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# Pupil Absenteeism, Measurement, and Menstruation: Evidence from Western Kenya

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**Abstract**

Due to data limitations it is unclear if biological processes such as periods hinder girls in developing countries from participating in school to a greater extent than boys. We collect 32,000 unannounced random spot-checks for 6,000 primary school students in Kenya to assess if girls miss more school than boys. Absenteeism is common among both boys and girls, with pubescent girls missing more schooldays because of school transfers, but less if transfer students are excluded. Boys miss more days because of illness compared to girls. Cohen's kappa coefficient reveals non-random inconsistencies across the spot-check data and school registers, which would lead to bias if school register data were used in impact evaluations. To illustrate this point, we replicate the results from a three-arm pilot cluster randomized control study that provided sanitary products to schoolgirls to reduce absenteeism using the school records instead of the spot-checks for the same calendar dates. As shown, the school register data would lead to erroneous conclusions regarding the treatment effects.

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# 1 Introduction

Girls and boys face different constraints to their education in developing countries, leading to inequality in attainment. Health is one such factor that impacts education, and in particular school attendance (Bleakley 2007; Miguel and Kremer 2004). For adolescent girls in low- and middle-income countries, lack of menstrual hygiene management (MHM) within and outside the school may pose a serious challenge to their schooling. It has been suggested, for example by the World Bank, that girls do not attend school when they have their periods (Mooijman et al., 2005), which could lead to them missing four schooldays every 28 days. Secondary school absenteeism is linked to lower performance (Liu et al., 2019), therefore menstruation-oriented health campaigns have the potential to increase educational attainment among adolescent girls around the world, and shrink the gender gap in education.

The results emerging from the literature focusing on menstruation and absenteeism are, however, contradictory across studies and sometimes within studies. The quality of the data analyzed could be contributing to the inconsistent results as previous empirical studies have used qualitative observations from focus groups and semi-structured interviews (e.g. Mason et al. 2013), school register data (e.g. Montgomery et al. 2016), or student self-reported data using diaries or surveys (e.g. Grant et al. 2013; Tegegne and Sisay 2014)[1]. In most of these cases, absence is reported by agents with potential incentives to not answer truthfully, or with a significant time lag from the behavior to the reporting, with implications for the reliability of the data.

A baseline qualitative study from Kenya found that schoolgirls and their parents reported that *other* girls missed school during their period; however, the girls reported that they themselves did not miss school for this reason (Mason et al., 2013). While such findings are interesting as they point to the presence of norms, stigma, and social desirability bias relat-

[1] Or a combination of cross-validated data sources (Oster and Thornton, 2011) which should increase reliability.

ing to menstruation-reported absence, they fail to provide conclusive evidence on *de facto* school absenteeism behavior.

Researchers collecting unannounced spot-checks are now considered best-practice for measuring school absenteeism in developing countries (Miguel and Kremer 2004; Kremer et al. 2009; and Muralidharan and Sheth 2016), instead of school records. Studies focusing on Kenya describe school records as ”unreliable” (Kremer et al., 2009), or ”notoriously inaccurate” (Miguel and Kremer, 2004), although these claims have not been formally tested. In this paper, we will substantiate these claims using multiple data sources.

Moreover, spot-checks are often preferred over other possible data sources capturing school attendance, such as, student diaries, recall data, and semi-structured interviews, as these likely suffer from self-reporting bias and recall bias. For example, students participating in a cash transfer program in Malawi were found to overreport enrollment and school attendance, although the same study found that school records in Malawi were accurate (Baird and Özler, 2012)[2].

We test if adolescent schoolgirls are more likely to be absent from school compared to boys of similar ages, and if it is plausible that girls miss several school days during their period. We analyze a novel, high-quality, researcher-collected dataset for more than 6,000 female and male primary school students in Western Kenya. The data contains 32,349 random and unannounced spot-checks across 30 schools, and the equivalent number of school register entries. We argue that our dataset is original and of high-quality because the spot-checks (i) were performed by the research team, (ii) were unannounced to the students and to the school administration before the beginning of the school day, (iii) contain data on more than 3,000 boys which allows for benchmarking of girls' absenteeism behavior. The data was collected for all students enrolled in the study schools of a cluster randomized controlled fea-

[2]A study focusing on teacher absences in Pakistan found that official records for teacher absences were inaccurate while pupil attendance records were fairly reliable (Banerjee et al., 2012). The measures were not exactly for the same time frame. The pupil attendance records at government schools tended to underreport absences, in contrast to private schools that tended to overreport attendance

sibility study that provided sanitary products (menstrual cup or sanitary pads) to 751 female students. The program impacts on were previously analyzed in Phillips-Howard et al. (2016) (for epidemiological outcomes) and Benshaul-Tolonen et al. (2019) (for absenteeism and psychosocial wellbeing outcomes).

We find that overall rates of absences are high, and girls are more likely to be absent from school compared to boys, controlling for age, and grade, school, and month fixed effects. Girls aged 13-16 years—who should be reaching menarche according to previous research from Kenya (Leenstra et al., 2005)—are more likely to be absent than boys of the same age[3]. However, the significant differences between boys and girls disappear when we exclude students who are absent because they migrated or transferred to another school. In fact, the majority of absence records are due to transfers. We cannot exclude the possibility that transfers to other schools is endogenous to menstrual management issues. However, we find no support for the hypothesis that girls are more likely to transfer from schools with fewer latrines, although girls are marginally more likely absent from such schools. We estimate all non-transfer related absent schooldays to 1.1 for girls per month, which is well below the menstruation-related hypothesized absences for girls (Mooijman et al., 2005), and lower than the average for boys at 1.2 schooldays.

Our multiple data sources also allow us to gauge the accuracy of the official school records. This is important, first, as school records have been used in policy evaluation research on absenteeism in developing countries[4], leading to a potentially biased body of evidence. Second, school records would provide a cost-efficient, high frequency data source if found unbiased. We test for the accuracy of school register data benchmarked against the spot-check data using Cohen's kappa coefficient (Cohen, 1968). The analysis reveals incon-

[3] The share of girls who have reached menarche varies by age and grade. We focus on age rather than class because we note a wide distribution of school ages per grade in Kenya due to retakes and late school start.

[4] School attendance records have also been used to understand effects of pollution on attendance in the U.S., e.g. Currie et al. (2009). Administrative school attendance records from developed nations are likely of better quality than such data from developing countries.

sistencies between the school register data and the spot-check data with $\kappa = 0.26 - 0.38$. A large share of the discrepancies stems from missing entry in the school register data, but the discrepancies remain after excluding missing entries. Missing entry in the school record, in fact, correlates with absence as measured by the spot-check data, violating an assumption that missing school record is orthogonal to absence behavior. Studies that use unvalidated school record data in impact evaluations on pupil absenteeism may thus suffer from measurement bias. We subsequently illustrate this issue by replicating the impact evaluation results from Benshaul-Tolonen et al. (2019) using the school registers instead of the spot-checks. Using the school register data, we would conclude that the sanitary pad treatment arm failed to reduce absenteeism rates among adolescent girls. In reality, the sanitary pad treatment arm reduced absenteeism by 7.8 - 7.9 percentage points (Benshaul-Tolonen et al., 2019).

Programs relying on school registers may fail to understand the prevalence and causes of absenteeism among boys and girls. School registers underestimate absenteeism, and absenteeism is an issue not isolated to adolescent girls. There are few rigorous trials that show the importance of menstrual health-related interventions for school outcomes. A previous study in Nepal with 198 female students (Oster and Thornton 2011) used self-reported school attendance diary data triangulated with school records. The study found low levels of baseline absenteeism within the sample: girls missed only 0.4 days in a 180 day school year because of their menstrual period, and a menstrual cup intervention did not reduce absence. Because of the dearth of evidence, and varying poverty levels, sanitation, and cultural norms across countries and populations, we call for more evidence on the possibility of menstrual health policies to reduce absence, and that such studies carefully measure absenteeism with validated or reliable data.

In line with Sommer et al. (2016), we call for further studies understanding how MHM determines outcomes for adolescent girls. Eliminating school absenteeism may demand complementary approaches (Grant et al., 2013), including targeting loss of concentration and pain associated with the menstrual cycle (Sivakami et al., 2019), providing adequate latrines (Adukia 2017; Alexander et al. 2018; Freeman et al. 2012), and tackling stigma and fear. Moreover, because of high absenteeism rates among adolescent boys, we encourage further research to explore determinants and potential solutions to tackle this issue. We recommend all studies using school record cross-validate such data before employing the data in impact evaluations.

The remainder of the paper is organized as follows. We discuss the literature and previous evidence in Section 2, followed by a description of the study context and program in Section 3. We describe the data and the empirical strategy in Section 4, and results in Section 5. We illustrate the need for validated school records or spot-checks in impact evaluation in Section 7. We conclude in Section 8.

# 2 Background

## 2.1 School Enrollment and Pupil Absenteeism

Pupil absenteeism has several educational costs, such as lower academic performance (Lamdin 1996) and higher risk of drop-out. In sub-Saharan Africa, early drop-out from school is linked to higher incidence of teen pregnancy, early marriage, and HIV infection (Jukes et al., 2008), and other STIs (Baird et al., 2012)[5]. Several interventions can improve school attendance, including free school uniforms (Evans et al., 2008), deworming (Miguel and Kremer, 2004), matching teacher-student gender (Muralidharan and Sheth, 2016), and providing school meals (Kremer and Vermeersch, 2005). Studies focusing on adolescent girls, in particular, find that latrine access (Adukia, 2017) and free bicycle programs (Muralidharan and Prakash, 2017) increase school enrollment. In contrast, early age at menarche is negatively

[5]Although one study providing scholarships, school uniforms and encouragement to stay in school to orphans in Kenya increased school attendance but led to no reduction in HIV or herpes simplex II (Cho et al., 2018)

associated with school enrollment (Khanna, 2019) and school attainment (Field and Ambrus, 2008).

Because of the poor quality of school records, studies analyzing absenteeism often use unannounced spot-check data to measure school absenteeism[6]. This has emerged as best practice within the field. However, rigorous testing of the quality of administrative school records has not been sufficiently undertaken. Because spot-check data are expensive to collect and limited in scope, their main advantage is their reliability. No attempts of developing high-frequency data collection processes that could enable a large sample size, surveyed with high integrity, and at low cost, have been identified. However, with increasing digital presence among students such cost-effective solutions are likely in the future.

## 2.2 Health, Sanitation and Education

There are strong links between health and education, already in early childhood. Health interventions before birth improve future educational attainment, for example, maternal iodine treatment *in utero* increases later school attainment (Field et al., 2009). Returns to health interventions in early childhood are also substantial: a mass deworming intervention in Kenya reduced pupil absenteeism by 25% (Miguel and Kremer, 2004), from pre-intervention attendance rates at 96-97% in grades 3-8. Similarly, iron supplements and deworming tablets given to pre-school students reduced absenteeism by 20%, with the largest gains among students that were anemic at baseline (Bobonis et al., 2006), and a hand-washing campaign evaluated in primary schools in Egypt increased school attendance through reductions in influenza, diarrhea, and conjunctivitis (Talaat et al., 2011).

Water, sanitation and hygiene (WASH) interventions in schools play an important role

[6]School absenteeism has also been studied both from the perspective of teachers. A study in Kenya found that teachers on incentivized contracts were more likely to be present at the school (with 28%) and in the class room (with 12%) than teachers on the normal civil-service contract (Duflo et al., 2015). Unannounced spot-checks of teachers have been used to assess such programs, instead of official school records. A study from Pakistan found that official school records of teacher absences were inaccurate (Banerjee et al., 2012).

in determining girls' access to education. In western Kenya, a cluster randomized trial that improved WASH facilities reduced absenteeism among girls, but the intervention did not change absenteeism rates for boys (Freeman et al., 2012). The authors estimated that a WASH program could reduce girls' absences by up to 6.8 days per year. However, the study found no subsequent improvement in test scores or enrollment (Freeman et al., 2012). A school latrine construction program in India increased enrollment for pubescent girls, but only if the latrines were gender-specific (Adukia, 2017), highlighting the importance of privacy and safety[7]. One study found that school latrine cleanliness was the only school WASH factor associated with a decrease in absenteeism (Dreibelbis et al., 2013).

## 2.3 Menstrual Hygiene Management in Developing Countries

The link between menstruation and productivity has received some attention in developed countries, and the results have also been mixed. In a since then refuted study (see Herrmann and Rockoff (2012)), menstruation was found to increase absences in 28-day cycles among women employees in Italy (Ichino and Moretti, 2009). Women in the Netherlands report missing on average 1.3 work days per year because of their period, although productivity loss was estimated at a total of 8.9 days per year (Schoep et al., 2019). A different study found that menstruation accounts for less than 1% of the gender wage gap in the U.S. (Herrmann and Rockoff, 2013).

Menstruation is thought to have productivity implications also in developing countries, although largely for different reasons. A rich qualitative literature points to the barriers that, in particular, adolescent girls from low-income households face. Poverty, leading to an

[7] There are multiple reasons to why female and male students respond differently to health policies including WASH improvements. For example, girls may miss more school because of care roles for other family members when hit by unexpected health shocks (Archibong and Annan, 2017), or because the menstrual cycle increases their need for sanitation. Safety and time costs associated with travel to secondary schools may also impede girls' continued education: a state-wide program where girls received a bicycle in Bihar, India, increased girls' enrollment in secondary school by 32 percent, compared with boys and pupils in nearby states (Muralidharan and Prakash, 2017).

inability to purchase disposable sanitary products such as sanitary pads is reported (Mason et al., 2013). Girls from low-income households are unable to purchase disposable sanitary products due to poverty. Instead, they choose solutions that may be inefficient and unsafe, such as cloths, mattresses, or grass. Some research points to young women engaging in transactional sex to pay for sanitary pads, or receiving sanitary pads from sexual partners (Mason et al. 2013; Phillips-Howard et al. 2015).

In addition, menstruation can be a social stressor (Mason et al. 2013; McMahon et al. 2011) that affects self-esteem, school attendance, and concentration while in school among adolescent girls (Mason et al., 2015). In focus group research conducted in Kenya, girls report significant worries such as leaking of menstrual blood, fear of sexual harassment from teachers and male peers, shame, and confusion surrounding menstruation (McMahon et al., 2011). Girls in Tanzania also report navigating the onset of puberty without proper guidance and access to facilities (Sommer, 2010). Poverty, coupled with stigma and lack of information, hinder adolescent girls from properly managing their menstruations(Adinma and Adinma, 2009; El-Gilany et al., 2005; McMahon et al., 2011; Sommer, 2010). Menstrual hygiene management in developing context is therefore considered a neglected issue(Sommer and Sahin, 2013), with need for more comparative, high-quality studies (Sommer et al., 2016)

Age at menarche varies across populations. Schoolgirls in Western Kenya (in particular, in areas Mumias and Asembo) on average reach menarche 1.5-2 years later than WHO and U.S. reference populations, a delay attributed to malnutrition (Leenstra et al., 2005). Average age at menarche ranges from 14.6 to 15.1 years, a time during which they may be enrolled in the last years of primary school or in secondary school. We hypothesize that the need for water, soap, sanitation facilities and physical safety increases during this time period, in line with Adukia (2017) and Muralidharan and Prakash (2017). In contrast, a baseline study of latrine quality conducted within this project found that facilities were often lacking, with many latrines missing running water, soap, doors and locks, and were visibly dirty (Alexander et al., 2014).

### 2.3.1 MHM and Absenteeism

It has been widely reported that girls in developing countries miss school because of their periods (Mooijman et al., 2005), with 41% in Bangladesh (Alam et al., 2017), and 24% in India (van Eijk et al., 2016) of girls reporting being absent during their period. The level of absenteeism, however, varies significantly across studies and study contexts. Another study that surveyed schoolgirls in grades 8-10 across three Indian states found absenteeism in the range of 6-11% (Sivakami et al., 2019), and the lowest level of absenteeism was reported in a study in Nepal, where 0.19% of period days were missed (Oster and Thornton, 2011).

Most evidence is only based on qualitative surveys, self-reported recall data, or school records. A longitudinal study from Malawi showed that only 4% of missed school days were due to menstruation when using traditional face-to-face surveys. Importantly, girls reported significantly higher incidence of menstruation-related absenteeism when they reported in private on a computer (Grant et al., 2013). Similarly, Kenyan schoolgirls and their parents reported in focus groups pre-intervention that *other* students missed school during their menses, but no one reported that they themselves missed school for this reason (Mason et al., 2013). These examples illustrate that menstruation-related absenteeism is likely reported with a large error due to social desirability bias. Recall bias is likely also an issue as surveys often rely on recall of absenteeism during, for example, the last or last three menstrual cycles.[8] In addition, in high absenteeism contexts, such as Malawi (Grant et al., 2013) and Kenya (according to this dataset), marginal changes in absenteeism due to period may be hard to identify.

[8] Asking smallholder farmers in Tanzania to estimate hours worked per week over the last agricultural season led to 400% overestimation of hours per week, validated with weekly data (Arthi et al., 2018).

To better understand how MHM in particular can improve girls' schooling, we need impact evaluation research and reliably measured absenteeism. Thus far, few studies have plausibly identified the role of menstrual hygiene interventions in reducing absenteeism. One exception is a study in Nepal that evaluated if menstrual cups[9] could reduce absenteeism among pubescent girls. The authors found weak pre-intervention difference in school attendance between girls and boys, and very low levels of absenteeism overall. The students were only missing one day of school annually because of their periods. Providing menstrual cups, in this context, had little effect on school absenteeism. The Nepalese girls indicated that menstrual cramps were the main reason behind missing school, rather than the dearth of suitable menstrual hygiene products (Oster and Thornton, 2011).

A few studies use non-randomized methods to understand the effect of menstrual hygiene interventions on schooling. A non-randomized study in Ghana evaluated a sanitary pad program rolled out across four villages (with no within-village randomization) with a sample of 120 schoolgirls aged 12-18. The program provided sanitary pads and/or puberty education, and compared with a control village. School attendance initially increased in the villages that received sanitary pads, but after 5 months there was no difference in absence rates between groups having education alone and those having pads and education(Montgomery et al., 2012). A follow-up study in Uganda with four treatment arms rolled out across eight intervention schools found that absenteeism worsened over time, an effect somewhat mitigated in the intervention schools across all three the treatment arms (Montgomery et al., 2016).

While these three studies do not confirm significant reductions in school absenteeism from menstrual health interventions, two of them suffer from sub-optimal research design with significant risk of biased estimates (Montgomery et al. 2012; Montgomery et al. 2016),

[9]A menstrual cup is a device that is inserted vaginally and collects the menstrual blood. A recent meta-study showed the safety of the menstrual cup and it's use internationally. The menstrual cup is reusable for up to 10 years, making it a potential economically and environmentally sustainable product (van Eijk et al., 2019). The authors also showed that friend-networks influenced adoption of the menstrual cup, which was a new technology for the study population (Oster and Thornton, 2012).

and one study was rolled out in a population where girls did not report missing school because of their periods at baseline (Oster and Thornton, 2011). These studies are not sufficient to draw final conclusions regarding the efficacy of providing menstrual products in reducing absenteeism, in contexts where absenteeism during periods is an issue.

### 2.4 Kenya Primary School System

Kenya's primary school system consists of cost-based private and free public schools. Private schools range from high-cost, quality schools, to low-cost schools managed and supported financially by parents and the community (Nishimura and Yamano, 2013). The low-cost private schools often lack proper resources such as infrastructure, learning resources, and trained teachers (Wamalwa and Burns, 2018). While the public primary schools are free, and should offer free basic textbooks and notebooks, students are required to wear uniforms with costs that range from US$4-7 (Evans et al., 2008). The average expenditure for households that send their children to public primary schools, including uniforms, school fees, textbooks, and other school-related material per pupil attending was about $31 in 2007, whereas the expenditure for children attending private school was $130 per pupil (Nishimura and Yamano, 2013). A further difference between public and private schools is that the Kenyan government provides free sanitary pads in public schools, although the provision has been found unreliable and inequitable (Girod et al., 2017).

## 3 Study context and data

The data were collected in Siaya County, western Kenya between October 24, 2012 and November 1, 2013 by the field researcher team. Thirty schools were selected based on WASH scores and inclusion criteria (Alexander et al. 2014; Phillips-Howard et al. 2016) described further in Section 3.1 to participate in a pilot cluster randomized control study.

Further data collected for these schools' grades 5 to 8 included the complete official school attendance records and student spot-check data on selected school days. The schools agreed to the spot-check data collection, but were not informed in advance of the dates during which the data would be collected. Head teachers provided verbal consent to allow these data to be reviewed, and ethical approval was obtained from the Kenya Medical Research Institute and from Liverpool School of Tropical Medicine, the U.K.. The study was retrospectively registered in December 2014 (with registry number ISRCTN17486946[10]) before data analysis commenced.

## 3.1 Study schools

The data was collected as part of a three-arm (sanitary pads, menstrual cup or control) pilot cluster randomized control study rolled out in 30 primary schools in western Kenya. The program effect of epidemiological outcomes have been published by Phillips-Howard et al. (2016), and additional study results have been published including focus group research at baseline (Mason et al., 2013) and endline (Mason et al., 2015), the use of the menstrual cups (van Eijk et al., 2018), and an evaluation of sanitation infrastructure in the schools (Alexander et al., 2018).

An initial total of 71 primary schools were identified in the study area. From 71, 9 schools did not have grade girls 5-8 or did not consent and were excluded from the study. The remaining 62 primary schools were surveyed. The school survey indicated that 60% of the schools had water available for hand washing, and a mere 2% of schools had soap (Alexander et al., 2014). Gender-specific latrines were found in 84% of schools, the majority (77%) of which were without locks, and only 16% of the latrines were deemed clean by the research team using a check sheet (Alexander et al, 2014). From the 62 schools, 30 schools fulfilled the criteria of having a girls-only latrine, available water for hand washing, and a

[10]See http://www.isrctn.com/ISRCTN17486946 for more information

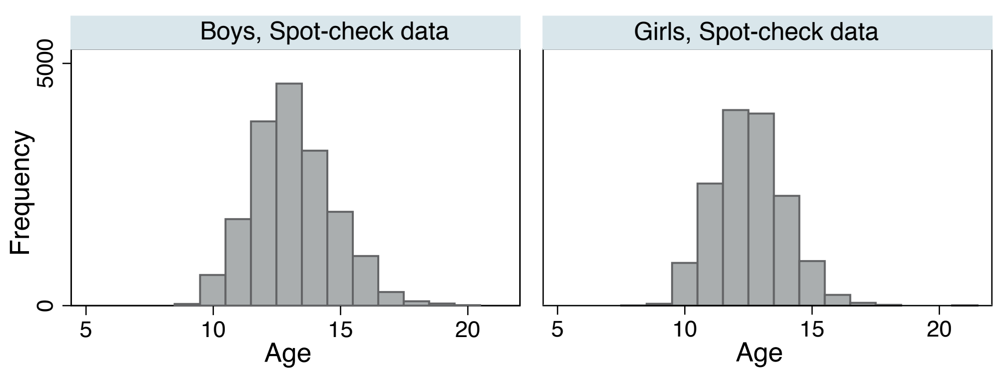
pupil-to-latrine ratio that was below 70:1 (Phillips-Howard et al, 2016). The research project did not *per se* target intervention on the latrines, with the exception of provision of soap to all schools, but latrine quality was monitored during the study period. Soap availability did increase, but latrine quality, in fact, deteriorated over time (Alexander et al., 2018).

# 4 Data and Empirical Strategy

Table 1: Summary statistics

| Variable | Mean | Std. Dev. | Min. | Max. |
|---|---|---|---|---|
| female | 0.461 | 0.499 | 0 | 1 |
| grade at baseline | 5.809 | 0.859 | 5 | 8 |
| age at baseline | 12.872 | 1.553 | 8 | 21 |
| month of spot-check | 7.354 | 2.958 | 1 | 11 |
| absent from spot-check | 0.125 | 0.331 | 0 | 1 |
| absent from spot-check (girls) | 0.13 | 0.337 | 0 | 1 |
| absent from spot-check (boys) | 0.121 | 0.326 | 0 | 1 |
| N | | 32,349 | | |

Figure 1: Sample distribution




*Notes:* Histogram distribution of sample size per age groups (horizontal axis) across genders.

The full data set consists of 71,140 observations, 6,836 of which are spot-checks and register entries for students who participated in the randomized control study. All observations on the study participants were removed from the initial analysis, to avoid contamination from the intervention (except when we use the intervention to illustrate the need for spot-checks or validated school data, see Section 7). 32,349 spot-checks remains for 6,057 students. These spot-checks were matched to an equal number of official school attendance register entries. The data is described in Table 1. The average student was 12.9 years old, with the age ranging from 8 to 21 years, and 46% of the students were girls. Students were absent from 12.5% of spot-checks, with girls missing 13.0% and boys 12.1% of checks. Figure 1 shows that slightly more boys are likely to be found in the data set but that the distributions of age are similar across the genders. Note that female study participants are excluded from these data, and that the slightly lower share of women in the dataset should not be taken as indicative of lower enrollment among girls. Because of study program eligibility rules girls in the age range of 14-16 who had experienced three menstrual cycles will be underrepresented in the dataset of non-study participants. However, only 16.9% of girls initially contacted were excluded because they had not yet experienced 3 menses, indicating that girls ages 14-16 who were included in the study are in broad terms similar to those that were not.

In the first section of the paper, we analyze spot-check data with more than 32,000 observations to understand gender and age patterns in absenteeism. The simplest specification is the following:

$$Absent_{ism} = \beta_0 + \beta_1 female_i + \beta_2 age_i + \beta_3 grade_i + \delta_m + \alpha_s + \varepsilon_{ism} \tag{1}$$

where $i$ indicates an individual observation, $s$ school, $m$ is month of the observation. The standard errors are clustered using robust standard errors. We include month $(\delta_m)$ and/or school fixed effects $(\alpha_s)$, to take care of heterogeneity in timing of absenteeism, and variability that come from school-specific factors in absenteeism. The month fixed effects will soak up any variation that comes from the timing of the spot-check. This may be important if absenteeism differs across the months, for example due to the agricultural seasons. Moreover, the school fixed effects absorb any observable or unobservable variation at the school level (including a more permissive norm toward absenteeism at some schools). We include controls for both age and grade, despite them being correlated. In Kenya, there is ample variation in age within a given grade because some students start school later or retake grades. Therefore, in heterogeneity analysis, we focus on the role of age instead of grade.

To measure heterogeneity by age, we use a linear interaction term and a spline specification:

$$Absent_{ism} = \beta_0 + \beta_1 female_i + \beta_2 age_i + \beta_3 female * age_i + \beta_4 grade_i + \delta_m + \alpha_s + \varepsilon_{ism} \quad (2)$$

Or

$$Absent_{ism} = \beta_0 + \sum_{a=10}^{18} \beta + \beta_{10} female_i + \beta_{11} grade_i + \delta_m + \alpha_s + \varepsilon_{ism} \quad (3)$$

for $a \in \{10, \ldots, 18\}$

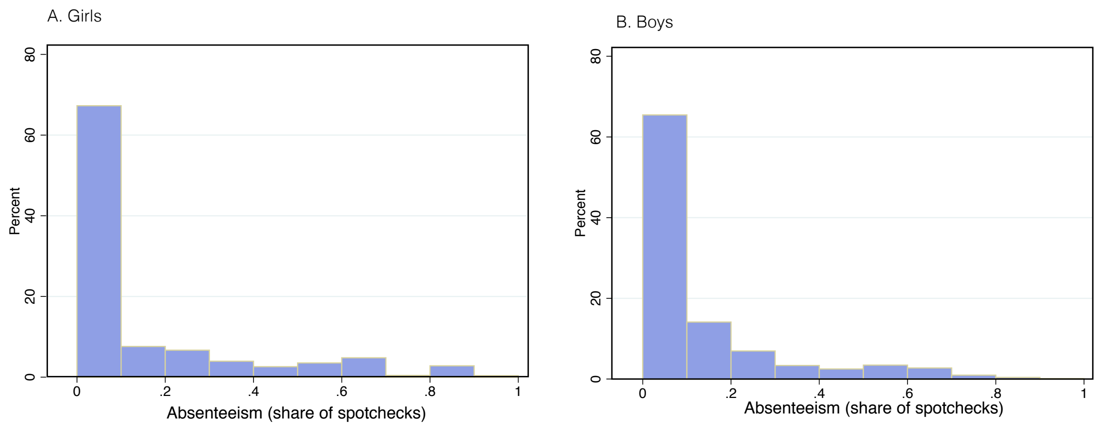
For the spline, we compare the results with students aged 8-9. All students older than 18 are excluded from the analysis in this subsection because of small sample sizes. Each age category will have its own regression coefficient, allowing for a non-linear relationship with age. We plot the coefficients to help with interpretation.

# 5 Results

The histograms in Figure 2 of the absenteeism data illustrate that absenteeism patterns are similar for girls (A) and boys (B) with the majority of students being absent less than 10% of the time, and a smaller share of students absent in between 10% and 100% of the time.

A limitation of this simple analysis is that it does not take the reason for absenteeism into account. As we will explore later, school transfers are common and students who have transferred show up as absent in the spot-checks.

Figure 2: Absenteeism for girls (A) and boys (B)

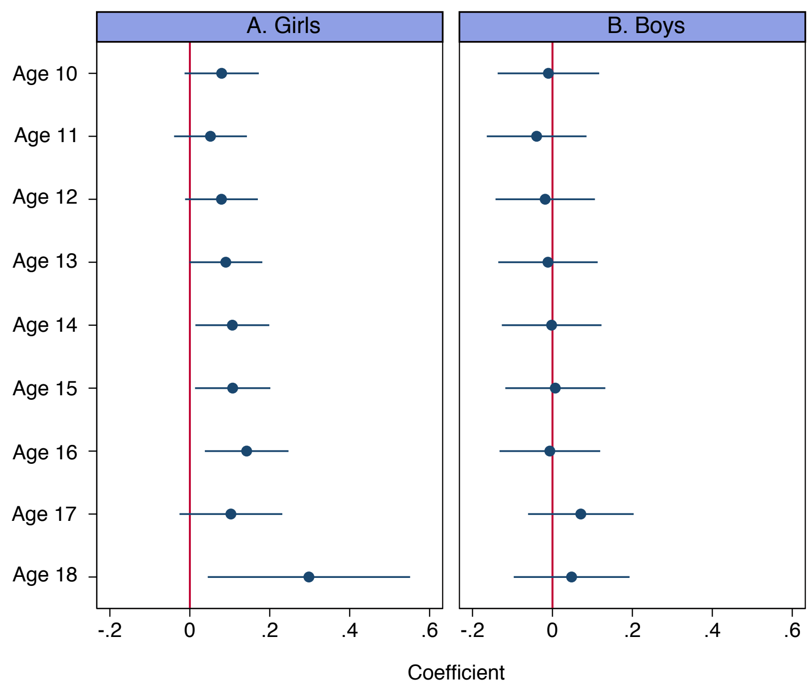



*Notes:* The data is collapsed by student and student mean absenteeism is plotted on the X axis.

We estimate the effects by age and gender using the spline specification in equation 3 shown in Figure 3. Age 8-9 is used as the reference category, and the effect size for each age category is plotted on the vertical axis. Absenteeism among boys in each age category is not statistically different from the reference category of 8-9 years old. However, the majority of age coefficients are statistically significant for girls, meaning that absenteeism is more common among older girls, controlling for grade and fixed effects for school and survey month.

To confirm these effects, we create two-year age bins that can increase the statistical power. We confirm that girls are 1.3 percentage points more likely to be absent than boys, controlling for school FE, month FE, and age and grade (see Table 2, column 1). Introducing an interaction effect for female*age switches the main coefficient for female to negative and significant (column 2), but with a positive interaction effect female*age.

Figure 3: Regression results on absenteeism for girls (A) and boys (B)




*Notes:* Reference category is age 8-9. Ages 19-21 are excluded because of small sample sizes. The regressions control for grade, school fixed effects and month fixed effect, and uses robust standard errors. Column 1 and 2 are two separate regressions.

Table 2: Main results Absenteeism

| *Outcome:* | Absent | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *Reference group age:* | | | 8-10 | 8-10 | 8-12 | 8-12 |
| female | 0.013*** | -0.068** | 0.012*** | -0.002 | 0.012*** | 0.002 |
| | (0.004) | (0.032) | (0.004) | (0.017) | (0.004) | (0.006) |
| grade | -0.013*** | -0.014*** | -0.011*** | -0.011*** | -0.011*** | -0.011*** |
| | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) |
| age | 0.010*** | 0.008*** | | | | |
| | (0.002) | (0.002) | | | | |
| female*age | | 0.006** | | | | |
| | | (0.003) | | | | |
| age 11-12 | | | -0.012 | -0.015 | | |
| | | | (0.009) | (0.014) | | |
| age 13-14 | | | 0.010 | -0.000 | 0.021*** | 0.013** |
| | | | (0.009) | (0.014) | (0.004) | (0.006) |
| age 15-16 | | | 0.019* | 0.006 | 0.030*** | 0.019** |
| | | | (0.011) | (0.015) | (0.007) | (0.008) |
| age 17-18 | | | 0.074*** | 0.065*** | 0.085*** | 0.078*** |
| | | | (0.021) | (0.024) | (0.019) | (0.021) |
| age 20-21 | | | -0.033 | -0.027 | -0.022 | -0.014 |
| | | | (0.037) | (0.041) | (0.036) | (0.039) |
| female*age 11-12 | | | | 0.004 | | |
| | | | | (0.018) | | |
| female*age 13-14 | | | | 0.020 | | 0.016** |
| | | | | (0.018) | | (0.008) |
| female*age 15-16 | | | | 0.033 | | 0.029** |
| | | | | (0.021) | | (0.013) |
| female*age 17-18 | | | | 0.020 | | 0.016 |
| | | | | (0.053) | | (0.050) |
| female*age 20-21 | | | | -0.120*** | | -0.124*** |
| | | | | (0.047) | | (0.044) |
| Observations | 32,349 | 32,349 | 32,349 | 32,349 | 32,349 | 32,349 |
| R-squared | 0.021 | 0.022 | 0.030 | 0.031 | 0.030 | 0.031 |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes |
| School FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Month FE | Yes | Yes | Yes | Yes | Yes | Yes |

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Reference category are students ages 8-10 (columns 3-4) and 8-12 (columns 5-6) which yields a larger comparison group and therefore more statistical power while limiting to a pre-menarche population.

To further understand the age effects, columns 4 and 6 uses two year age bins (11-12, 13-14, 15-16, 17-18, 19-21) with reference category 8-10 years (or 8-12), interacted with female. In column 6, which uses ages 8-12 as a reference category, the interaction effects for ages 13-14 and 15-16 are positive and statistically significant[11].

Girls in the age group 13-16 may be most likely absent because of periods, given that this is the age period in which most girls will reach menarche. The only study identified that analyzed age of menarche in Western Kenya, found mean age of menarche to be 14.6-15.1 years of age, which is about 1.5 to 2 years later than WHO reference populations (Leenstra et al., 2005). We shed particular focus on this group in Table 3, and find that for this age group, girls are 1.9-2.2 percentage points more likely absent on a spot-check day. Columns 1-5 vary the specifications by introducing controls and fixed effects, but the results are robust across specifications. The mean value of absence among boys and girls aged 13-16 is 12.8 percent, making the effect equivalent to 14.8% higher absenteeism among girls using preferred specification (5).

#### 5.0.1 Reasons for Absenteeism

The true reasons for the school absenteeism may vary across ages and gender, as girls and boys face different expectations and demands from parents, peers, and teachers, and have different biological needs. We analyze the data collected at the time of a spot-check on the reason for the absence. The spot-checks were still collected by the researchers doing roll-call. However, upon noticing that a student was absent, they noted a reason. One limitation is that the reason is not directly reported by the absent student him or herself, but by the teachers and peers. It is likely that certain reasons would be under-reported (such as menstruation, which is stigmatized) and others over-reported (such as sickness, if it becomes a ”catch all”

[11] We can now include ages 19-21 which we excluded from Figure 3 because too small sample sizes, and the interaction effects female*age 20-21 are negative.

Table 3: Specification robustness for age group 13-16

| *Outcome:* | Absent | | | | |
|---|---|---|---|---|---|
| *Age:* | 13-16 | 13-16 | 13-16 | 13-16 | 13-16 |
| | (1) | (2) | (3) | (4) | (5) |
| female | 0.019*** | 0.020*** | 0.022*** | 0.021*** | 0.019*** |
| | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) |
| grade | | -0.014*** | -0.018*** | -0.017*** | -0.017*** |
| | | (0.003) | (0.003) | (0.003) | (0.003) |
| age | | | 0.011*** | 0.010*** | 0.011*** |
| | | | (0.004) | (0.004) | (0.004) |
| Observations | 16,867 | 16,867 | 16,867 | 16,867 | 16,867 |
| R-squared | 0.001 | 0.002 | 0.003 | 0.011 | 0.035 |
| Sample aged 13-16 | Yes | Yes | Yes | Yes | Yes |
| Mean value of absent | 12.8 | 12.8 | 12.8 | 12.8 | 12.8 |
| School FE | No | No | No | Yes | Yes |
| Month FE | No | No | No | No | Yes |

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Sample is limited to students ages 13-16.

category).

Table 4 ranks the reason for absenteeism for the 4,051 recorded absences in the spot-check data, and presents a p-value for the difference in means between boys and girls. Note this data excludes all present students, as well as all register data.

Table 4 ranks the reason for absenteeism for the 4,051 recorded absences in the spot-check data, and shows a p-value for the difference in means between boys and girls. Note this data excludes all present students, as well as all register data. For 6.79% of the absent spot-checks *unknown reason* was stated, which is different from no reason stated (*not available*, 0.04%). Girls are more likely absent because of school transfer, but are less likely absent because of being sick or having dropped out. There is no gender difference in having left school early on the day of the spot-check. It must be noted that we cannot confirm that students who are reported as having transferred to another school, did so. It remains possible that "transfer" is capturing both transfers and drop-outs.

Table 4: Reason for absenteeism for boys and girls

| *Sample:* | All students | | Boys | Girls | | |
|---|---|---|---|---|---|---|
| *Reason for absenteeism* | Frequency | Percent | Mean | Mean | p-value | $\alpha = 0.005$ |
| | (1) | (2) | (3) | (4) | (5) | |
| Transferred to other school | 2,390 | 59.00 | 0.542 | 0.642 | 0.000 | * |
| Sick | 883 | 21.80 | 0.236 | 0.199 | 0.0049 | * |
| Dropped out | 199 | 4.91 | 0.061 | 0.037 | 0.004 | * |
| Fees | 135 | 3.33 | 0.04 | 0.026 | 0.0155 | * |
| Left school early | 130 | 3.21 | 0.034 | 0.03 | 0.4308 | |
| Passed away | 17 | 0.42 | 0.007 | 0.001 | 0.0027 | * |
| Changed class | 12 | 0.30 | 0.002 | 0.004 | 0.4737 | |
| Domestic duties | 3 | 0.07 | 0 | 0.001 | 0.5178 | |
| Suspended | 2 | 0.05 | 0.001 | 0 | 0.1741 | |
| Attending Funeral | 1 | 0.00 | 0 | 0.001 | 0.2981 | |
| Got married | 1 | 0.02 | 0 | 0.001 | 0.2981 | |
| Is pregnant | 1 | 0.02 | - | 0.001 | 0.2981 | |
| Unknown reason | 275 | 6.79 | 0.076 | 0.059 | 0.0241 | * |
| Not available | 2 | 0.04 | 0 | 0.001 | 0.9551 | |
| Total | 4,051 | 100.00 | 2,106 | 1,945 | | |

Notes: Reason stated for absenteeism in the spot-check data. The reasons are not reported by the student. Column 5 presents the p-value to a two-sided t-test of the mean for boys (column 3) and girls (column 4).

Table 5 further shows that while girls are absent from 13% of the spot-checks, this drops to 5.1% when excluding the female students who have transferred to another school. For boys, the equivalent numbers are 12.1% and 5.9%, meaning that while boys are less absent on average, they are more likely to be absent for non-transfer related reasons. These differences could be because of the slight differences in age and grade, which are visible in the table. Regression analysis could control for these demographic differences across the two genders.

Table 5 translates the average days absent into days per school month, counting a school month as 21 days. Total absenteeism including transfers is 13% for girls, equivalent to 2.73 school days in a month. This is the upper bound in the data, as it includes students who are absent because of transfer from or to the school. Excluding such transfer students, the absenteeism drops to just above 1 day per month. Girls are absent because of sickness in 2.6% of spot-checks, equivalent to 0.546 days per month because of sickness. Boys miss on average 0.588 schooldays per month because of sickness.

Before turning to the regression analysis using only students who did not transfer school, we will discuss a few caveats. First, as seen in Table 4, the school did not know why the student was absent in 275 cases. This could be because the student has not reported to the school why he or she is absent. There is also missing data on the reason for absenteeism in only two cases, although some reasons are listed as *not available*. Second, the reasons were not confirmed through home visits. This is challenging for the next step in the analysis where we exclude students who transferred. In contrast to the randomized control study sample, transfers were not verified; researchers did not confirm the students subsequent enrollment in the new school. Students who dropped out may have stated that they were transferring schools. Validation of the transfer records, do not show perfect adherence to either of two patterns (i) student was present, then transferred school and was permanently absent, or (ii) student was not recorded, then transferred into the study schools. A small subset of students were recorded absent because of transfers, but returned at a later spot-check spot-check,

Table 5: Summary statistics by gender

| | (1) Mean | (2) Std. Dev. | (3) Min. | (4) Max. | (5) Obs. | (6) Days missed in a month |
|---|---|---|---|---|---|---|
| *Girls* | | | | | | |
| age | 12.547 | 1.4 | 8 | 21 | 14924 | - |
| grade | 5.737 | 0.830 | 5 | 8 | 14924 | - |
| absent | 0.13 | 0.337 | 0 | 1 | 14924 | 2.73 |
| absent (excluding transfers) | 0.051 | 0.22 | 0 | 1 | 13675 | 1.071 |
| reason for absent is sick | 0.026 | 0.159 | 0 | 1 | 14923 | 0.546 |
| *Boys* | | | | | | |
| age | 13.151 | 1.621 | 9 | 20 | 17425 | - |
| grade | 5.871 | 0.878 | 5 | 8 | 17425 | - |
| absent | 0.121 | 0.326 | 0 | 1 | 17425 | 2.541 |
| absent (excluding transfers) | 0.059 | 0.236 | 0 | 1 | 16284 | 1.239 |
| reason for absent is sick | 0.028 | 0.166 | 0 | 1 | 17425 | 0.588 |

making it difficult to know if they were listed as transferred in error, or if the student did leave for another school and later returned to their original study school. While this is not true for the majority of students who transferred, making it difficult to know if they were listed as transferred in error, or if the student did leave for another school and later returned to their original study school.

## 5.1 Mechanism

### 5.1.1 Excluding Students Who Transferred

We continue the analysis using only the students who never transferred schools. In total, 5,699 student observations were dropped because they were, at least once, registered as absent because of transfer. Note that this number is larger than the number in Table 4, which shows that 2,390 observations were recorded as absent because of transfer. The reason is that we drop all students who are ever recorded as absent due to transfers from the subsequent analysis.

We do not exclude absence because of other reasons, such as death, dropout, suspended, pregnant, or married in this analysis. The reason is two-fold: first, transfers are the most common reported reason, second, transfer students have not interrupted their schooling but are purportedly continuing it elsewhere.

Table 6 shows the main results excluding the students who have transferred schools. Grade is negatively associated with absenteeism (with age controls). The female dummy is negative and weakly significant (columns 1, 3-6). The specifications in columns 3-6 use age categories interacted with female that are all insignificant, with the exception of ages 19-21 which is marginally significant and negative (less likely absent). The results in Table 6 contrast sharply with the results in Table 2, yet the only difference is the exclusion of transfer students. Table 7 focuses in on the group 13-15 years old, who are within the common onset period for menarche and thus may be most vulnerable to menstruation-related absence. However, the female dummy is negative and insignificant across specifications.

### 5.1.2 Sickness-Related Absenteeism

Subsequently, we explore if girls are more likely to be absent because of sickness, hypothesizing that menstruation-related absenteeism is reported as sickness (since menstruation is never reported as a reason) (8). We exclude all students who are absent because of transfers, and we condition upon being absent for the spot-check. The outcome variable is the likelihood that the student is absent because of sickness, rather than because of any other reason. The conditionality reduces the sample size: we have 1,194 spot-check observations that were recorded absent for reasons other than transfers. Girls are not more likely to be absent because of sickness, also when conditioned on or interacting with age.

Table 6: Main results by age excluding transfer students

| *Outcome:* | Absent | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Reference group: | | | 8-10 | 8-10 | 8-12 | 8-12 |
| female | -0.006** | 0.005 | -0.006** | -0.002 | -0.006** | -0.007* |
| | (0.003) | (0.025) | (0.003) | (0.013) | (0.003) | (0.004) |
| grade | -0.015*** | -0.015*** | -0.015*** | -0.015*** | -0.015*** | -0.015*** |
| | (0.002) | (0.003) | (0.002) | (0.002) | (0.002) | (0.002) |
| age | 0.004*** | 0.004* | | | | |
| | (0.001) | (0.002) | | | | |
| female*age | | -0.001 | | | | |
| | | (0.002) | | | | |
| age 11-12 | | | -0.003 | -0.000 | | |
| | | | (0.007) | (0.010) | | |
| age 13-14 | | | 0.003 | 0.003 | 0.006* | 0.004 |
| | | | (0.007) | (0.010) | (0.003) | (0.004) |
| age 15-16 | | | 0.008 | 0.013 | 0.012** | 0.014** |
| | | | (0.008) | (0.011) | (0.005) | (0.006) |
| age 17-18 | | | 0.037** | 0.041** | 0.040*** | 0.042*** |
| | | | (0.015) | (0.018) | (0.014) | (0.016) |
| age 19-21 | | | -0.001 | 0.008 | 0.002 | 0.008 |
| | | | (0.027) | (0.031) | (0.026) | (0.029) |
| female*age 11-12 | | | | -0.006 | | |
| | | | | (0.013) | | |
| female*age 13-14 | | | | 0.000 | | 0.005 |
| | | | | (0.013) | | (0.006) |
| female*age 15-16 | | | | -0.014 | | -0.009 |
| | | | | (0.015) | | (0.008) |
| female*age 17-18 | | | | -0.015 | | -0.010 |
| | | | | (0.038) | | (0.036) |
| female*age 19-21 | | | | -0.064* | | -0.060* |
| | | | | (0.033) | | (0.031) |
| Observations | 26,612 | 26,612 | 26,612 | 26,612 | 26,612 | 26,612 |
| R-squared | 0.008 | 0.008 | 0.016 | 0.016 | 0.016 | 0.016 |
| Controls | No | No | Yes | Yes | Yes | Yes |
| School FE | No | No | Yes | Yes | Yes | Yes |
| Month FE | Yes | Yes | Yes | Yes | Yes | Yes |

Notes: Robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Reference category are students ages 8-10 (columns 3-4) and 8-12 (columns 5-6).

Table 7: Specification robustness for age group 13-16 excluding transfer students

| *Outcome:* | Absent | | | | |
|---|---|---|---|---|---|
| *Age:* | 13-16 | 13-16 | 13-16 | 13-16 | 13-16 |
| | (1) | (2) | (3) | (4) | (5) |
| female | -0.005 | -0.004 | -0.003 | -0.004 | -0.004 |
| | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) |
| grade | | -0.014*** | -0.015*** | -0.016*** | -0.016*** |
| | | (0.002) | (0.002) | (0.002) | (0.002) |
| age | | | 0.003 | 0.003 | 0.003 |
| | | | (0.002) | (0.002) | (0.002) |
| Observations | 13,578 | 13,578 | 13,578 | 13,578 | 13,578 |
| R-squared | 0.000 | 0.004 | 0.004 | 0.013 | 0.018 |
| Sample aged 13-16 | Yes | Yes | Yes | Yes | Yes |
| School FE | No | No | No | Yes | Yes |
| Month FE | No | No | No | No | Yes |

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The outcome variable is binary and takes a value of 1 if the absence is because of sickness, and 0 if it is for another reason.

Table 8: Sickness Related Absenteeism

| *Outcome:* | Absent because of sickness (conditional upon being absent) | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| female | 0.030 | 0.024 | 0.222 | -0.010 | 0.190 |
| | (0.027) | (0.025) | (0.208) | (0.040) | (0.642) |
| grade | -0.005 | 0.006 | 0.007 | 0.020 | 0.021 |
| | (0.023) | (0.022) | (0.022) | (0.027) | (0.027) |
| age | -0.018* | -0.020** | -0.015 | -0.007 | -0.004 |
| | (0.011) | (0.010) | (0.011) | (0.022) | (0.023) |
| female*age | | | -0.016 | | -0.015 |
| | | | (0.017) | | (0.047) |
| Observations | 1,194 | 1,194 | 1,194 | 610 | 610 |
| R-squared | 0.125 | 0.305 | 0.306 | 0.283 | 0.283 |
| Controls | No | Yes | Yes | Yes | Yes |
| School FE | No | Yes | Yes | Yes | Yes |
| Month FE | No | Yes | Yes | Yes | Yes |
| Sample aged 13-16 years | | | | Yes | Yes |

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Sample is conditional on being absent, and the outcome variable is absent because of sickness.

Table 9: Absent with latrine controls for girls

| *Outcome:* | Absent | Absent | Absent because of transfer | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| total latrines | -0.002* | | -0.001 | | |
| | (0.001) | | (0.001) | | |
| ratio girls to latrine | | -0.001*** | | -0.000*** | |
| | | (0.000) | | (0.000) | |
| age | 0.012*** | 0.012*** | 0.006*** | 0.006*** | 0.006*** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) |
| grade | -0.009** | -0.010** | 0.003 | 0.002 | 0.003 |
| | (0.004) | (0.004) | (0.003) | (0.003) | (0.003) |
| Observations | 14,924 | 14,924 | 14,923 | 14,923 | 14,923 |
| R-squared | 0.024 | 0.025 | 0.019 | 0.020 | 0.036 |
| School FE | No | No | No | No | Yes |
| Month FE | Yes | Yes | Yes | Yes | Yes |

Notes: Robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

### 5.1.3 Latrine controls

The school fixed effects will control for unobserved differences in latrine availability and quality. To understand the effect of latrine availability on absenteeism behavior of girls, we ran the main regression with one variable capturing total latrines available at the school, and one capturing the ratio of girls to latrines (Table 9). Importantly, we find no association between girls transferring and latrine availability. The main limitation of this analysis is that latrine availability likely correlates with school quality more broadly. However, we measure a statistically insignificant (column 3) and precisely estimated zero (column 4) effect of latrines and transfers, meaning that girls are not more likely to transfer because of low latrine availability.

# 6 Validation of Register Data using Cohen's $\kappa$ coefficient

Table 10 illustrates the difference in quality between the register data and the spot-check data. The spot-check data has almost 13% of students registered as absent on a random spot-check day. The register data has a fewer number of total observations. Not captured indicates that the school register data was available, but there was no record for the individual student. This is true for 3,459 observations. Students may also be recorded as not captured if the register is missing, which is true for 2,466 observations. The remainder of the 8,091 student observations are marked as not captured because they were not in the register (they could for example be incoming transfer students), or for other unknown reasons (130 students). Figure 4 illustrates that girls have higher recorded absenteeism from age 12 (although the confidence intervals are largely overlapping), but most of this difference is due to the higher transfer records among girls (panel B). The administrative school record data show a somewhat similar pattern to the spot-check data, especially when transfer students are excluded. Appendix Figure A2 shows the same data but allows easier comparison across data sets, instead of by gender.

Further analysis into the discrepancies between the school register data and the spot-check data, shows that the register data has fewer non-missing observations (23,863 vs 32,349), a difference that remains after excluding all students that ever are recorded as transfers (20,264 vs 26,076) and any student who we judge as potentially permanently absent (students who ever during the study period changed class, died, dropped out, married, were suspended or transferred) (18,209 vs 21,419). This exercise shows that the data discrepancies are not limited to cases where students quit school and were removed from the school register (leading to missing entries) but whose absence was recorded by the researchers and not by the schools.

Table 10: Validating register data

| | Spot-check data | | Register data | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Marking | Frequency | Percent | Frequency | Percent |
| Absent | 4,052 | 12.53 | 1,688 | 5.28 |
| Present | 28,297 | 87.47 | 22,176 | 69.40 |
| Attendance not captured | 0 | 0 | 8,091 | 25.32 |
| Total | 32,349 | 100.00 | 31,955 | 100.00 |

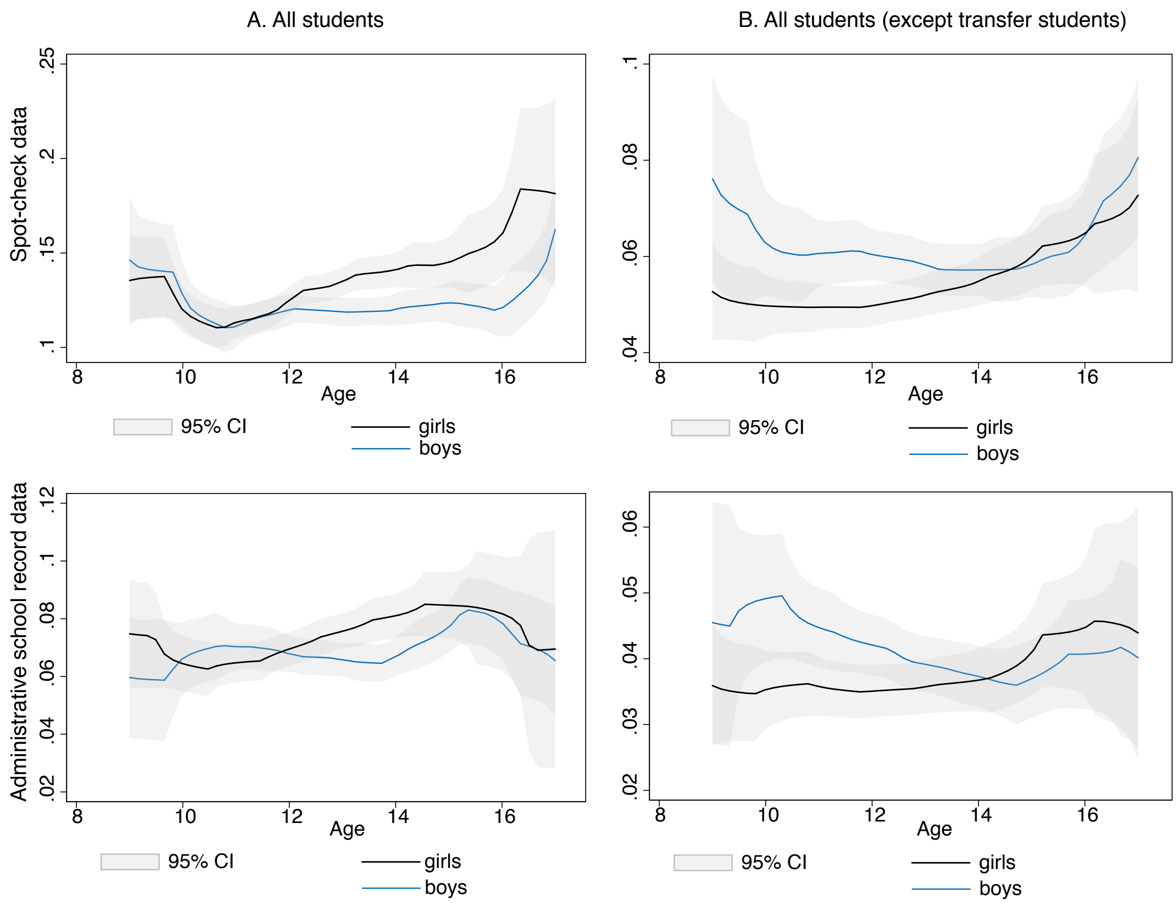
#### 6.0.1 Cohen's $\kappa$ coefficient

To further understand the differences in the two measures of absenteeism, the spot-check and the register data, we use Cohen's kappa coefficient. A kappa coefficient is used to measure the agreement be of two alternative measures for a categorical variable. The kappa coefficient shows the proportion of agreement between the two measures, correcting for chance. The scale varies from negative 1 to positive 1, where negative values indicate lower than chance agreement, and positive values indicate higher than chance agreement. If the two variables are identical, the kappa coefficient will be 1. A weighted kappa (not applied here) takes into account the relative seriousness of the different types of disagreements observed in the data (Fleiss and Cohen, 1973).

We calculate two kappa coefficients. The first calculation codes missing absenteeism records from the register data as absent. The agreement between the variables is 74.33%, and the expected agreement is 65.36%. The kappa coefficient is $\kappa$=0.2588 (S.E.=0.005, Z= 52.08, p-value=0.000). The positive kappa illustrates that there is more agreement between the variables than determined by chance, and Landis and Koch (1977) classifies the strength of the agreement as fair (Fair = 0.21 - 0.40) although this classification has been criticized for being arbitrary.

An issue with the school records is missing observations, that is, the school record does

Figure 4: Absenteeism for boys and girls across spot-check and school register data




*Notes:* Local polynomial smooth with 95% confidence intervals. The data is collapsed by student age (9-17) on the X-axis and student mean absenteeism is plotted on the Y axis. Because of small sample sizes below 8 and above 17, these ages are excluded.

not indicate if the student was absent or present on the data. When excluding all student-day observations (from both datasets) when the school record is missing, the agreement between the two variables (spot-checks and school records) should thus increase. The new kappa coefficient is $\kappa$=0.3824 (SE=0.0065, Z=58.54, p-value=0.000) and the agreement is 91.03%, and the expected agreement 85.47%. The kappa coefficient is still classified as fair (Landis and Koch, 1977), while underestimating the differences between the two records as we have removed the missing observations from the school records.

Existing education studies that use school records in developing countries may thus estimate effects on attendance with significant bias, as the school records show significant disagreement with spot-check data both at the intensive margin (absent or present, conditional upon record) and extensive margin (availability of record). Measurement bias would arise if the missing record (no entry) correlates with the absenteeism rate. In fact, there is a significant negative correlation between an absent record in the spot-check and an entry in the school record (OLS coefficient is -0.2389, SE=0.007, p-value=0.000, using school fixed effects and robust standard errors), meaning that absence sometimes show up as no record rather than absent. An intervention that changes a student's absenteeism pattern would thus also affect the likelihood of the student having an entry in the school record.

These results contrast with previous attempts to validate school records, such as a study in Malawi (Baird et al., 2011), where the authors found perfect agreement between the teacher's record of absence and spot-checks. Upon successful validation of the teacher-administered records, spot-checks were discontinued because of costs. These contrasting findings from Malawi and Kenya highlight the need to cross-validate school records; if there is perfect agreement, school records are preferred because of their frequency, if inadequate agreement, spot-checks are needed despite the costs associated. We encourage future studies to use smart technology for monitoring of student attendance.

# 7 Illustrating the Need for Verified School Register Date in Impact Analysis

To further validate our claim that school record data must be validated before being employed in impact analysis, we reran the results of the study using the spot-checks and the school records. The spot-check data was collected for a pilot cluster randomized control study across the 30 schools targeting adolescent girls. The program, described in detail in Phillips-Howard et al. (2016), reduced incidence of STIs and bacterial vaginosis.

The study girls received either (i) an insertable menstrual cup[12], or (ii) 16 sanitary pads monthly, or (iii) control (usual practice). All girls participating in the study received soap, puberty education, and had access to a study nurse. In addition, all 30 schools received soap for hand washing. All students who were enrolled at the beginning of the year and who participated in the study are included in the analysis. The sample was balanced across the three treatment groups (Phillips-Howard et al., 2016). The first spot-check data was collected mostly between October and November in 2012, but some individuals were added in later months. The last spot-check data was collected between October and November, 2013.

Table 11 panel 1 uses the main difference-in-difference specification used in Benshaul-Tolonen et al. (2019). The coefficient of interests are $\beta_1$ for *post*sanitarypad* and $\beta_2$ for *post*menstrual cup*, the two indicator variables that take the value 1 if the student participated in that treatment arm and the observation was collected after the program start. The regression specification thus follows a standard difference-in-difference approach:

$$
\begin{aligned}
Absent_{ism} = \beta_0 + \beta_1 sanitarypad_i + \beta_2 menstrualcup_i + \beta_2 post_i \\
+\beta_3 post * sanitarypad_i + \beta_4 post * menstrualcup_i \\
+\lambda_i + \delta_m + \alpha_s + \varepsilon_{ism}
\end{aligned}
\tag{4}
$$

Where $\lambda_i$ is a vector of controls (age and grade), and the specification controls for month fixed effects and school fixed effects. The specification uses all observations from the beginning of the study to endline, and columns 1 and 2 recreates results from Benshaul-Tolonen et al. (2019), but in contrast to Benshaul-Tolonen et al. (2019), columns 3 and 4 show the results using the same specification but defining absenteeism using the school register data instead of the spot-checks.

[12] See van Eijk et al. (2019) for a review of the research on menstrual cups

Two main findings stand out. First, girls that received the sanitary pads were 7.9 percentage points less likely to be absent after receiving the intervention. The treatment effect for the menstrual cup treatment is statistically insignificant. The lack of effect of the menstrual cup could be because of the slow adoption of the menstrual cup (van Eijk et al., 2018), and because these are intent-to-treat specifications.[13]. Second, using the inadequate administrative school record data, we are at risk of concluding that the sanitary pad arm did not reduce absenteeism. Column 5 provides a chi-square test of equality of the coefficients in columns 1 and 3. The treatment effect for post * sanitary pad is biased when we use the school record data.

Table 11: Treatment effects on absenteeism using spot checks or school records

| *Outcome:* | Absent | | | | |
|---|---|---|---|---|---|
| *Data source:* | Spot-check data | | School record data | | Chi-square (columns 1 and 3) |
| | (1) | (2) | (3) | (4) | (5) |
| post * menstrual cup | 0.019 | 0.020 | -0.014 | -0.015 | 0.75 (p = 0.386) |
| | (0.023) | (0.025) | (0.034) | (0.033) | |
| post * sanitary pad | -0.079* | -0.078* | -0.017 | -0.017 | 3.39 (p = 0.655) |
| | (0.044) | (0.043) | (0.029) | (0.029) | |
| Observations | 3,083 | 3,083 | 2,229 | 2,229 | |
| R-squared | 0.056 | 0.058 | 0.071 | 0.071 | |
| Controls | Yes | Yes | Yes | Yes | |
| SES control | Yes | No | No | Yes | |
| School fixed effects | Yes | Yes | Yes | Yes | |

Clustered standard errors at the school level in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The table compares spot-check data and school record data across three main different specifications. Column 5 presents the equality of coefficients in column 1 and 3 for the main treatment variables.

# 8 Discussion

Adolescent girls may be at risk of missing school days because of their menstruation, especially when they also face poverty and lack of adequate WASH facilities. We review a novel,

[13]For a fuller discussion and robustness of these results, please see Benshaul-Tolonen et al. (2019)

large dataset on school absenteeism in western Kenya to test this hypothesis. The dataset was collected by the researchers during unannounced school-level spot-checks, and is used to provide reliable insights into absenteeism levels for boys and girls in primary schools,

We note that absenteeism is high among both boys and girls. Data suggests girls are about 1 percentage point more likely to be absent than boys (13% of days missed, compared to 12.1% for boys). However, we do find some differences in reported reasons for absenteeism. Some findings are in contrast to conventional wisdom. Boys are more likely to be reported absent because of sickness and have higher drop-out rate than girls, while girls are more likely to transfer to another school. A large share of absenteeism is reported as due to transfers to other schools. Non-transfer related absenteeism is fairly low, at around 1 school day per month for both girls and boys, of which roughly half a day is missed because of reported sickness.

We argue that not accounting for transfers could lead to bias as transfers are more common among older students and girls, however we do not find a link between latrine availability and the likelihood of transfer to another school. When including students who are reported as absent because of transferring to another school (the upper bound measure of absences), the rate of absenteeism is calculated as 2.73 days per school month. A back-of-the-envelope calculation indicates that girls and boys miss around 13 to 15 days of schooling per year, and that sickness accounts for about half of them. These numbers are still below the hypothesized level of menstruation-related absences often cited in the media, and highlight that boys also face challenges that similarly constrain attendance.

We note some limitations in the cross-sectional analysis. First, students who quit school prior to the study period are not included, meaning that the most vulnerable part of the population may have been excluded. If female students, upon reaching menarche, drop out of school, they will not be included in the sample with the exception for the year in which they dropped out. However, supporting the accuracy of the analysis, a student that was still enrolled in school at the beginning of the study period but drops out during the year will be recorded as absent.

Second, school eligibility criteria may have by design excluded the most vulnerable population who attend schools with the lowest latrine quality. Third, while the quality of the spot-check data is deemed high, the recorded reasons of absenteeism are based on the school reporting as the student was not present to report directly to the researcher. Menstruation was never recorded as a reason for absence. While there could be significant bias in the reported reasons for absence from a spot-check, it should not affect the quantification of being absent/present. Additionally, the time of the day the spot-check was conducted was not recorded.

We illustrate the need for spot-checks or validation of school data in impact analysis by evaluating a three arm feasibility cluster randomized control study. The analysis show that the monthly provisions of sanitary pads reduced absenteeism with 7.9 percentage points and the menstrual cup treatment arm did not reduce absenteeism when we use the spot-checks (in line with the results from Nepal by Oster and Thornton (2011)). Using the school record data for the exact same student-dates does not lead to statistically significant treatment effects, illustrating the need for high quality data.[14] The analysis adds to a growing literature on the role of access to sanitary products for school absenteeism, such as Montgomery et al. (2016) and Oster and Thornton (2011). Given the reported absenteeism levels among boys (12.1%) and girls (13%), in the absence of constraints specific to boys, a program aiming to reduce absenteeism among girls through an MHM intervention would need to be well-powered to detect such an effect.

The results do not infer that MHM is of no importance for female students in Kenya and in other developing countries. School absenteeism behavior may not be the most relevant margin at which the lack of MHM affects female students. In fact, 22% of girls in the

[14]Further details on the program can be found in Phillips-Howard et al. (2016), and its effects on absenteeism are provided in Benshaul-Tolonen et al. (2019)

randomized control study sample reported heavy bleeding, and 61% reported that they experience cramps during period. A recent qualitative study in India among schoolgirls above age 12 found that menses affected concentration in school (reported by 40-45% of girls) and that pain management was an issue (reported by 31-38% of girls), although only 6% of girls reported reduced attendance (Sivakami et al., 2019). Similarly, 66% of girls interviewed for a study in Nigeria suffer from abdominal pain and discomfort during their period (Adinma and Adinma, 2009). Future studies should focus on the potential challenge of managing menstrual pain and impacts on menstruation on concentration, participation in school, and test scores. Future studies also need to consider psychosocial outcomes such as self-esteem, wellbeing, and empowerment; and where feasible, outcomes on sexual and reproductive health. Moreover, the results indicate that pupil absenteeism for both boys and girls should be further explored, and that adolescent boys' absenteeism patterns warrant attention equal to that concerned with girls. Lastly, the study highlights that studies using administrative school records may suffer from measurement error resulting in biased estimates.

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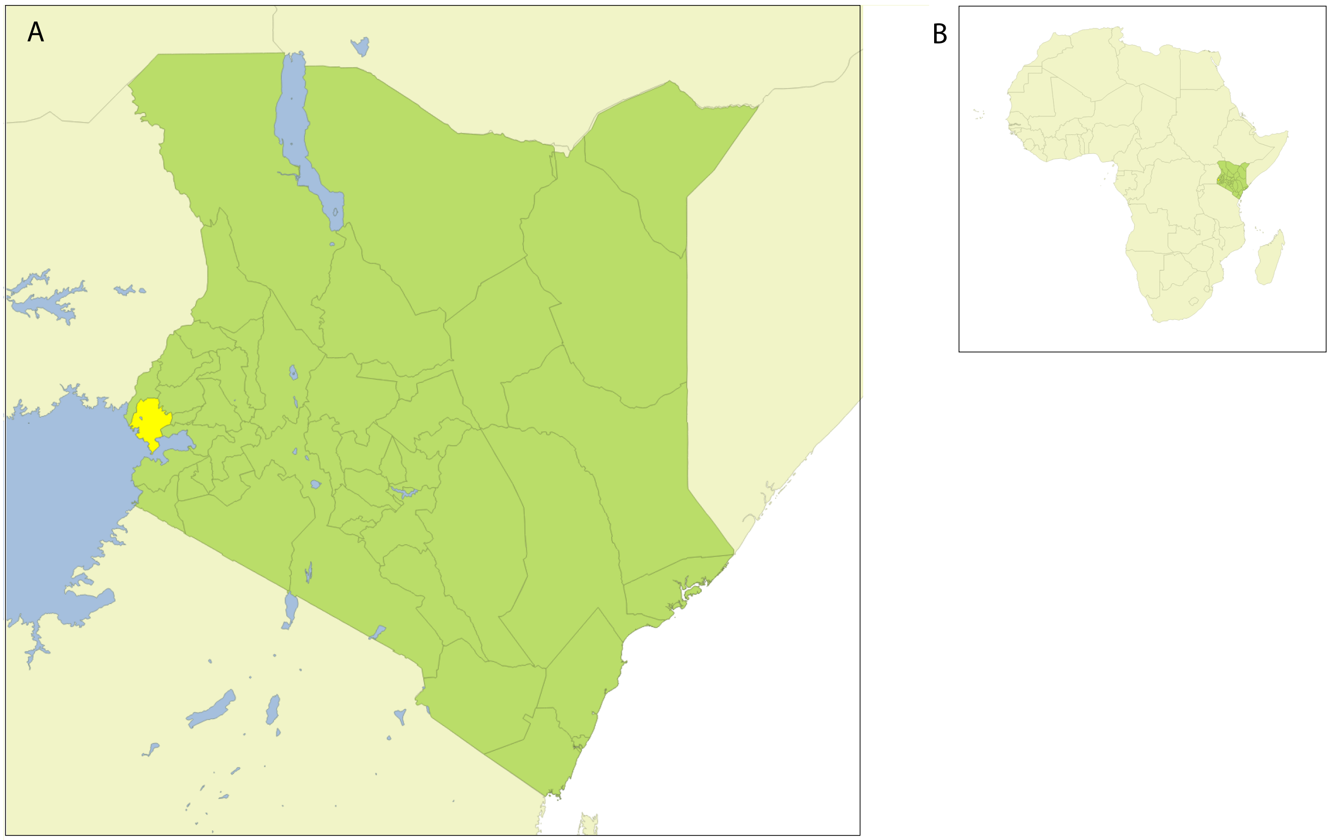
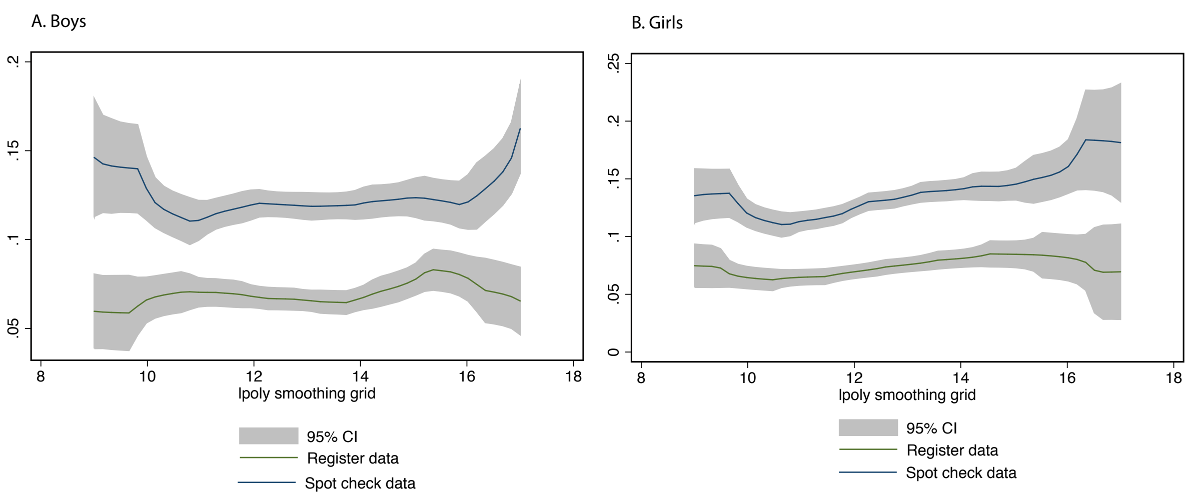
# Appendix: Figures and Tables

Figure A1: Siaya County, Kenya




*Notes:* Map of Kenya and Siaya County (A), and Africa (B)

Figure A2: Absenteeism for boys and girls across spot-check and school register data




*Notes:* Local polynomial smooth with 95% confidence intervals. The data is collapsed by student age (9-17) on the X-axis and student mean absenteeism is plotted on the Y axis. Because of small sample sizes below 8 and above 17, these ages are excluded.

Table A1: spot-checks and register entries by term for the randomized control study

| Term | spot-check | Freq. | Percent |
|---|---|---|---|
| Term 0 | spot 1 | 1,094 | 16.00 |
| Term 1 | spot 1 | 1,168 | 17.09 |
| Term 2 | spot 1 | 1,104 | 16.15 |
| Term 2 | spot 2 | 1,147 | 16.78 |
| Term 3 | spot 1 | 1,161 | 16.98 |
| Term 3 | spot 2 | 1,162 | 17.00 |
| Total | | 6,836 | 100.00 |

Table A2: spot-checks by term for the randomized control study

| Term | spot-check | Freq. | Percent |
|---|---|---|---|
| Term 0 | spot 1 | 547 | 16.01 |
| Term 1 | spot 1 | 564 | 16.51 |
| Term 2 | spot 1 | 528 | 15.45 |
| Term 3 | spot 2 | 590 | 17.27 |
| Term 3 | spot 1 | 596 | 17.44 |
| Term 3 | spot 2 | 592 | 17.33 |
| Total | | 3,419 | 100.00 |