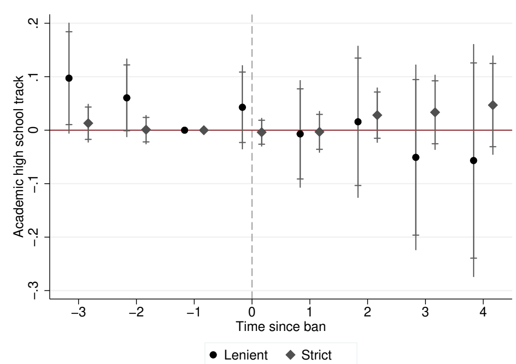
(a) GPA



(b) Teacher's grades



(c) Externally corrected mathematics exam



(d) P(Academic track=1)

Notes: Each graph is from a separate regression. All specifications include a full set of cohort and school fixed effects. Robust standard errors are clustered at the school level. Additional control variables are a dummy variable for gender, the mother's education and mother's age at the birth of the child, mother's marital status at the birth of the child, father's education and father's age at birth of the child, a dummy for having foreign-born parents, a dummy for being 1 year older than classmates, a dummy for being 1 year younger than classmates, test score in grade 5, peer's grade from grade 5, a dummy for whether there was a change in leadership during the individual's middle-school years, and the individual's birth order. The reference year is 1 year prior to the introduction of a smartphone ban. Error bars show 95% and 90% confidence intervals.

Table 1: Descriptive Statistics for Responding Versus Non-responding Schools

	All schools (1)	Responding schools (2)	Non-responding schools (3)	Non-responding schools, within responding municipality (4)	Difference between column (2) and (3) (5)	Difference between column (2) and (4) (6)
	Panel A: Educational performance and mental health					
Test score grade 5	-0.12	-0.09	-0.14	-0.12	-0.06**	-0.04
	[0.31]	[0.25]	[0.34]	[0.39]	(-3.04)	(-1.78)
GPA	-0.02	0.01	-0.04	-0.07	-0.05*	-0.08**
	[0.37]	[0.23]	[0.44]	[0.51]	(-2.24)	(-3.17)
Teachers average grades	-0.01	0.01	-0.03	-0.06	-0.04*	-0.08**
	[0.37]	[0.23]	[0.44]	[0.51]	(-2.00)	(-3.00)
Academic high school track	0.23	0.24	0.22	0.23	-0.02**	-0.02*
	[0.10]	[0.07]	[0.12]	[0.13]	(-2.98)	(-2.29)
Specialist consultation	0.10	0.08	0.12	0.13	0.03***	0.04***
	[0.10]	[0.05]	[0.12]	[0.14]	(5.51)	(6.23)
GP consultation	0.18	0.15	0.19	0.20	0.04***	0.05***
	[0.11]	[0.06]	[0.13]	[0.15]	(6.29)	(6.87)
Number of specialist consultations	4.05	2.69	4.97	6.19	2.27***	3.50***
	[10.89]	[4.32]	[13.55]	[16.86]	(3.55)	(4.38)
Number of GP consultations	1.06	0.84	1.21	1.36	0.37***	0.52***
	[1.58]	[0.55]	[1.98]	[2.41]	(3.96)	(4.57)
	Panel B: School and teacher characteristics					
Number of students	50.92	57.66	46.39	50.03	-11.27***	-7.63**
	[42.96]	[42.63]	[42.61]	[44.85]	(-4.47)	(-2.65)
Sex ratio students	0.49	0.49	0.49	0.49	-0.00	-0.00
	[0.08]	[0.05]	[0.09]	[0.11]	(-0.93)	(-0.38)
Birthyear	1999.42	1999.42	1999.41	1999.47	-0.01	0.04
	[0.61]	[0.25]	[0.76]	[0.77]	(-0.40)	(1.11)
Share of teacher with teaching degree	0.49	0.49	0.49	0.49	0.01	-0.00
	[0.11]	[0.11]	[0.12]	[0.12]	(0.74)	(-0.31)
Sex ratio teachers	0.70	0.69	0.71	0.69	0.01	0.00
	[0.13]	[0.12]	[0.13]	[0.14]	(1.61)	(0.15)
Average experience principal	24.06	24.17	23.97	23.80	-0.20	-0.37
	[8.06]	[7.82]	[8.25]	[8.53]	(-0.40)	(-0.65)
	Panel C: Individual-level characteristics					
Parental income	484.74	495.02	477.83	484.86	-17.19**	-10.16
	[95.42]	[84.68]	[101.47]	[119.21]	(-3.05)	(-1.50)
Parental education	13.05	13.11	13.01	13.15	-0.10*	0.04
	[0.75]	[0.65]	[0.80]	[0.88]	(-2.27)	(0.77)
Share with married parents	0.47	0.46	0.48	0.50	0.01	0.04***
	[0.16]	[0.13]	[0.17]	[0.17]	(1.60)	(3.82)
Share with foreign born parents	0.06	0.05	0.07	0.09	0.02*	0.04***
	[0.11]	[0.09]	[0.13]	[0.16]	(2.33)	(4.37)
Birthorder	1.93	1.92	1.94	1.92	0.02	0.01
	[0.26]	[0.20]	[0.29]	[0.31]	(1.60)	(0.34)
Observations	1187	477	710	447		

Notes: Descriptive statistics for key outcome and control variables between responding schools and non-responding schools. Standard deviations are shown in square brackets. Column (5) shows the difference between students in responding schools versus non-responding schools over the entire period. Column (6) shows the difference between students in responding schools versus non-responding schools, but within a municipality with at least one responding school. Parental income is reported in thousands of Norwegian kroner. T-statistics are shown in parentheses.

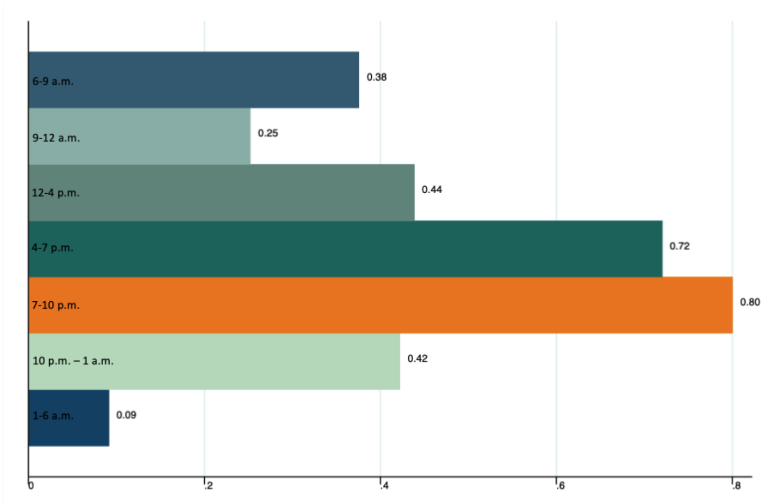
Table 2: The Effect of School, Student and Teacher Characteristics on the Timing of Smartphone Bans

		2008 baseline characteristics		Changes in characteristics between 2008 and 2010	
	Mean 2008	Year implemented	Implementing before 2016	Year implemented	Implementing before 2016
	(1)	(2)	(3)	(4)	(5)
Student characteristics					
Average GPA	39.60	0.060	0.011	-9.224	0.767
		(0.230)	(0.040)	(7.785)	(1.229)
Share attending an academic high school track	0.59	1.095	-0.720	-0.456	0.157
		(4.388)	(0.757)	(1.832)	(0.361)
Share having a mental health consultation specialist	0.04	6.452	2.119	-0.068	-0.006
		(15.040)	(2.270)	(0.278)	(0.049)
Share having a mental health consultation GP	0.10	-1.821	-0.085	0.180	-0.001
		(13.814)	(1.947)	(0.642)	(0.128)
Average number of mental health consultations specialist	0.84	0.162	-0.062	-0.011*	0.002
		(0.364)	(0.058)	(0.006)	(0.001)
Average number of mental health consultations GP	0.44	-0.919	0.069	-0.055	0.002
		(2.458)	(0.264)	(0.151)	(0.028)
Bullying	1.44	1.875	-0.220	-1.599	0.064
		(1.517)	(0.249)	(2.004)	(0.363)
School and teacher characteristics					
Number of students	68.19	0.006	-0.001	0.335	0.041
		(0.010)	(0.002)	(1.159)	(0.205)
Share foreign born	0.05	-4.257	0.713	-0.682	-0.027
		(11.264)	(1.795)	(0.612)	(0.088)
Share female students	0.49	1.577	0.015	0.372	-0.038
		(4.063)	(0.640)	(1.029)	(0.169)
Average education parents	12.20	-0.601	0.129	-1.951	1.646
		(0.899)	(0.150)	(10.666)	(1.794)
Average income parents	388.37	0.001	-0.000	0.425	-0.213
		(0.006)	(0.001)	(1.960)	(0.447)
Share with married parents	0.56	1.782	-0.069	-2.084	0.298
		(3.809)	(0.650)	(1.590)	(0.309)
Share foreign born parents	0.05	-5.420	0.271	0.654	0.007
		(7.482)	(1.236)	(0.406)	(0.072)
Average experience teachers	19.84	-0.056	0.013	0.282	0.027
		(0.079)	(0.015)	(1.981)	(0.383)
Share female teachers	0.64	0.858	-0.241	-1.735	0.484
		(2.025)	(0.413)	(3.003)	(0.414)
Share teacher with a teaching degree	0.52	-1.445	0.288	-1.509	-0.265
		(3.388)	(0.561)	(2.907)	(0.414)
Average experience principal	25.59	0.002	0.004	0.044	0.015
		(0.052)	(0.007)	(0.149)	(0.020)
City	0.13	4.933**	-0.334		
		(2.279)	(0.368)		
R^2		0.734	0.626	0.749	0.628
Observations	429	429	429	429	429

Notes: Each column represents a separate linear probability model of the likelihood of the implementation of a smartphone ban in a given period in relation to various student, school and teacher characteristics or changes in various student, school and teacher characteristics. The experience of principals and teachers is defined as the number of years employed at any school. The regression controls for county fixed effects. Robust standard errors are shown in parentheses. Significance levels: *** 1% level, ** 5% level, * 10% level.

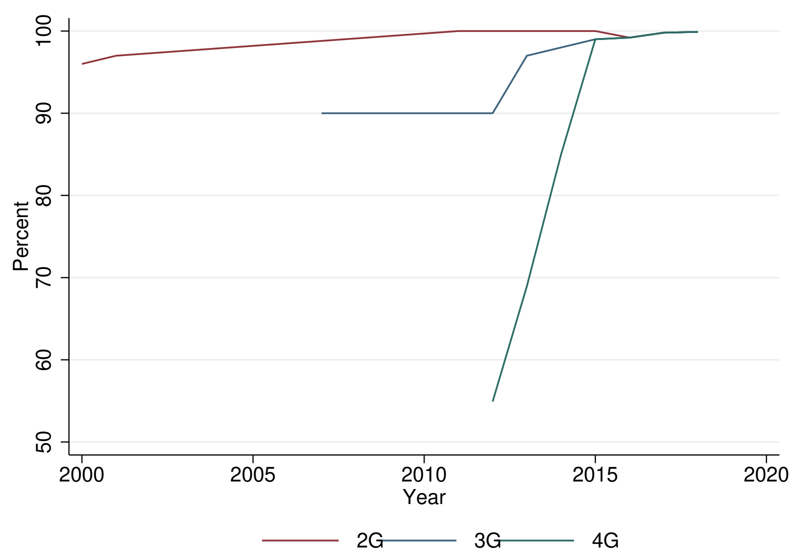
For Online Publication: Online Appendix

Figure A1: Distribution of Screen Time Over the Day for 13–16 Years Old



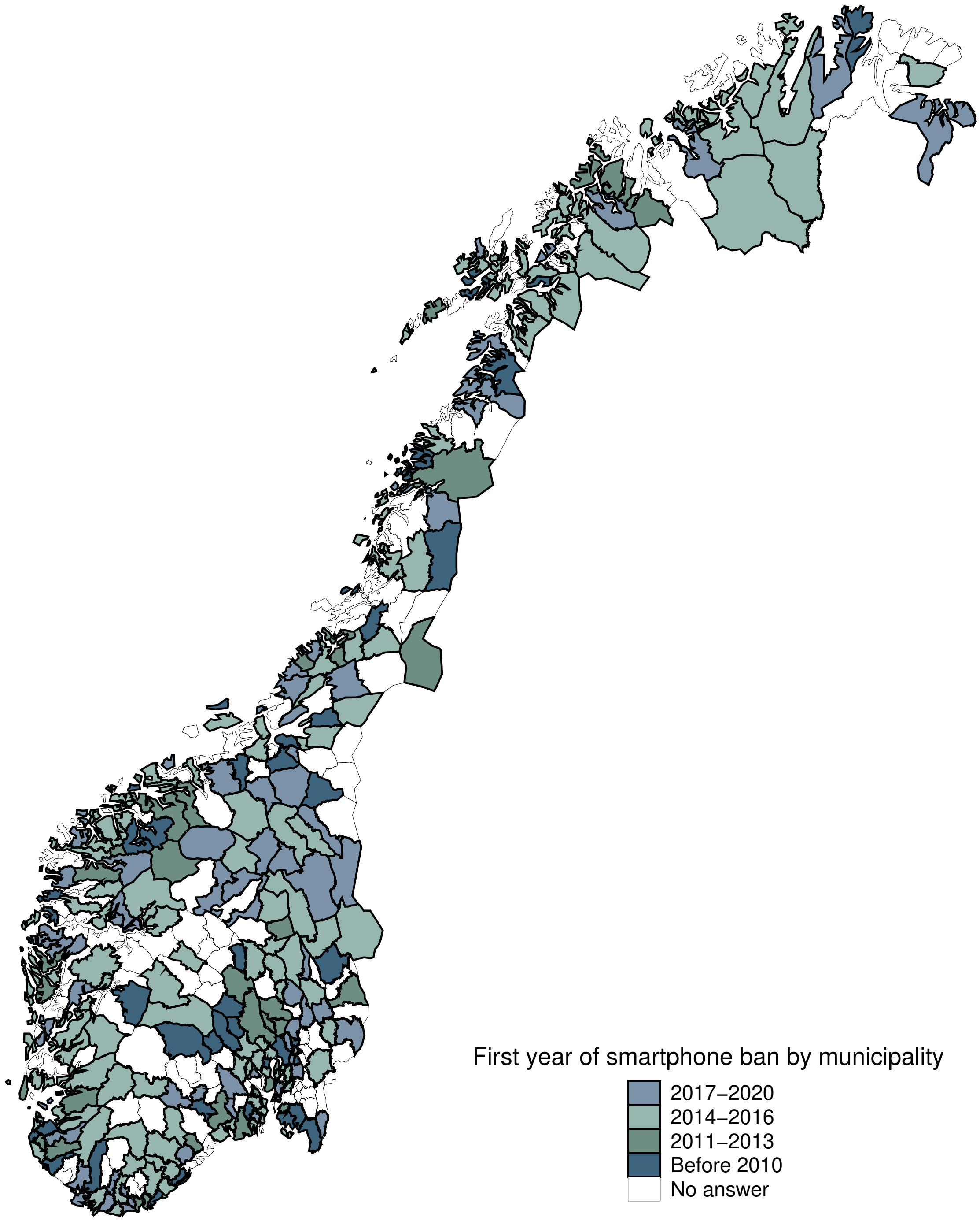
Notes: Distribution of screen time over a week day for 13–16 years old adolescents. Screen time include time spent on smartphone, PC or TV. Source: Ungdata, own calculations.

Figure A2: Proportion of Population Covered by a Mobile Network



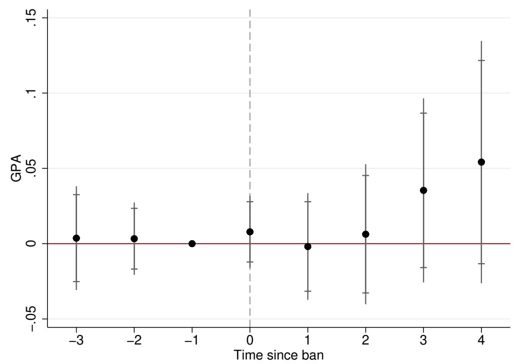
Source: SDG Indicators, United Nations Statistics Division, own calculations.

Figure A3: Geographical Coverage over Municipalities with at Least one School Implementing a Smartphone Ban

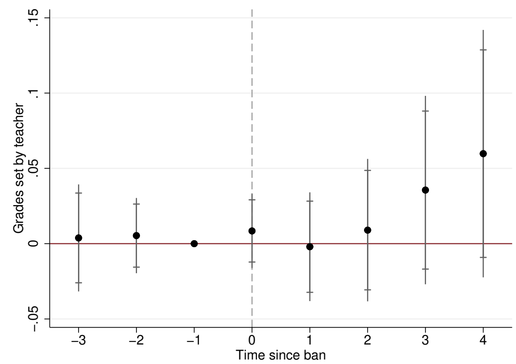


Notes: The map displays Norway's 425 municipalities. All colored municipalities have at least on middle school with a ban against smartphones. The different colors indicate when the first middle school in each of these municipalities implemented a ban. In the white municipalities there where no school answering my survey.

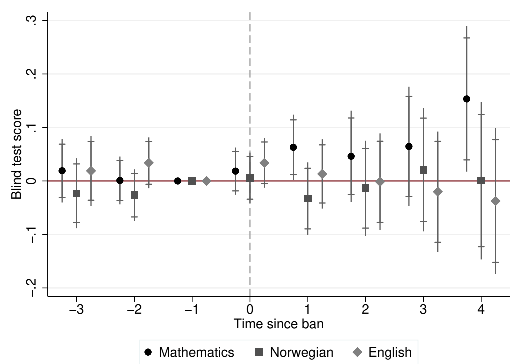
Figure A4: Effect of Smartphone Ban on GPA, Test Scores and Likelihood of Attending an Academic High School Track



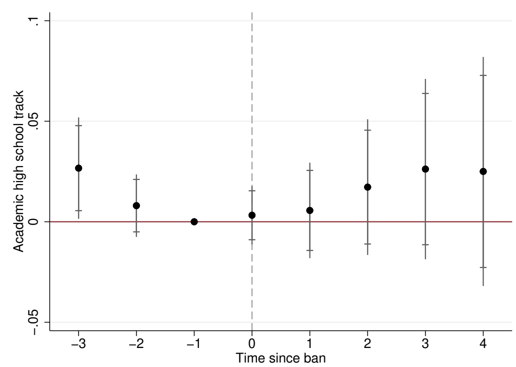
(a) GPA



(b) Teacher's grades



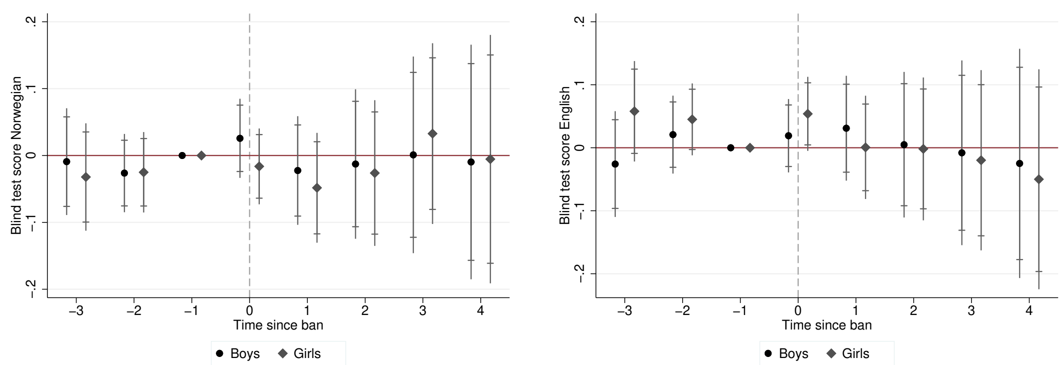
(c) Externally corrected exams



(d) P(Academic track=1)

Notes: Each graph is from a separate regression. All specifications include a full set of cohort and school fixed effects. Robust standard errors are clustered at the school level. Additional control variables are a dummy variable for gender, the mother's education and mother's age at the birth of the child, mother's marital status at the birth of the child, father's education and father's age at birth of the child, a dummy for having foreign-born parents, a dummy for being 1 year older than classmates, a dummy for being 1 year younger than classmates, test score in grade 5, peer's grade from grade 5, a dummy for whether there was a change in leadership during the individual's middle-school years, and the individual's birth order. The reference year is 1 year prior to the introduction of a smartphone ban. Error bars show 95% and 90% confidence intervals.

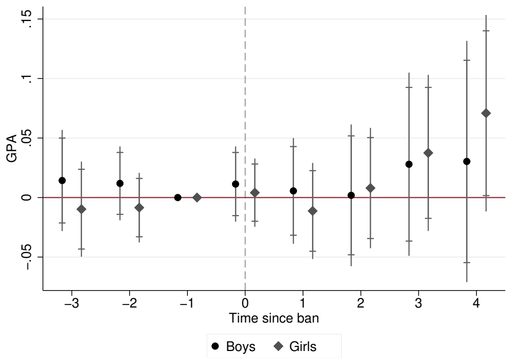
Figure A5: Effect of Externally Corrected Exams in Norwegian and English by Gender



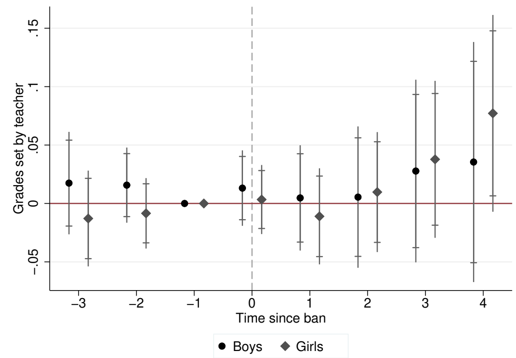
(a) Externally corrected Norwegian exam (b) Externally corrected English exam

Notes:Each graph is from a separate regression. All specifications include a full set of cohort and school fixed effects. Robust standard errors are clustered at the school level. Additional control variables are a dummy variable for gender, the mother's education and mother's age at the birth of the child, mother's marital status at the birth of the child, father's education and father's age at birth of the child, a dummy for having foreign-born parents, a dummy for being 1 year older than classmates, a dummy for being 1 year younger than classmates, test score in grade 5, peer's grade from grade 5, a dummy for whether there was a change in leadership during the individual's middle-school years, and the individual's birth order. The reference year is 1 year prior to the introduction of a smartphone ban. Error bars show 95% and 90% confidence intervals.

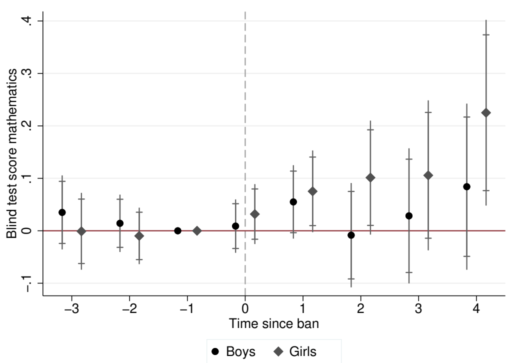
Figure A6: Effect of Smartphone Ban on GPA, Test Scores and Likelihood of Attending an Academic High School Track by Gender, while Controlling for the Number of Specialist Consultations for Psychological Symptoms and Diseases



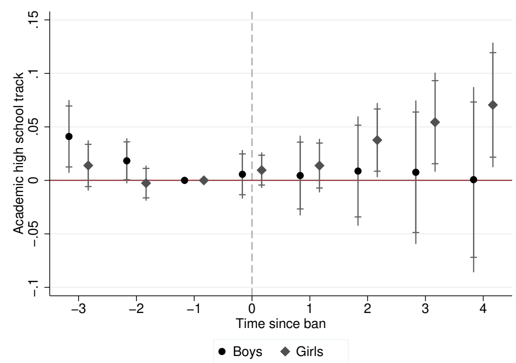
(a) GPA



(b) Teacher's grades



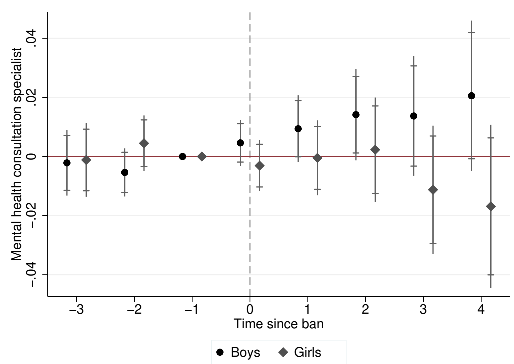
(c) Externally corrected exams



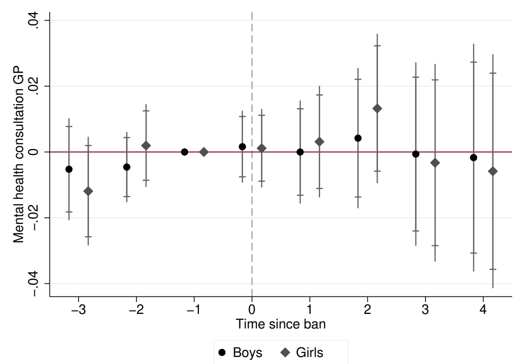
(d) P(Academic track=1)

Notes: Each graph is from a separate regression. All specifications include a full set of cohort and school fixed effects. Robust standard errors are clustered at the school level. Additional control variables are a dummy variable for gender, the mother's education and mother's age at the birth of the child, mother's marital status at the birth of the child, father's education and father's age at birth of the child, a dummy for having foreign-born parents, a dummy for being 1 year older than classmates, a dummy for being 1 year younger than classmates, test score in grade 5, peer's grade from grade 5, a dummy for whether there was a change in leadership during the individual's middle-school years, the individual's birth order, and a control for the number of specialist consultations for psychological symptoms and diseases. The reference year is 1 year prior to the introduction of a smartphone ban. Error bars show 95% and 90% confidence intervals.

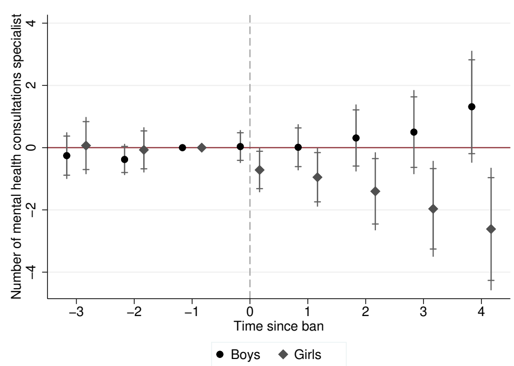
Figure A7: Effect of Smartphone Ban on Diagnosis and Treatment by Specialist and GPs for Psychological Symptoms and Diseases by Gender, Excluding Parental Control Variables



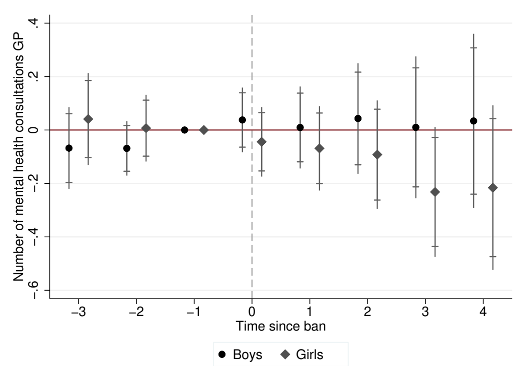
(a) P(Specialist consultation=1)



(b) P(GP consultation=1)



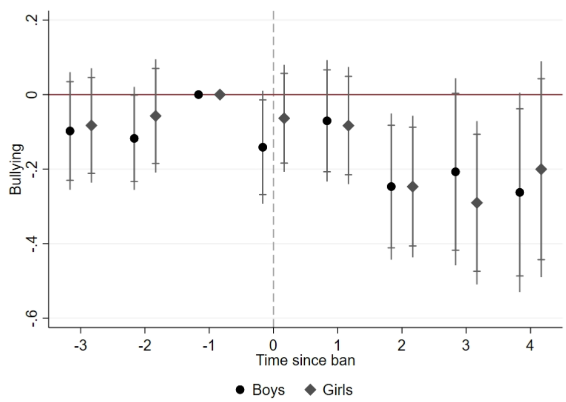
(c) Number of specialist consultations



(d) Number of GP consultations

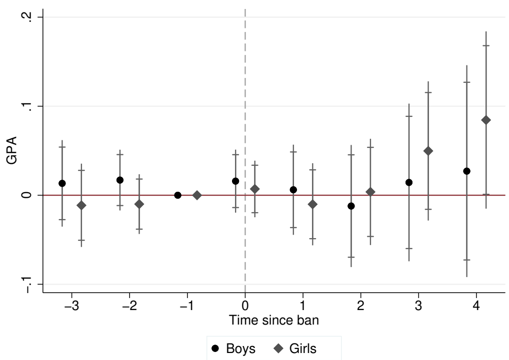
Notes: Each graph is from a separate regression. All specifications include a full set of cohort, school fixed effects and a control variable for test score in grade 5. Robust standard errors are clustered at the school level. The reference year is 1 year prior to the introduction of a smartphone ban. Error bars show 95% and 90% confidence intervals.

Figure A8: Effect of Smartphone Ban on Bullying by Gender, Excluding Parental Control Variables

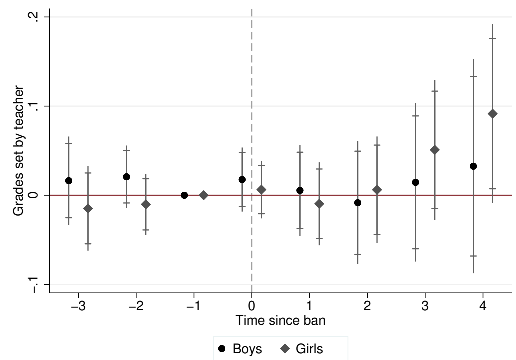


Notes: Each graph is from a separate regression. All specifications include a full set of cohort and school fixed effects. Robust standard errors are clustered at the school level. The reference year is 1 year prior to the introduction of a smartphone ban. Error bars show 95% and 90% confidence intervals.

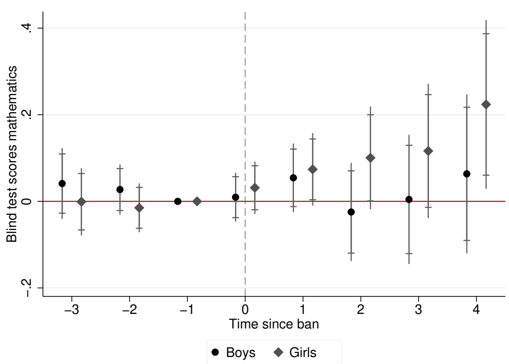
Figure A9: Effect of Smartphone Ban on GPA, Test Scores and Likelihood of Attending an Academic High School Track by Gender, Excluding Parental Control Variables



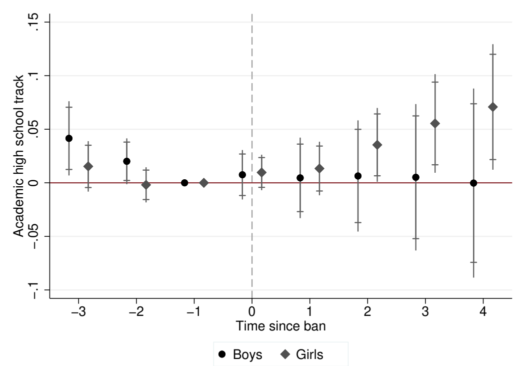
(a) GPA



(b) Teacher's grades



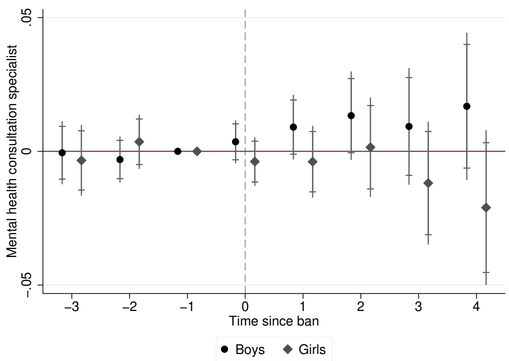
(c) Externally corrected mathematics exam



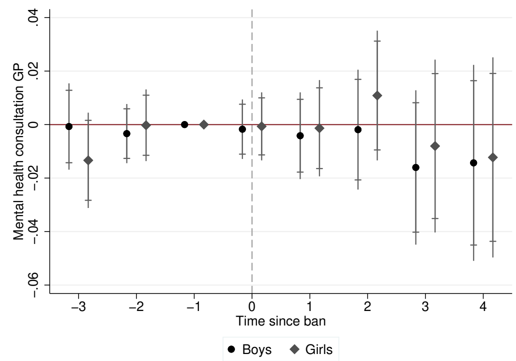
(d) P(Academic track=1)

Notes: Each graph is from a separate regression. Each graph is from a separate regression. All specifications include a full set of cohort, school fixed effects and a control variable for test score in grade 5. Robust standard errors are clustered at the school level. The reference year is 1 year prior to the introduction of a smartphone ban. Error bars show 95% and 90% confidence intervals.

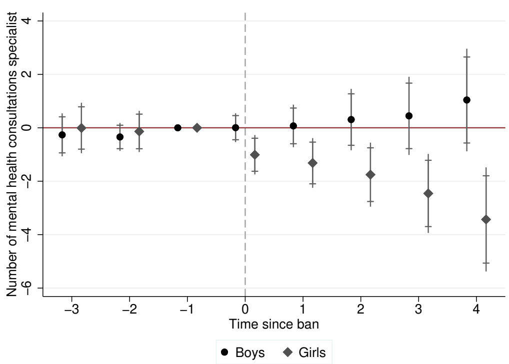
Figure A10: Effect of Smartphone Ban on Diagnosis and Treatment by Specialist and GPs for Psychological Symptoms and Diseases by Gender, Excluding Middle Schools in Oslo and Bergen



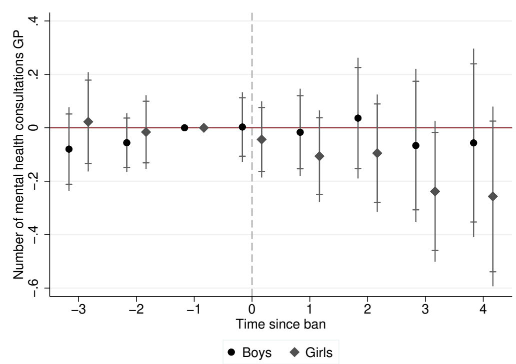
(a) P(Specialist consultation=1)



(b) P(GP consultation=1)



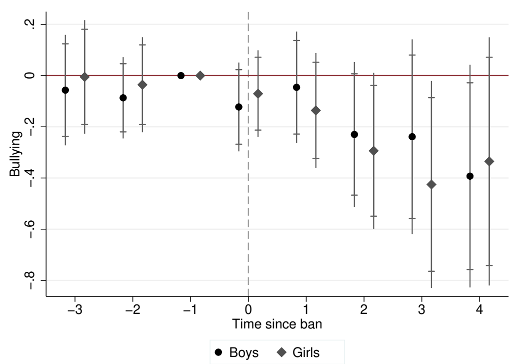
(c) Number of specialist consultations



(d) Number of GP consultations

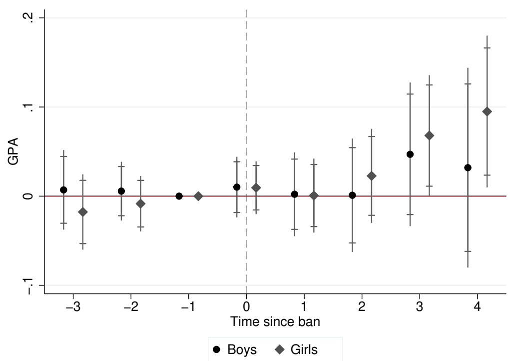
Notes: Each graph is from a separate regression. All specifications include a full set of cohort and school fixed effects. Robust standard errors are clustered at the school level. Additional control variables are a dummy variable for gender, the mother's education and mother's age at the birth of the child, mother's marital status at the birth of the child, father's education and father's age at birth of the child, a dummy for having foreign-born parents, a dummy for being 1 year older than classmates, a dummy for being 1 year younger than classmates, test score in grade 5, peer's grade from grade 5, a dummy for whether there was a change in leadership during the individual's middle-school years, and the individual's birth order. The reference year is 1 year prior to the introduction of a smartphone ban. Error bars show 95% and 90% confidence intervals.

Figure A11: Effect of Smartphone Ban on Bullying by Gender, Excluding Middle Schools in Oslo and Bergen

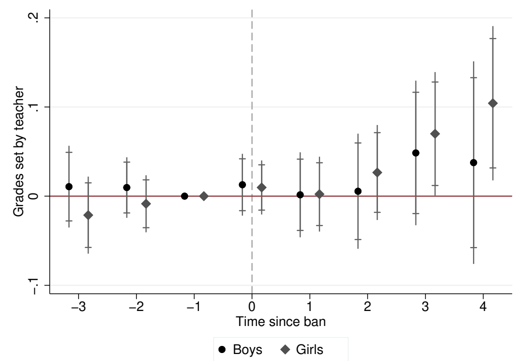


Notes: Each graph is from a separate regression. All specifications include a full set of cohort and school fixed effects. Robust standard errors are clustered at the school level. Additional control variables are the mean of mothers' education, the mean of mothers' age at the birth of the child, share of students with married parents at birth, the mean of fathers' education, the mean of fathers' age at birth, share of students being 1 year older than classmates, share of students being 1 year younger than classmates, mean of birth order, share of students with foreign-born parents, mean of students' test scores in grade 5, and a dummy controlling for leadership change. The reference year is 1 year prior to the introduction of a smartphone ban. Error bars show 95% and 90% confidence intervals.

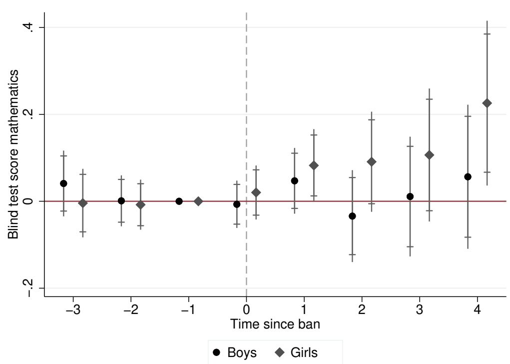
Figure A12: Effect of Smartphone Ban on GPA, Test Scores and Likelihood of Attending an Academic High School Track by Gender, Excluding Middle Schools in Oslo and Bergen



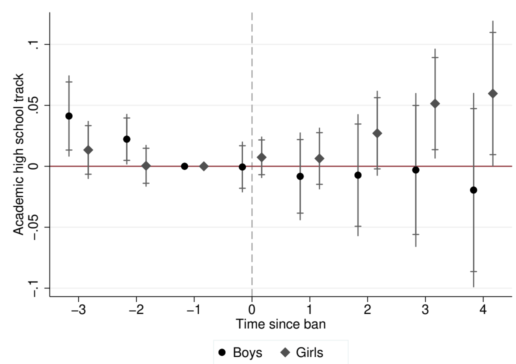
(a) GPA



(b) Teacher's grades



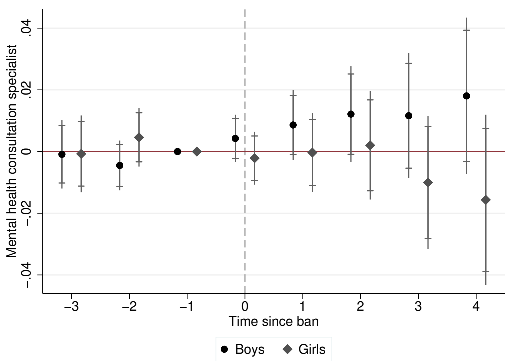
(c) Externally corrected mathematics exam



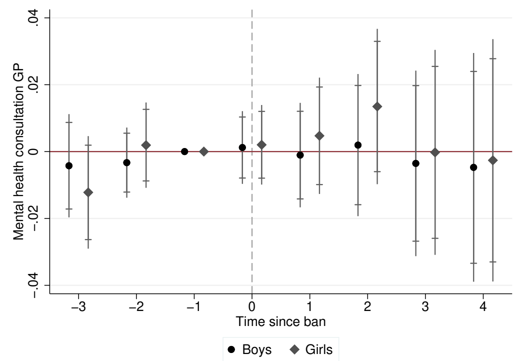
(d) P(Academic track=1)

Notes: Each graph is from a separate regression. All specifications include a full set of cohort and school fixed effects. Robust standard errors are clustered at the school level. Additional control variables are a dummy variable for gender, the mother's education and mother's age at the birth of the child, mother's marital status at the birth of the child, father's education and father's age at birth of the child, a dummy for having foreign-born parents, a dummy for being 1 year older than classmates, a dummy for being 1 year younger than classmates, test score in grade 5, peer's grade from grade 5, a dummy for whether there was a change in leadership during the individual's middle-school years, and the individual's birth order. The reference year is 1 year prior to the introduction of a smartphone ban. Error bars show 95% and 90% confidence intervals.

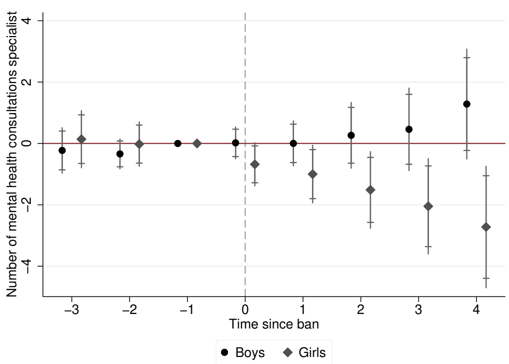
Figure A13: Effect of Smartphone Ban on Diagnosis and Treatment by Specialist and GPs for Psychological Symptoms and Diseases by Gender, Excluding Private Middle Schools



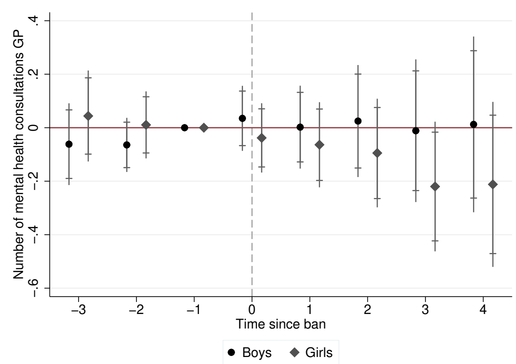
(a) P(Specialist consultation=1)



(b) P(GP consultation=1)



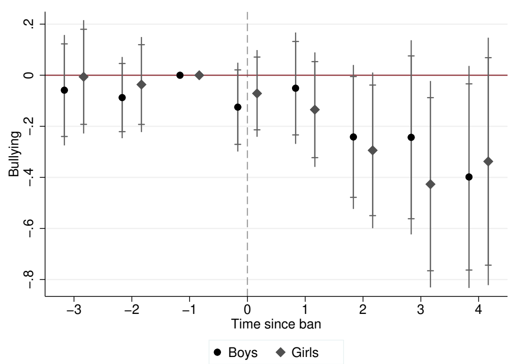
(c) Number of specialist consultations



(d) Number of GP consultations

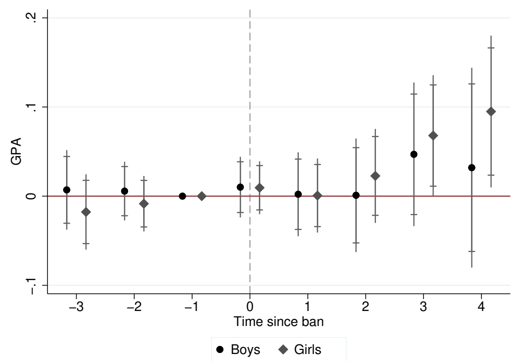
Notes: Each graph is from a separate regression. All specifications include a full set of cohort and school fixed effects. Robust standard errors are clustered at the school level. Additional control variables are a dummy variable for gender, the mother's education and mother's age at the birth of the child, mother's marital status at the birth of the child, father's education and father's age at birth of the child, a dummy for having foreign-born parents, a dummy for being 1 year older than classmates, a dummy for being 1 year younger than classmates, test score in grade 5, peer's grade from grade 5, a dummy for whether there was a change in leadership during the individual's middle-school years, and the individual's birth order. The reference year is 1 year prior to the introduction of a smartphone ban. Error bars show 95% and 90% confidence intervals.

Figure A14: Effect of Smartphone Ban on Bullying by Gender, Excluding Private Middle Schools

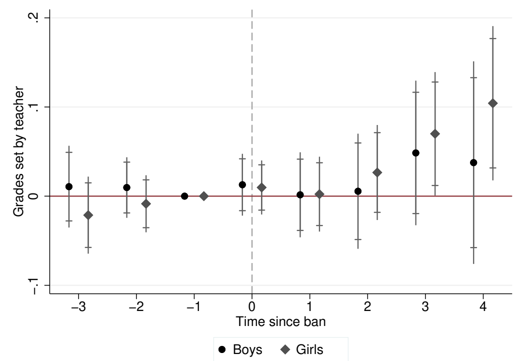


Notes: Each graph is from a separate regression. All specifications include a full set of cohort and school fixed effects. Robust standard errors are clustered at the school level. Additional control variables are the mean of mothers' education, the mean of mothers' age at the birth of the child, share of students with married parents at birth, the mean of fathers' education, the mean of fathers' age at birth, share of students being 1 year older than classmates, share of students being 1 year younger than classmates, mean of birth order, share of students with foreign-born parents, mean of students' test scores in grade 5, and a dummy controlling for leadership change. The reference year is 1 year prior to the introduction of a smartphone ban. Error bars show 95% and 90% confidence intervals.

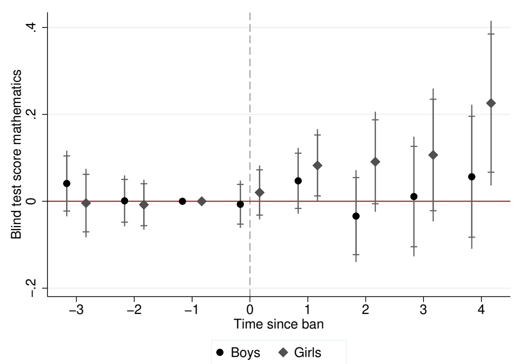
Figure A15: Effect of Smartphone Ban on GPA, Test Scores and Likelihood of Attending an Academic High School Track by Gender, Excluding Private Middle Schools



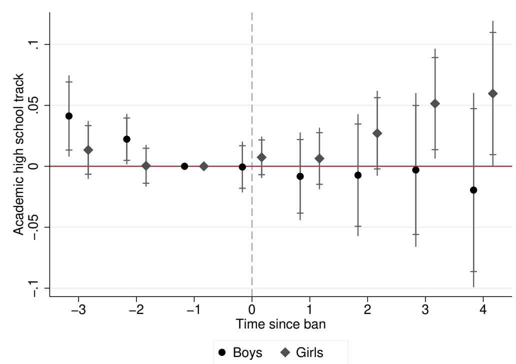
(a) GPA



(b) Teacher's grades



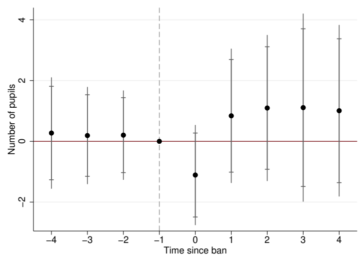
(c) Externally corrected mathematics exam



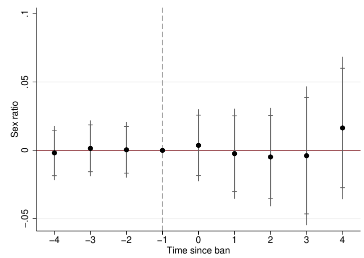
(d) P(Academic track=1)

Notes: Each graph is from a separate regression. All specifications include a full set of cohort and school fixed effects. Robust standard errors are clustered at the school level. Additional control variables are a dummy variable for gender, the mother's education and mother's age at the birth of the child, mother's marital status at the birth of the child, father's education and father's age at birth of the child, a dummy for having foreign-born parents, a dummy for being 1 year older than classmates, a dummy for being 1 year younger than classmates, test score in grade 5, peer's grade from grade 5, a dummy for whether there was a change in leadership during the individual's middle-school years, and the individual's birth order. The reference year is 1 year prior to the introduction of a smartphone ban. Error bars show 95% and 90% confidence intervals.

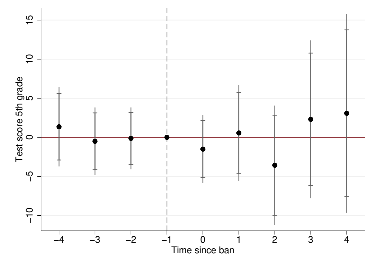
Figure A16: Event-Study Figures for Compositional Changes at the School Level



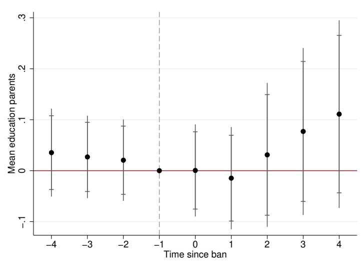
(a) Number of pupils



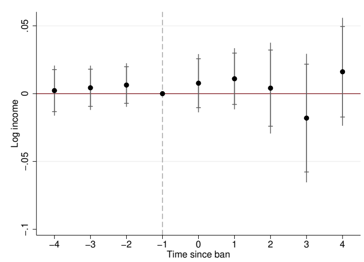
(b) Sex ratio pupils



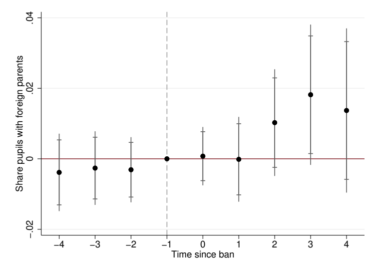
(c) Previous achievement



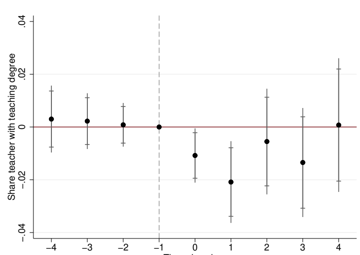
(d) Parents average education



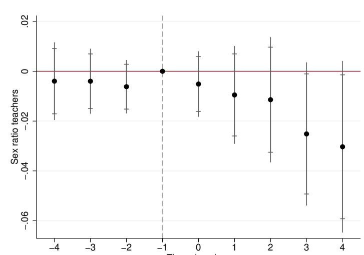
(e) Parents average income



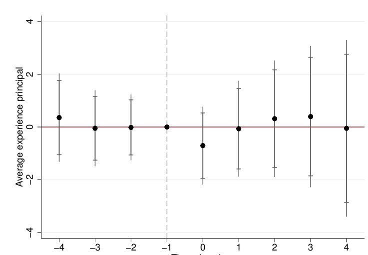
(f) Share foreign born parents



(g) Share with teaching degrees



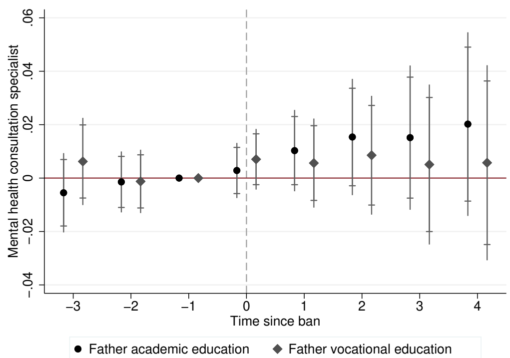
(h) Sex ratio teachers



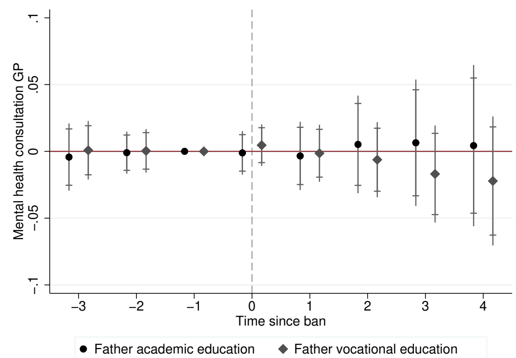
(i) Average experience principal

Notes: Estimated impact on various student, teacher, and socioeconomic characteristics of parents to students, conditional on school and year fixed effects. The reference year is 1 year prior to the introduction of a smartphone ban. Error bars show 95% and 90% confidence intervals.

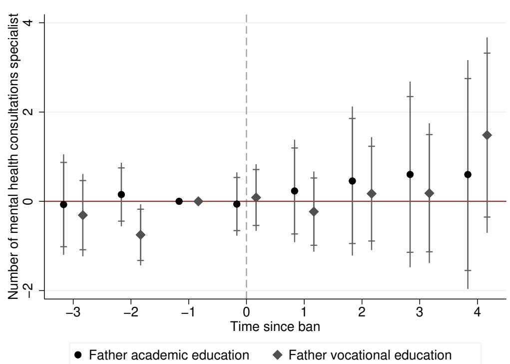
Figure A17: Effect of Smartphone Ban on Diagnosis and Treatment by Specialist and GPs for Psychological Symptoms and Diseases by Father's Education for Boys



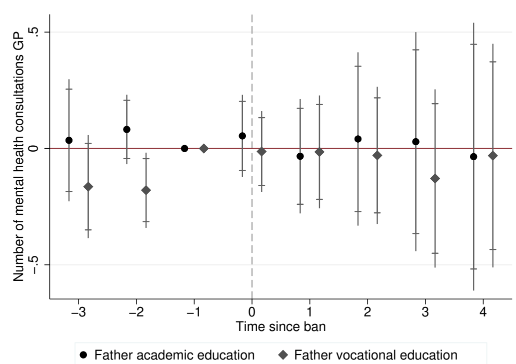
(a) P(Specialist consultation=1)



(b) P(GP consultation=1)



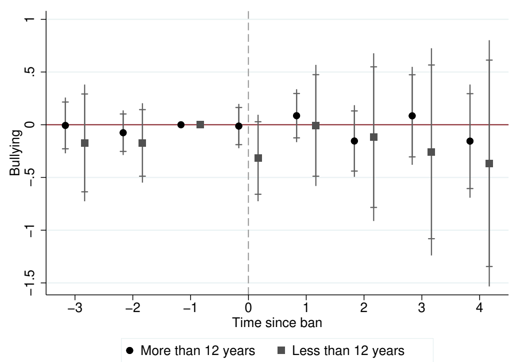
(c) Number of specialist consultations



(d) Number of GP consultations

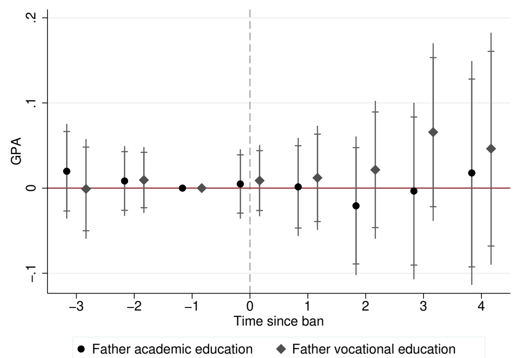
Notes: Each graph is from a separate regression. All specifications include a full set of cohort and school fixed effects. Robust standard errors are clustered at the school level. Additional control variables are a dummy variable for gender, the mother's education and mother's age at the birth of the child, mother's marital status at the birth of the child, father's education and father's age at birth of the child, a dummy for having foreign-born parents, a dummy for being 1 year older than classmates, a dummy for being 1 year younger than classmates, test score in grade 5, peer's grade from grade 5, a dummy for whether there was a change in leadership during the individual's middle-school years, and the individual's birth order. The reference year is 1 year prior to the introduction of a smartphone ban. Error bars show 95% and 90% confidence intervals.

Figure A18: Effect of Smartphone Ban on Bullying by Father's Education for Boys

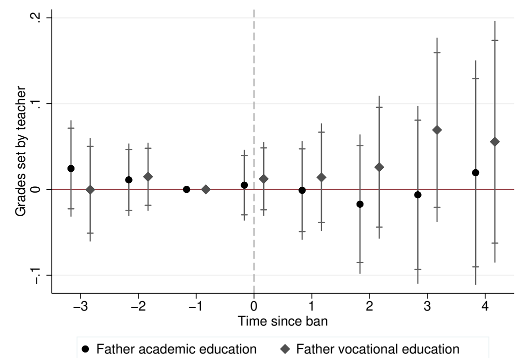


Notes: Each graph is from a separate regression. All specifications include a full set of cohort and school fixed effects. Robust standard errors are clustered at the school level. Additional control variables are the mean of mothers' education, the mean of mothers' age at the birth of the child, share of students with married parents at birth, the mean of fathers' education, the mean of fathers' age at birth, share of students being 1 year older than classmates, share of students being 1 year younger than classmates, mean of birth order, share of students with foreign-born parents, mean of students' test scores in grade 5, and a dummy controlling for leadership change. The reference year is 1 year prior to the introduction of a smartphone ban. Error bars show 95% and 90% confidence intervals.

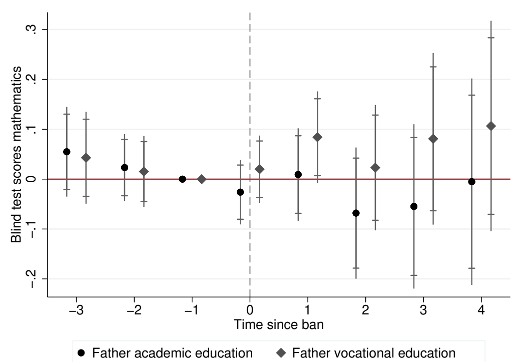
Figure A19: Effect of Smartphone Ban on GPA, Test Scores and Likelihood of Attending an Academic High School Track by Father's Education for Boys



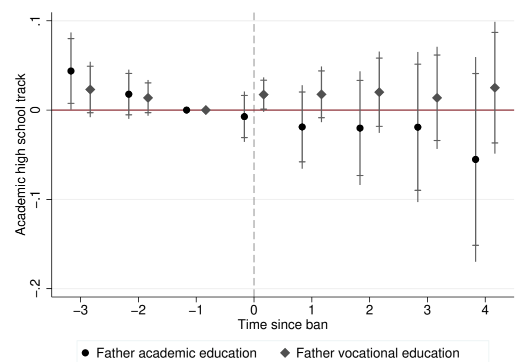
(a) GPA



(b) Teacher's grades



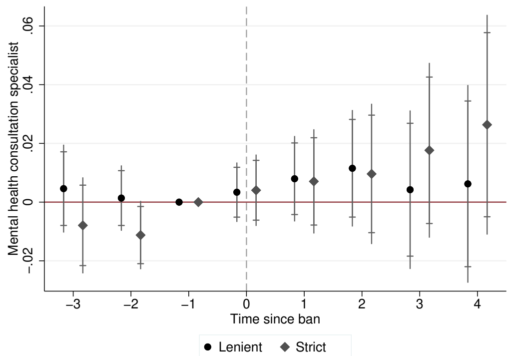
(c) Externally corrected mathematics exam



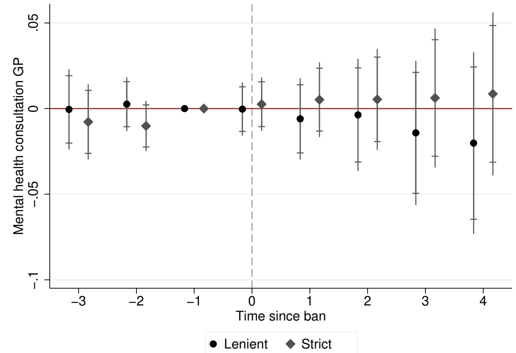
(d) P(Academic track=1)

Notes: Each graph is from a separate regression. All specifications include a full set of cohort and school fixed effects. Robust standard errors are clustered at the school level. Additional control variables are a dummy variable for gender, the mother's education and mother's age at the birth of the child, mother's marital status at the birth of the child, father's education and father's age at birth of the child, a dummy for having foreign-born parents, a dummy for being 1 year older than classmates, a dummy for being 1 year younger than classmates, test score in grade 5, peer's grade from grade 5, a dummy for whether there was a change in leadership during the individual's middle-school years, and the individual's birth order. The reference year is 1 year prior to the introduction of a smartphone ban. Error bars show 95% and 90% confidence intervals.

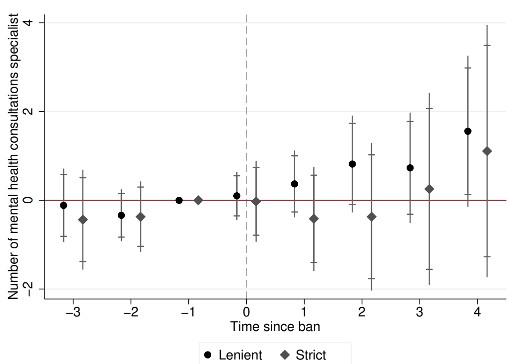
Figure A20: Effect of Smartphone Ban on Diagnosis and Treatment by Specialist and GPs for Psychological Symptoms and Diseases by Type of Ban for Boys



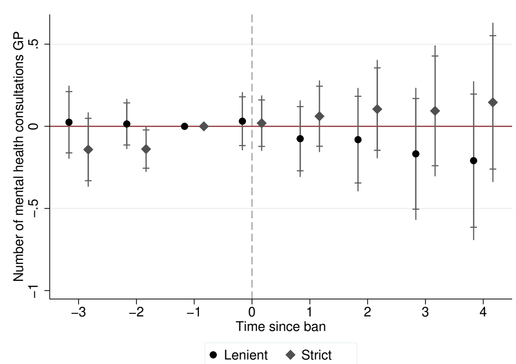
(a) P(Specialist consultation=1)



(b) P(GP consultation=1)



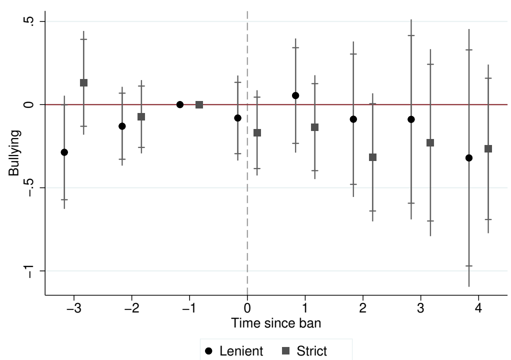
(c) Number of specialist consultations



(d) Number of GP consultations

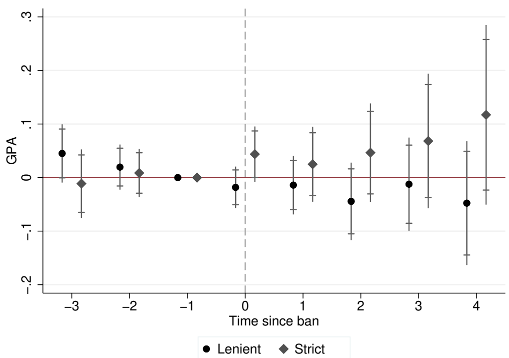
Notes: Each graph is from a separate regression. All specifications include a full set of cohort and school fixed effects. Robust standard errors are clustered at the school level. Additional control variables are a dummy variable for gender, the mother's education and mother's age at the birth of the child, mother's marital status at the birth of the child, father's education and father's age at birth of the child, a dummy for having foreign-born parents, a dummy for being 1 year older than classmates, a dummy for being 1 year younger than classmates, test score in grade 5, peer's grade from grade 5, a dummy for whether there was a change in leadership during the individual's middle-school years, and the individual's birth order. The reference year is 1 year prior to the introduction of a smartphone ban. Error bars show 95% and 90% confidence intervals.

Figure A21: Effect of Smartphone Ban on Bullying by Type of Ban for Boys

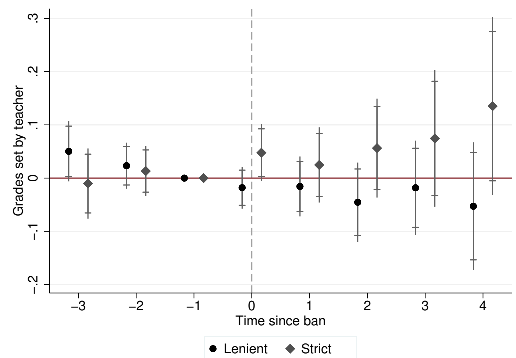


Notes: Each graph is from a separate regression. All specifications include a full set of cohort and school fixed effects. Robust standard errors are clustered at the school level. Additional control variables are the mean of mothers' education, the mean of mothers' age at the birth of the child, share of students with married parents at birth, the mean of fathers' education, the mean of fathers' age at birth, share of students being 1 year older than classmates, share of students being 1 year younger than classmates, mean of birth order, share of students with foreign-born parents, mean of students' test scores in grade 5, and a dummy controlling for leadership change. The reference year is 1 year prior to the introduction of a smartphone ban. Error bars show 95% and 90% confidence intervals.

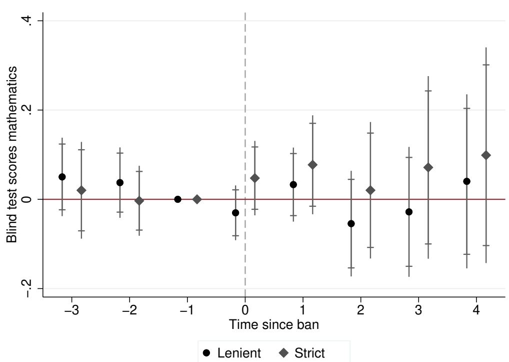
Figure A22: Effect of Smartphone Ban on GPA, Test Scores and Likelihood of Attending an Academic High School Track by Type of Ban for Boys



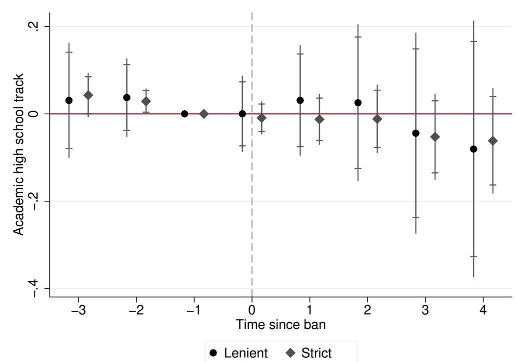
(a) GPA



(b) Teacher's grades



(c) Externally corrected mathematics exam



(d) P(Academic track=1)

Notes: Each graph is from a separate regression. All specifications include a full set of cohort and school fixed effects. Robust standard errors are clustered at the school level. Additional control variables are a dummy variable for gender, the mother's education and mother's age at the birth of the child, mother's marital status at the birth of the child, father's education and father's age at birth of the child, a dummy for having foreign-born parents, a dummy for being 1 year older than classmates, a dummy for being 1 year younger than classmates, test score in grade 5, peer's grade from grade 5, a dummy for whether there was a change in leadership during the individual's middle-school years, and the individual's birth order. The reference year is 1 year prior to the introduction of a smartphone ban. Error bars show 95% and 90% confidence intervals.

Survey Questions

The survey was sent out by email. It was originally in Norwegian, although questions and answer categories are documented in English.

1. Which school are you answering on behalf of?
2. Which alternative best describes your school's mobile phone policy?
    - (a) Mobile phones are not allowed on school premises
    - (b) Mobile phones are allowed, but should always be turned off or kept in "mobile phone hotels"
    - (c) Mobile phones are allowed, but should always be on silent mode and turned off during class
    - (d) Mobile phones are allowed, but should always be on silent mode
    - (e) Mobile phones are allowed, but should not disturb during class
    - (f) No mobile phone policy
    - (g) Other
3. If "other", what mobile phone policy do you have?
4. Which year was your present mobile phone policy introduced?
5. Did you have another mobile phone policy before your present policy?
6. If yes, which alternative best describes your previous mobile phone policy?
    - (a) Mobile phones are not allowed on school premises
    - (b) Mobile phones are allowed, but should always be turned off or kept in "mobile phone hotels"
    - (c) Mobile phones are allowed, but should always be on silent mode and turned off during class
    - (d) Mobile phones are allowed, but should always be on silent mode
    - (e) Mobile phones are allowed, but should not be disturbing during class
    - (f) No mobile phone policy
    - (g) Other
7. Do you have any other questions or comments?

Issued in the series Discussion Papers 2023

2023

01/23 January, Felix Chopra, **Ingar Haaland** and Christopher Roth. "The Demand for News: Accuracy Concerns versus Belief Confirmation Motives"

02/23 March, **Ola Honningdal Grytten** and Viktoriia Koilo. "Offshore Industries as Growth Sector: The Norwegian Case"

03/23 March, **Ingvild Almås**, **Alexander W. Cappelen**, **Erik Ø. Sørensen** and **Bertil Tungodden**. "Fairness Across the World"

04/23 March, **Kurt R. Brekke**, Dag Morten Dalen and Odd Rune Straume. "The price of cost-effectiveness thresholds"

05/23 March, Leonardo Bursztyn, **Alexander W. Cappelen**, **Bertil Tungodden**, Alessandra Voena and David Yanagizawa-Drott. "How Are Gender Norms Perceived?"

06/23 April, **Alexander W. Cappelen**, Stefan Meissner and **Bertil Tungodden**. "Cancel the deal? An experimental study on the exploitation of irrational consumers"

07/23 May, **Sara Abrahamsson**, **Aline Bütikofer** and Krzysztof Karbownik. "Swallow this: Childhood and Adolescent Exposure to Fast Food Restaurants, BMI, and Cognitive Ability"

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14/23 June, **Aline Bütikofer**, Rita Ginja, Krzysztof Karbownik and Fanny Landaud. "(Breaking) intergenerational transmission of mental health"

15/23 June, **Aline Bütikofer,** Antonio Dalla-Zuanna and **Kjell G. Salvanes.** "Natural Resources, Demand for Skills, and Schooling Choices"

16/23 July, Philipp Ager, Marc Goñi and **Kjell Gunnar Salvanes.** "Gender-biased technological change: Milking machines and the exodus of women from farming"

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18/23 November, Yves Breitmoser and **Justin Valasek**. "Why do committees work?"

19/23 November, **Kurt R. Brekke**, Dag Morten Dalen and Odd Rune Straume. «Taking the competitor's pill: when combination therapies enter pharmaceutical markets"

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24/23 December, **Samuel Dodini, Alexander Willén** and **Julia Li Zhu**. "The Role of Labor Unions in Immigrant Integration"

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