Sanitation and Education*

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Abstract

I explore whether the absence of school-sanitation infrastructure impedes educational attainment, particularly among pubescent-age girls, using a national Indian school-latrine-construction initiative and administrative school-level data. School-latrine construction substantially increases enrollment of pubescent-age girls, though predominately when providing sex-specific latrines. Privacy and safety appear to matter sufficiently for pubescent-age girls that only sex-specific latrines reduce gender disparities. Any latrine substantially benefits younger girls and boys, who may be particularly vulnerable to sickness from uncontained waste. Academic test scores did not increase following latrine construction, however. Estimated increases in enrollment are similar across the substantial variation in Indian district characteristics.

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Worldwide, one in five children between the ages of 10 and 15 are out of school (UNESCO, 2010). Girls in developing countries disproportionately drop out of school, particularly around puberty. Addressing gender biases in educational attainment is central to reducing gender inequality, as education provides opportunities for upward economic mobility. Gender equality in education and economic opportunity has also been associated with a broad range of social and economic benefits (Duflo, 2012). The Millennium Development Goals reflected a call from the international policy community to expand access to education and to address a gender gap in enrollment that is particularly pronounced among adolescents.

In considering the reasons for high dropout rates, particularly among pubescent-age girls, some have directed attention toward the absence of sanitation facilities in many schools worldwide (Fentiman, Hall and Bundy, 1999; Burgers, 2000; WHO, 2005; Kirk and Sommer, 2006; Raising Clean Hands, 2010). One concern is that the absence of school latrines may cause girls to miss school on their menstruation days and then drop out from school (Lidonde, 2004), though the number of missed school days coinciding with menstruation may not be substantively large (Mensch and Lloyd, 1998; Oster and Thornton, 2011). A broader concern is that the absence of school latrines potentially exposes pubescent-age girls to every-day threats of verbal and physical harassment at school, with potential consequences for female educational attainment. While girls menstruate for only a few days each month, pubescent-age girls are impacted every day by the physical, emotional, and societal changes associated with the onset of menstruation. Further, a narrow focus on menstruation might neglect other factors that also impact boys and younger girls, obscuring a broader link between school sanitation and education.

In a review of this literature, Birdthistle et al. (2011) highlight the absence of a quantitative empirical evaluation of a large-scale latrine-construction initiative. School sanitation has traditionally been neglected; indeed, even the standard school supported by the World Bank need not include sanitation facilities. There is an increasing policy emphasis on school sanitation, however, and these ideas have manifested in the recent Indian government's campaign slogan of "toilets before temples" and recent *Swachh Bharat: Swachh Vidyalaya* ("Clean India: Clean Schools") initiative to provide universal access to sex-specific latrines in all government schools.

In this paper, I explore how improved school sanitation impacts educational decisions of both girls and boys across different ages. Using an earlier national school-latrine-construction initiative in India, I compare changes in schools that received a latrine in 2003 to changes in similar schools that did not receive a latrine. I begin by analyzing the impact of access to any latrine, but I then contrast the impacts from a unisex latrine and separate sex-specific latrines and consider how these impacts vary by children's gender and age. I find that school sanitation substantially increases enrollment of pubescent-age girls but predominately when providing sex-specific school latrines. Unisex sanitation facilities benefit younger girls and boys of all ages. As India was home to 20 million out-of-school children in 2000 (UNESCO, 2015), with large gender gaps among adolescents, there are substantial potential impacts from expanding and re-directing policy efforts in India. More broadly, evaluation of this large-scale policy initiative provides the first systematic empirical view of the link between school sanitation and education outcomes. By using the substantial variation in district characteristics across India, I explore how the relationship between sanitation and education might vary across developing contexts.

I use administrative data that I obtained from the Indian government (DISE), which provide a large sample of 139 thousand schools. Due to potential reporting biases in the main DISE dataset, I also supplement this analysis using a separate smaller nationally-representative dataset collected by an independent NGO (ASER).

In exploring linkages between school sanitation and education, the general empirical challenge is that schools with latrines may differ systematically from schools without latrines. This cross-sectional selection bias can be overcome using the Indian government's latrine-construction initiative in 2003: estimating changes in schools that received a latrine in 2003, relative to schools that did not receive a latrine. The remaining empirical concern, however, is that schools receiving latrines may have changed differently even in the absence of latrine construction.

Much of the empirical analysis is focused on the potential for schools that received latrines to have otherwise changed differently. The empirical analysis focuses on comparing changes among initially-similar "treatment" and "control" schools, either by controlling for initial school characteristics or by matching on initial school characteristics. The main empirical assumption is that new latrine construction is uncorrelated with other changes after 2003, conditional on school fixed effects, district-year fixed effects, and the included school-level controls interacted with year. To relax this identification assumption further, I explore whether schools receiving latrines were also more likely to receive other infrastructure and control for changes in these other school infrastructure characteristics. I also use alternative comparison groups, such as: comparing schools that received a latrine in 2003 to schools that received a latrine shortly thereafter or to the pooled sample of schools that never had a latrine or always had a latrine from 2002 – 2005. I further examine the results' robustness by limiting the sample to villages with only one school to avoid displacement effects, restricting the sample to strictly-coeducational schools, and quantifying potential mean-reversion bias from measurement error.

I estimate that school latrines positively impact all students, across genders and ages.

Access to school sanitation increases student enrollment and lowers dropout. These impacts persist for at least three years, despite the potential for problems with latrine maintenance. Increased enrollment is also reflected in the number of students who take and pass a middle-school board exam.

To explore the mechanisms behind these impacts, particularly potential improvements in privacy and safety for pubescent-age girls, I examine differential impacts by type of school latrine. The presence of any school latrine generally increases female enrollment moderately more than male enrollment, but latrine type matters greatly. Pubescent-age girls benefit little from a unisex latrine but benefit greatly from sex-specific latrines. Unisex latrines have a greater impact on pubescent-age boys than pubescent-age girls. Privacy and safety appear to matter sufficiently at older ages that school sanitation only reduces gender disparities with the construction of sex-specific latrines; by contrast, the construction of unisex latrines exacerbates gender disparities at older ages.

School latrines may also have important impacts through child health, especially as younger children are particularly vulnerable to the health consequences from uncontained waste. While many policymakers and researchers focus on pubescent-age girls and menstruation, I find that younger girls (and boys) experience even larger benefits than pubescent-age girls (and boys). Unisex latrines are mostly sufficient at younger ages for both girls and boys, suggesting that verbal and physical harassment may be of greater concern at pubescent ages. Sex-specific latrines have some additional impacts at younger ages, however, which is consistent with some concerns of bullying also at younger ages for both boys and girls.

I also explore whether school latrines impact children by increasing the presence of female teachers. Female teachers may be more willing to work at schools with latrines, or more willing to show up for work, with this improvement in work and educational environment. School-latrine construction moderately increases the share of female teachers at schools, especially when sex-specific latrines are built. If female children benefit in particular from having female teachers (Fentiman, Hall and Bundy, 1999; Nixon and Robinson, 1999; World Bank, 2001; Kirk and Sommer, 2006), these estimates suggest another potential mechanism through which latrines may impact female student enrollment.

Despite increases in school participation, there are not increases in student test scores. Using DISE data, I estimate no increases in the number of students scoring high marks on a middle-school board exam. Using ASER data, I estimate no increases in children's reading and math ability. These estimates point toward barriers in children's learning, despite additional time in school, and suggest caution against focusing exclusively on bringing more children into school through greater infrastructure investment without complementary efforts to improve learning in schools. Schooling interventions have led to benefits later in life, however, even in the absence of contemporaneous increases in academic achievement (*e.g.*, Chetty et al., 2011; Baird et al., 2015).

Finally, I explore whether the estimated impact of latrines varies across India, reflecting differences in underlying social factors or local economic opportunities. An advantage from studying a national policy initiative in India, in combination with a large administrative dataset, is the substantial within-sample variation: income differences between districts at the 10th and 90th percentiles of my sample are similar to income differences between countries at the 5th and 25th percentiles of the world income distribution in 2002 (*e.g.*, Rwanda and Nepal vs. Georgia and Ukraine) (World Bank, 2002). The estimated impact of latrines does not vary substantially, however, with districts' average per capita income or with districts' gender parity in educational enrollment. These estimates suggest that the educational impacts of school sanitation may be similar across a corresponding range of less-developed contexts.

Overall, the inadequacies in school sanitation worldwide appear to impede educational attainment. School latrines have the potential to improve gender parity at older ages, but the construction of sex-specific latrines is necessary for older girls. While there are many deep roots to problems of gender inequality, improving school sanitation is one opportunity to increase gender equality for pubescent-age girls. School sanitation has broader impacts on younger girls and boys, however, which are often neglected in the focus on pubescent-age girls. Sex-specific latrines also benefit children at younger ages, but unisex latrines may be sufficient for younger children when resources are scarce. As substantial sums are increasingly being spent on school sanitation, it is useful to know how scarce resources might be directed to maximize their desired effect. Understanding children's motivations to drop out from school is important for influencing their behavior and subsequent educational and economic outcomes, and the estimated impacts of school latrines suggest how girls and boys of different ages are impacted by threats to their health, privacy, and safety.

I Policy Context

The Millennium Development Goals identified eight priorities for improving the lives of the world's poorest people, which included the elimination of gender disparity in education (UN, 2012). There was a particular focus on educating pubescent-age girls, who experience the highest dropout rates. These issues are of tremendous concern to policy-makers because of the sense that childhood access to education shapes adults' economic and social lives (Bellamy, 2004).

In 2000, India was home to almost 20 percent of the out-of-school children in the world, with approximately 20 million children not enrolled in school. By 2013, this had decreased to

11 percent, with 6 million out-of-school children in India. This is out of a total of 98.5 million out-of-school children in the world in 2000 and 59.2 million in 2013 (UNESCO, 2015). In the year 2000, the Indian government began promoting universal primary education through the *Sarva Shiksha Abhiyan* (SSA) program (World Bank, 2012).

Roughly half of Indian schools lacked basic sanitation facilities in 2002 (DISE, 2002). Qualitative research and policy reports have increasingly associated the absence of school latrines with lower educational attainment, and higher dropout rates among pubescent-age girls in particular (Bellamy, 2004; Burrows, Acton and Maunder, 2004; UNICEF, 2005). Indeed, India's 2010 Right to Education Act emphasizes infrastructure investment as a key mechanism to bring more children into school. There is a lack of quantitative evidence, however, on the educational impacts from large-scale investments in school infrastructure.

I.A A Large School-Latrine-Construction Initiative in India

The School Sanitation and Hygiene Education program (SSHE) was launched in 1999 as part of the broader Total Sanitation Campaign by the Ministry of Drinking Water and Sanitation to improve sanitation facilities throughout India. UNICEF collaborated in the program's implementation, along with similar initiatives in six other countries (Burkina Faso, Colombia, Nepal, Nicaragua, Vietnam, and Zambia), and has continued to expand its efforts. SSHE emphasized school sanitation as a mechanism to bring about broader social change in sanitation practices (Snel, 2003).

The SSHE program sought complete school-latrine coverage in rural areas for two main purposes: (1) creating a healthier environment through the elimination of open defecation and reductions in disease and worm infestation; and (2) reducing security risks for girls attending school, particularly for pubescent-age girls. Nearly all resources went to construction of school latrines, whereas the hygiene education component was generally limited to the distribution of handouts and posters to teachers and schools.

The national government began committing substantial financial resources to support widespread school-latrine construction in 2003. In Figure 1, I show the total number of school latrines built in each year between 2001 and 2006, as recorded by the Indian Ministry of Drinking Water and Sanitation. School-latrine construction increased seven-fold in 2003, due to increased resources from the SSHE program, as compared to the previous lower levels of construction in 2001 and 2002. SSHE latrine construction continued over the next decade.

Various bureaucratic processes influenced which schools received latrines in 2003. School-latrine construction was generally managed by Public Health Engineering Departments of district governments, which received funds from state governments that included earmarked funds from the national government. Districts varied in their implementation of latrine construction: some districts attempted to prioritize schools with the greatest demonstrated need, some districts claim to have followed a lottery-style selection process, and other districts simply began by constructing latrines in schools closest to the district office.

While some districts may have directed latrine construction to larger schools in greatest need, of most relevance to the empirical analysis is how much latrine construction was directed toward schools that were projected to have increases in enrollment. District education officials had limited capacity to track their schools' characteristics in this era (Aggarwal, 2001), though some schools may also have successfully lobbied for latrines.

One potential advantage of focusing on school-latrine construction in 2003, in the first year of substantial SSHE funding, is that districts' or schools' efforts to direct latrine construction may have been most focused on high-enrollment schools with backlogged need. The empirical concern will be if latrine construction was shifted amongst similar-sized schools toward those with different projected increases in enrollment. Choice of latrine type may be more subject to influence by schools, based on the school's needs, though this may also depend more on the level of current needs than on anticipated changes in needs.

Particularly relevant, however, is that school-latrine construction was managed by water and sanitation departments rather than by education officials. Kumar Alok, who played a key role in overseeing SSHE as Director of Rural Sanitation in the Department of Drinking Water Supply in the Ministry of Rural Development, writes: "The school community is not fully involved in construction of toilet facilities as a result even site selection is not done in consultation with them" (Alok, 2010). The traditional lack of involvement by education officials, generally to the regret of sanitation officials and to the detriment of these programs, does not imply that school latrines were randomly allocated though. The empirical analysis will explore alternative ways of comparing schools that receive latrines in 2003 to other initially-similar schools that might have otherwise changed similarly.

Given that school-latrine construction was managed by water and sanitation officials, a natural question is whether school latrines were constructed along with other improvements in school infrastructure. While the schools generally received basic pit latrines, which did not require piped water, there was a few percentage point increase in these schools' probability of having piped water. I explore these changes further in the empirical analysis, and report estimates controlling for changes in school infrastructure. More generally, while the SSHE program was part of the broader Total Sanitation Campaign (TSC), construction of school latrines was not explicitly combined with other local efforts to improve household sanitation.

I.B Potential Impacts of School-Latrine Construction

A broad research literature, surveyed by Birdthistle et al. (2011), outlines reasons why school latrines may impact educational outcomes and particularly those of pubescent-age girls. Birdthistle et al. (2011) highlight the absence of a quantitative empirical evaluation of a large-scale latrine-construction initiative, however, in contrast to the increased policy emphasis on school sanitation.

Much of the research literature has focused on how pubescent-age females may leave schools without private sanitation facilities, in part, due to stigma and threats associated with menstruation (Fentiman, Hall and Bundy, 1999; Burgers, 2000; WHO, 2005; Kirk and Sommer, 2006; Raising Clean Hands, 2010). If the absence of latrines discourages girls from attending school during their menstruation days, they may increasingly fall behind and drop out from school (Lidonde, 2004). For example, girls were observed missing school during their menstrual periods when their school latrines lacked a door (Burrows, Acton and Maunder, 2004). The direct impact of menstruation on school absenteeism may not be substantively large, however, when focusing primarily on girls' attendance for those days when menstruating (Mensch and Lloyd, 1998; Oster and Thornton, 2011).[1]

While girls menstruate for only a few days each month, the onset of puberty impacts girls every day through a broad range of physical, emotional, and societal channels. Pubescent-age girls may then be affected every day by threats to their privacy and safety, in ways not reflected in differential attendance on menstruation days. Pubescent-age females may be disinclined to use public spaces as latrines due to privacy concerns and verbal or physical harassment (Human Rights Watch, 2001; Leach et al., 2003; IRC, 2005; UNICEF, 2005). Construction of separate sex-specific latrines in schools may then impact pubescent-age girls every day, with potential consequences for female educational attainment.

I saw parallels to this literature in a set of interviews that I conducted in India, which explored factors influencing educational decisions. The Qualitative Data Appendix further describes these interviews, in which I spoke with children, parents, school headmasters, and government officials, following interviewing and participant observation guidelines discussed by Seidman (1998) and Emerson, Fretz and Shaw (1995). Through this work, girls highlighted concerns for safety and privacy at school arising from the absence of school sanitation facilities.[2] By contrast, boys never indicated safety or privacy as reasons for dropping out of

[1] Oster and Thornton (2011) find that school attendance in Nepal falls by a small, but statistically significant, 2.4 percentage points on those days when girls are menstruating. They also find no impact on school attendance from the provision of menstrual cups. Mensch and Lloyd (1998) find that 5 percent of girls in rural Kenya claim to have stayed away from school during their last period.

[2] One 12-year-old discussed her passion for school but that she failed out because of her absence due to monthly menses during mandatory exams that could not be retaken. Another girl recounted a story of a

school. School headmasters were generally not attuned to girls' concerns, commonly expressing a sentiment that children did not require school sanitation facilities. These interviews highlight how, in the absence of centralized government initiatives, local schools may not be responsive to the needs of traditionally-disadvantaged children.

Even unisex latrines may be insufficient for pubescent-age girls, and separate sex-specific latrines may be required if privacy and safety are central concerns (UNICEF and IRC, 1998; Burgers, 2000; Leach et al., 2003; IRC, 2005). When girls have to share latrines with boys, or otherwise seek private spaces away from the school, they risk harassment or assault from male classmates and teachers (Mensch and Lloyd, 1998; Abrahams, Mathews and Ramela, 2006; Kirk and Sommer, 2006).[3]

Children's educational attainment not only reflects their concerns and decisions, but importantly reflects parental choices. The absence of school latrines may heighten safety concerns among parents, and discourage parents from enrolling their pubescent-age daughters in school (Human Rights Watch, 2001; Nekatibeb, 2002; Snel, 2003; Kirk and Sommer, 2006). Aside from the direct benefits of latrines, the mere presence of latrines may signal to parents that the school is dedicated to protecting their child's safety and dignity. These effects may be particularly important for communities worldwide that place a cultural premium on privacy and modesty of pubescent-age girls.

Teachers may also be impacted by the presence of school latrines, in ways that then disproportionately impact pubescent-age girls. Teachers may be more willing to work at schools, or show up for work at schools, when those schools have latrines (Burrows, Acton and Maunder, 2004; Kremer et al., 2005). Female teachers in particular are often thought to increase girls' enrollment, by increasing girls' safety and providing role models (Fentiman, Hall and Bundy, 1999; Nixon and Robinson, 1999; World Bank, 2001; Kirk and Sommer, 2006). Some parents in conservative communities do not allow their daughters to be taught by a male teacher, due to safety concerns (Brock and Cammish, 1997; Nekatibeb, 2002). Some girls also fear sexual harassment by male teachers and feel safer with female teachers (Mensch and Lloyd, 1998; Nekatibeb, 2002; Leach et al., 2003; Abrahams, Mathews and Ramela, 2006).

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friend who was sexually assaulted while urinating behind bushes, and described an atmosphere of fear where males would target females who were isolated from view. She said that this fear discouraged her and her friends from eating, drinking, and relieving themselves during the school day. Indeed, my school visits often revealed an absence of private locations for students to relieve themselves. In these cases, when I asked about where students could go to the restroom, students often pointed to various places on the school premises such as behind a school sign, next to the building, or behind trees.

[3] Unisex latrines can either take the form of doorless latrines in an open room or individual stalls available to boys and girls. In the former, a girl would be physically exposed any time she urinated or defecated. In either instance, however, a girl could be more easily isolated and sexually harassed.

Despite the literature's focus on pubescent-age girls, boys may also have related concerns over safety and privacy. Boys sometimes express fear of being teased and bullied even when using school latrines (Moore and Frost, 1986; Vernon, Lundblad and Hellstrom, 2003; Njuguna et al., 2009), and may be intimidated to use open urinals in the presence of others (Moore and Frost, 1986). Boys also face the threat of harassment and molestation at school (Mensch and Lloyd, 1998; IRC, 2005; Malhi, Bharti and Sidhu, 2014) and care about privacy (Brown and Larson, 2009). Younger girls and boys are also often victims of bullying (Boulton and Underwood, 1992; Whitney and Smith, 1993; Fleming and Jacobsen, 2009).

Children's health may be adversely impacted from an absence of school latrines, with particular impacts on younger girls and boys. A lack of waste containment around schools makes children, and especially younger children, more susceptible to worm infections and other diseases (Crompton and Nesheim, 2002; Burrows, Acton and Maunder, 2004; Raising Clean Hands, 2010) with important consequences for educational outcomes (Nokes et al., 1992; Miguel and Kremer, 2004; UNDP, 2006; Spears and Lamba, 2015).[4] The absence of a school latrine may also cause children to refrain from eating or drinking during the day (WHO, 2004), worsening educational outcomes and causing urinary-tract infections or constipation (Hellstrom et al., 1991; Vernon, Lundblad and Hellstrom, 2003; Lundblad and Hellstrom, 2005).

Overall, the academic literature and contextual accounts suggest an examination of how India's efforts to provide school latrines impacted the educational attainment of pubescent-age girls, but also that of boys and younger girls. I begin by analyzing the impact of access to any latrine, but then contrast the impacts from a unisex latrine and separate sex-specific latrines and consider how these impacts vary by children's gender and age. I also examine how female teachers may be influenced by the presence of school latrines, and how the impacts of latrines vary across districts' levels of economic and social development.

II Data Construction and Summary Statistics

II.A DISE Database

The main dataset is drawn from the *District Information System for Education* (DISE) government database, which can be used to create an annual school-level panel dataset in India.[5] For each year, these data include: the number of enrolled students by sex, age, and

[4]Examples of such health problems include diarrhea (Burgers, 2000), blinding eye-trachoma (Emerson et al., 2004; Cumberland, Hailu and Todd, 2005), typhoid fever (Alvarez et al., 1990), and Hepatitis A (Rajaratnam et al., 1992).

[5]The DISE data reflect a multi-state data-collection process. First, school headmasters answer a nationally-standardized survey-questionnaire. Second, cluster officials examine the responses for completeness and accuracy. Third, district officials aggregate the data and check it for computational and consistency errors. Fourth, state-level officials conduct further checks. In a final step, each state is responsible for hiring

grade; the presence of latrines by latrine type; other measures of school infrastructure; the number of teachers by sex; and examination outcomes for middle-school board exams.

My analysis focuses on a large panel dataset of schools for the academic years 2002-03, 2003-04, and 2005-06. For simplicity, I will refer to school years by the year in which the fall term occurs (*e.g.*, school year 2002-03 is 2002). Data from these three years allow a comparison of schools before and after the first large wave of school-latrine construction in 2003. Limiting the analysis to these three years reflects a trade-off between a larger balanced panel of schools and more time periods. Before 2002, districts and villages were more often omitted in particular years. Most data from 2004 were lost due to a server error in India. After 2005, data often cannot be matched to schools in earlier periods.

The included schools come from 269 districts (Figure 2), which are drawn from nine states that DISE surveyed in these earlier years of its history. DISE sought to cover all registered primary and upper-primary schools in these surveyed districts, and the empirical analysis focuses on comparing schools within the same district.[6] These sample districts have average characteristics similar to the national rural average, based on data from the 2001 Census of India.[7] Section IV.G reports estimates when re-weighting the sample to reflect the national distribution of districts' income per capita. Further, Section IV.G uses the substantial variation in wealth and gender norms across these sample districts to explore how the estimates vary across economic and social conditions.

Of the schools surveyed in 2002, I match 86.1 percent to schools surveyed in 2003 after I adjust for changes in school codes associated with changes in town and district names and boundaries. Unmatched schools are slightly larger in 2002, moderately more likely to have a latrine, and vary between being moderately more or less likely to have other types of school infrastructure (Appendix Table 1). The empirical specifications control for differential changes associated with these observable baseline school characteristics. An empirical concern would be if the ability to match schools remains systematically correlated with residual changes in school latrines and residual changes in school enrollment. In particular, if receiving a latrine makes schools more likely to match and increased enrollment makes schools more likely to match, then the estimated impact of latrines on school enrollment would be downward biased. Whether schools match is determined mainly by the ability to match village and district names, rather than by changes in the schools themselves, which makes

external agents to conduct post-enumeration audits and cross-check data with site visits (Kaushal, 2010).

[6]The large majority of schools are government-run, which were required to register, although a few percent are private-run with government aid (also required to register) or without government aid (not required to register).

[7]For example, the average literacy rate in my sample districts is 58.4 percent in 2001, compared to the national rural average of 58.7 percent. Similarly, the average sex ratio of females per 1000 males in my sample districts is 955, compared to the national rural average of 946.

it less likely that matching schools is systematically related to changes in those schools' characteristics.

The main analysis then draws on a three-year balanced panel dataset of 121,206 primary schools (grades one through five) and 17,796 upper-primary schools (grades six through eight). The primary-school sample covers between 13.6 million and 13.8 million students in each year, whereas the upper-primary-school sample covers between 1.8 and 2.0 million students.

II.B Variable Definitions

Latrine Presence. The DISE data include detailed information on school infrastructure, including whether the school has a latrine. The data include whether there is a "unisex latrine" and/or a "girls-only latrine." In practice, the presence of a unisex latrine and a girls-only latrine reflects separate latrines for boys and girls.

My initial analysis combines these data and constructs a single measure of the presence of any latrine, which is equal to one if the school has either a girls-only latrine or a unisex latrine. For my later analysis that examines the impact of latrine type, I construct three dichotomous variables for: whether the school has a unisex latrine and no girls-only latrine, whether the school has separate sex-specific latrines for girls and boys, and whether the school has a girls-only latrine and no unisex latrine (which is relatively rare).

There was substantial construction of new latrines between 2002 and 2003, due largely to the SSHE program. Among the sample schools with no latrine in 2002, 43 percent of upper-primary schools received a latrine in 2003, and 27 percent of primary schools received a latrine in 2003. Among the upper-primary schools that built a latrine, 38 percent built unisex latrines, and 50 percent built separate sex-specific latrines. Among the primary schools that built a latrine, 48 percent built unisex latrines, and 46 percent built separate sex-specific latrines. While these large increases in latrine construction reflect the SSHE program, there is no direct information on which latrines were built using funds from the SSHE program.

School Participation. Enrollment data approximate the number of students who generally attend school and is measured at least three months into the school year when enrollment numbers are generally more stable (Aggarwal and Thakur, 2003). These data include enrollment by student sex, grade, and age, which allows for an analysis of how latrines impact boys and girls of different ages.

I generally analyze changes in log enrollment, which reflect how enrollment is affected in percentage terms, though there is sometimes zero enrollment for particular student sexes in particular years. Following standard practice, the main analysis looks at impacts on the logarithm of enrollment plus one. I also report estimated changes in the level of enrollment and report robustness of the logarithm results to restricting the sample to schools that have positive enrollment of boys and girls in each year.

Attendance data are unavailable in DISE, which would have been useful to explore whether girls miss school on particular days without access to latrines, though enrollment data capture whether these girls ultimately remain in school or drop out. School enrollment is also associated with the standard returns to schooling, even for older girls whose attendance might be limited. School enrollment also reflects parents' willingness to enroll girls in school, given potential concerns over privacy and safety.

Direct measures of student dropout are unavailable, but I can use the enrollment data to construct a cohort-based measure of dropout. For students of gender g in school s, cohort c, and year t, I define the fraction of students who drop out as the expected enrollment (derived from the previous year's enrollment) minus the current year's enrollment, divided by the expected enrollment: $(Enrollment_{gs(c-1)(t-1)} - Enrollment_{gsct})/Enrollment_{gs(c-1)(t-1)}$. For this measure, a negative coefficient indicates a decrease in the fraction of students who drop out. This is only a measure of net dropout, however, as this could reflect new students in an area in addition to previously-enrolled students who drop out from school.

Examination Outcomes. For students in eighth grade in Uttar Pradesh, data are available for their performance on the middle-school exams that are taken nine months into the academic year. These data include the number of students who appear for the exam and pass the exam, which largely provides another measure of school enrollment because 98 percent of students appear for the exam and 96 percent of students pass the exam. A more meaningful measure of academic achievement is the number of students who score "high marks" on the exam, which is achieved by 34 percent of students. This score cut-off is set at the state-level and is a fairly high bar for traditionally-disadvantaged children from rural areas.

Teachers. DISE data include information on the number of female and male teachers at a school each year in the states of Rajasthan and Madhya Pradesh. There is also data on the number of teachers by caste.

Other School Infrastructure. The DISE data also include other measures of school infrastructure: blackboards, computers, electricity, library, regular medical checkups, playground, ramps, and water source. Data are missing for between 1 percent and 4 percent for most of these infrastructure variables, though missing infrastructure data is generally uncorrelated with latrine status. I assign zero to all missing values and control for an indicator variable equal to one if the variable is missing, though the later estimates are indistinguishable when assigning the mean or one to all missing values.

II.C ASER Database and Other Data Sources

ASER. As an independent source of data on educational outcomes, I also use data from the Annual Status of Education Report (ASER). The DISE dataset is an administrative dataset collected by government officials, based on school self-reports and partial audits, and a concern is that schools may feel a need to report higher enrollment following the construction of a latrine. By contrast, ASER is a privately-funded survey created by the Indian NGO Pratham and is collected by volunteers from partner organizations around India. The ASER sample covers 15,500 villages each year, on average, with approximately 20 to 30 villages in each district. Within each village, information is collected on the villages largest government-run primary school and from a random sample of 20 households with children. The ASER school survey data include the number of enrolled students, the number of students in attendance on the day of the survey, and the presence of latrines by latrine type. The ASER household survey data include math and reading test scores for each child, regardless of their schooling status, and the age and gender of each child (ASER, 2015).

Other Data Sources. I also use supplemental data from the 2001 Census of India and from the Indian Planning Commission to explore whether the impact of latrines varies with state or district characteristics (Census of India, 2001; Planning Commission, 2013). These data provide local measures of income and gender parity. I define a district-level measure of gender parity as the average number of girls enrolled in upper-primary school for each boy enrolled in upper-primary school, which is then normalized to have a mean of zero and standard deviation of one. I also define a district-level measure of per capita income, which is also normalized to have a mean of zero and a standard deviation of one.

II.D Average School Characteristics and Baseline Differences

In Tables 1 and 2, I present average school characteristics in 2002 for upper-primary schools and primary schools. In Column 1, I report average characteristics for schools in the "treatment" group: schools without a latrine in 2002 that have a latrine in 2003 and 2005. In Column 2, I report average characteristics for schools in the main "control" group: schools without a latrine in 2002, 2003, and 2005. In Column 3, I report average characteristics for schools in an alternative control group for estimating relative changes between 2002 and 2003: those schools without a latrine in 2002 and 2003, but who received a latrine by 2005. In Column 4, I report average characteristics for another alternative control group: schools always without a latrine (2002, 2003, 2005) and schools always with a latrine (2002, 2003, 2005). In Columns 5, 6, and 7, I report the estimated within-district differences between schools in Column 1 and schools in Columns 2, 3, and 4.[8]

In all groups, boys' enrollment is higher than girls' enrollment in both upper-primary and primary schools. Enrollment is lower in upper-primary schools, particularly for girls.

Comparing across these groups, schools that received a latrine in 2003 are generally larger than schools that remained without (Column 5) or received a latrine in 2005 (Column 6). Schools that received a latrine in 2003 are smaller than, or similar to, the combined sample of schools that always had a latrine and never had a latrine (Column 7). That is, larger schools are more likely to receive a latrine and to receive a latrine earlier. The empirical analysis will focus on comparing similarly-sized schools, controlling for schools' initial size or matching on schools' initial size. When examining changes by gender, the analysis controls for initial enrollment by gender.

The various measures of school infrastructure are substantively similar across each group. There are some notable differences in the presence of particular infrastructure, even after controlling for district fixed effects, but the overall distributions of infrastructure across these schools is similar in contrast to the 100 percentage point relative change in latrine presence that these schools will experience between 2002 and 2003 (comparing schools in Column 1 to schools in Columns 2 or 3). The empirical analysis will also focus on comparing treatment and control schools that are similar along all of these reported measures of initial school infrastructure.

These other infrastructure characteristics vary some over time but are generally persistent, particularly in contrast to the substantial changes in latrine presence. The latrines are typically basic pit latrines, and do not themselves require piped water, but schools receiving a latrine are also 5 – 6 percentage points more likely to get access to piped water. Robustness checks control for changes in these other school-infrastructure variables.

While Tables 1 and 2 highlight some baseline differences between schools, the identification assumption concerns whether these schools would have otherwise changed similarly. Because initially-different schools might be more likely to change differently, however, the empirical analysis will focus on comparing changes in treatment and control schools that were similar in 2002 along all of the characteristics reported in Tables 1 and 2.

III Empirical Methodology

The analysis uses a differences-in-differences empirical strategy to estimate the impacts of school latrines. I begin by regressing outcome Y in school s, district d, and year t on an indicator variable for whether the school has a latrine (L_{st}), school fixed effects (α_s), district-

[8] These estimated differences reflect a regression of each school characteristic on an indicator variable for whether the school is in Column 1, controlling for district fixed effects.

by-year fixed effects (λ_{dt}), and a year-interacted vector of schools' initial characteristics (X_s):

$$Y_{sdt} = \beta L_{st} + \alpha_s + \lambda_{dt} + \gamma_t X_s + \epsilon_{sdt}. \tag{1}$$

The estimated β is the coefficient of interest, which reflects the average change in schools that received a latrine relative to the average change in schools that did not receive a latrine.

The identification assumption is that treatment schools receiving a latrine would otherwise have changed similarly, on average, to those control schools that did not receive a latrine. In practice, by controlling for district-by-year fixed effects (λ_{dt}), the identification assumption is that treatment schools would otherwise have changed similarly, on average, to control schools within their same district.

Tables 1 and 2 had reported some initial differences between treatment and control schools, which would not violate the identification assumption if these schools would still have changed similarly over this period. As schools differing along these initial dimensions might also change differentially over time, the empirical specifications control for year-interacted measures of schools' baseline enrollment and baseline infrastructure along each dimension reported in Tables 1 and 2 ($\gamma_t X_s$). The identification assumption then becomes that treatment schools would otherwise have changed similarly, on average, to control schools within their same district and with similar initial characteristics. Later robustness checks match treatment and control schools on observable characteristics and explore the sensitivity of the results to different comparison groups.

An extended empirical specification considers the potential for differential impacts of latrines on female and male outcomes. I regress outcome Y for students of gender g in school s, district d, and year t on similar variables to those above:

$$Y_{gsdt} = \beta_g L_{st} + \alpha_{gs} + \lambda_{gdt} + \gamma_{gt} X_s + \epsilon_{gsdt}. \tag{2}$$

The two estimated β coefficients, β_f and β_m, reflect the average impact of a school latrine on female child outcomes and male child outcomes. The control variables from equation (1) are now each interacted with child gender, which allows for differential changes across genders that might vary across districts or with schools' initial characteristics. The identification assumption becomes that female outcomes in treatment schools would have changed similarly to female outcomes in control schools within the same district and with similar initial characteristics, with an analogous assumption for males. This specification is similar to estimating the previous specification separately for males and females but allows for a comparison of the estimated impacts on female and male outcomes.

Similarly, I estimate these specifications separately for upper-primary schools and for primary schools. Comparing these estimated effects across schools corresponds roughly to a comparison of impacts on pubescent-age and pre-pubescent-age students.

In an extension to these specifications, I also consider how the impacts of latrines may vary by latrine type. Extending equation (2), I replace the presence of any latrine (L_{st}) with the presence of unisex latrines only (L^U), the presence of sex-specific latrines (L^S), and the presence of a female-specific latrine only (L^F):

$$Y_{gsdt} = \beta_g^U L_{st}^U + \beta_g^S L_{st}^S + \beta_g^F L_{st}^F + \alpha_{gs} + \lambda_{gdt} + \gamma_{gt} X_s + \epsilon_{gsdt}. \tag{3}$$

For each latrine type, the estimated β_f and β_m reflect the impact of that latrine type on female and male student outcomes. I can then explore whether female children are affected differently by each latrine type, for example, or whether female and male children are affected differently by a particular latrine type. Further, I can explore how these differences vary across younger and older children. The analysis by latrine type does require a stronger identification assumption, that latrine type is not otherwise associated with differential changes in enrollment, which I discuss more below along with showing differences in baseline characteristics by type of latrine received.

Later sections introduce further specifications, as they arise in extensions to these main results. Standard errors are clustered by school to allow for heteroskedasticity and serial correlation in school-level outcomes.

IV Estimated Impacts of School-Latrine Construction

IV.A Initial Results

Average Impact on Enrollment. In Table 3, Columns 1 and 3, I present estimated impacts of latrine construction on average enrollment in upper-primary schools and primary schools, respectively. From estimating equation (1), Panel A reports impacts on log enrollment: an eight percent increase in upper-primary-school enrollment and a twelve percent increase in primary-school enrollment. These effects are highly statistically significant and substantial in magnitude. These estimates imply that latrine construction in sample schools increased upper-primary-school enrollment by 75 thousand students and increased primary-school enrollment by 607 thousand students.[9] Panel B reports impacts on the level of enrollment that are also statistically significant and substantial, though the implied percent increase is somewhat smaller than estimated in Panel A.

[9] In the sample, approximately 0.9 million upper-primary students and 4.7 million primary students were attending a school in 2002 that received a latrine in 2003 (Tables 1 and 2, Column 1). The total implied increases in enrollment are found by multiplying these numbers by the estimated percent increases in enrollment (Table 3, Panel A, Columns 1 and 3).

Impacts by Student Sex. In Table 3, Columns 2 and 4, I report estimated impacts of latrine construction on female and male enrollment for upper-primary schools and primary schools. From estimating equation (2), Panel A reports impacts on log enrollment and Panel B reports impacts on the level of enrollment. School-latrine construction increased enrollment of both girls and boys. The estimated impacts are moderately larger for girls in some specifications, with p-values reported below for the difference in estimated coefficients for females and males. The difference between impacts on females and males is slightly larger for upper-primary schools than for primary schools, though sometimes less statistically significant, which alone provides only weak support for the literature's focus on latrines and pubescent-age girls.

Impacts by Student Age. In Table 3, I report estimated impacts on primary-school enrollment that are larger than impacts on upper-primary school enrollment. While the policy literature tends not to emphasize the importance of school latrines for younger children, as privacy and safety may be less impacted than for pubescent-age children, the health issues from waste contamination tend to most impact younger children.

Comparing the estimated impacts across primary schools and upper-primary schools is similar to examining impacts for children at pre-pubescent ages (5 to 9) and children at pubescent ages (10 to 16).[10] Appendix Table 2 reports similar estimates grouped directly by student age (children aged 5 to 9 vs. children aged 10 to 16). I generally focus on impacts in primary schools and in upper-primary schools, as the school-level data are naturally reported by primary school and by upper-primary school. Further, completion of particular grades creates natural benchmarks for variation in schooling and when particular schooling milestones are completed.[11]

Persistence of Impacts. One common concern with infrastructure interventions, and the construction of latrines in particular, is that resources are generally spent on construction with little regard for follow-up support and maintenance. The SSHE program was a typical case, in that it provided resources for latrine construction but no further support, which highlights the value of exploring potential attenuation over time in the impacts of latrine provision due to maintenance problems. While the physical structure of the latrine should last many years, an inattention to cleaning might quickly make the latrine unusable and ineffectual. Schools sometimes made teachers responsible for maintenance, and sometimes

[10]While the onset of puberty varies across children (ranging from approximately 10 to 14 years old), the median age of menarche has been estimated to be at approximately 12 years of age (Parent et al., 2003; Currie et al., 2012).

[11]For example, decreased upper-primary-school enrollment of 16-year-olds could reflect positive changes if these 16-year-olds are finishing 8th grade earlier and are no longer enrolled in upper-primary school (and high school data are not reported).

contracted with a private cleaner, but most often made students responsible for maintenance. The merits of this approach are controversial, as there is anecdotal evidence of latrine cleaning being used as a punishment or being made the responsibility of lower-caste students (SSHE, 2004).

In Table 4, I present separately estimated impacts of latrine construction after one year (in 2003) and after three years (in 2005). The impact of latrines does not appear to fade over this time horizon. There may still be longer-term maintenance issues, but the persistence of impacts over three years suggests that schools are at least dealing with short-term cleaning requirements.

Student Dropout. The main estimates report impacts on student enrollment, though these enrollment data can also be used to predict the fraction of students who have dropped out of school in a particular year. In Table 5, I report estimated impacts of latrine construction on the fraction of students who have dropped out of school. Latrines reduce the fraction of students who drop out by 5.3 percentage points in upper-primary schools and by 12.2 percentage points in primary schools. These estimated reductions in student dropout mirror the estimated impacts on student enrollment.

IV.B Robustness of the Initial Results

Matching on Baseline School Characteristics. The initial regressions estimate relative changes in schools that received a latrine in 2003, controlling for changes that are correlated with schools' baseline characteristics in 2002. Alternative approaches could match treatment schools to control schools that are similar along the observed baseline characteristics in 2002, with the idea that these matched schools would otherwise be expected to change similarly. In Appendix Table 3, Columns 2 through 7, I show that the initial estimates are similar to those obtained from different propensity-score matching methods (Rosenbaum and Rubin, 1983): Column 2 reports estimates from nearest-neighbor matching (Abadie and Imbens, 2006), Column 3 reports estimates from coarsened exact matching (Blackwell et al., 2009), Column 4 reports estimates using nearest-neighbor matching without replacement (Abadie and Imbens, 2006), Column 5 reports estimates from kernel-based matching (Heckman, Ichimura and Todd, 1997), Column 6 reports estimates using Mahalanobis matching (Rosenbaum and Rubin, 1985), and Column 7 reports estimates from radius matching (Dehejia and Wahba, 2002). The estimated impacts by student sex are also robust to these alternative matching techniques.

Alternative Comparison Groups. The initial regressions compare schools that receive a latrine in 2003 to schools that never have a latrine through 2005. In Appendix Table 4, Columns 1 and 2, I report these estimated impacts on enrollment in 2003 only, as a basis for comparison. In Columns 3 and 4, I report estimated impacts in 2003 from comparing schools that receive a latrine in 2003 to an alternative comparison group of schools that had no latrine in 2002 or 2003 and had received a latrine by 2005. In Columns 5 and 6, I report estimated impacts in 2003 using another comparison group of schools that had no change in latrine between 2002 and 2003 but also includes schools that had a latrine in 2002.

In Appendix Table 4, Columns 3 to 6, I report estimates that generally remain positive and statistically significant, though the magnitudes are smaller than those estimated using my main comparison group. There generally continues to be a larger effect on females than males. Also, the impacts remain larger in primary schools than in upper-primary schools.

These alternative comparison groups are more similar to treatment schools along some observed dimensions in 2002 (from Tables 1 and 2), though this need not imply that changes in these schools more closely approximate changes that would have occurred in treatment schools. Schools that will soon receive a latrine may be predisposed to experience prior increases in enrollment, as it seems more plausible that latrine construction responds to enrollment increases than latrines are constructed in anticipation of later enrollment increases. Schools that initially had a latrine may be in more-developed areas or otherwise reflecting different local economic and social environments, and my other estimates show that the impact of latrines is increasing moderately over time. Given these concerns, my preferred specifications use schools in the main comparison group and control for initial characteristics or match on initial characteristics.

Other School Interventions. Indian schools have undergone a variety of education reforms over the last two decades, so a potential concern is that the impacts of school-latrine construction may be confounded with impacts from another government initiative. The SSHE program was not directly bundled with other school programs, or directed toward schools excluded from other programs. The school-latrine funds were managed by water and sanitation officials, rather than by education officials, but other school infrastructure investments could still have happened concurrently or could have been combined by water and sanitation officials.

In Appendix Table 5, I show that the estimated impacts from Table 3 are robust to controlling for time-varying measures of each other school infrastructure characteristic. In Appendix Table 6, I report that there are statistically significant relationships between latrine construction and other measures of school infrastructure, though the estimated magnitudes are relatively small. Along with a 100 percentage point increase in latrine presence, there is generally a few percentage point increase in other aspects of school infrastructure.

In a related exercise, I consider whether the impact of latrines varies with the presence of other school infrastructure. I extend the previous estimating equation by interacting latrine presence with the presence of other school infrastructure (normalized to have mean zero) and control for the presence of other school infrastructure. In Appendix Table 7, I report the estimated main effect of latrines and the estimated interaction effects. The estimated main effect is similar, reflecting the impact of latrines in schools with average levels of infrastructure. The estimated impact of latrines does not increase substantially with greater presence of water; indeed, the constructed basic pit latrines do not typically require access to piped water. There is some indication that latrine impacts are increasing moderately with a few measures of school infrastructure, which may reflect greater impacts in wealthier areas. The effects are decreasing with some other types of infrastructure, though, and testing across so many measures can give spurious statistical significance. Later empirical analysis explores how the estimated impacts vary with districts' average income per capita.

Student Transfers. In principle, some of the increase in enrollment for treatment schools may reflect children moving from comparison schools, which would cause the empirical estimates to overstate the aggregate impact on school enrollment. In practice, however, children go to school within their village and most villages have only one school. In my sample, 93 percent of villages have only one upper-primary school, and 76 percent of villages have only one primary school. In Appendix Table 8, Column 2, I report that the estimates are robust to limiting the sample to schools that are the only school within their village.

Functional Form. The original specifications estimate changes in the logarithm of enrollment plus one, in addition to estimating changes in the level of enrollment. Estimating changes in the logarithm of enrollment can become difficult to interpret, however, for schools that have no females or males enrolled for some year. Alternatively, in Column 3 of Appendix Table 8, I report that the estimates are robust to limiting the sample to schools that have positive enrollment of each sex in each year. For this restricted sample, I report in Column 4 of Appendix Table 8 that the estimates are robust to estimating changes in log enrollment (rather than the logarithm of enrollment plus one).[12] As a final modification to the functional-form assumptions, I report in Column 5 of Appendix Table 8 that the estimates are not sensitive to replacing the year-interacted measures of baseline school characteristics with more-restrictive linear time trends for each baseline school characteristic.

Standard Errors. In the main results, I cluster standard errors at the school level. Treatment occurs at the school level, and this clustering allows for student outcomes to be correlated over time within the same school. However, district-wide shocks could lead to correlated outcomes among students within the same district. In Appendix Table 8, Column 6, I re-

[12]When looking at the impact by student sex for the estimates in Columns 3 and 4, the impact of latrines is moderately larger for males than for females; for the other robustness checks, the impact of latrines tends to be moderately larger for females than for males.

port that the standard errors increase when I cluster at the more-conservative district level, though the estimates remain highly statistically significant.

Measurement Error. Measurement error in the enrollment data would typically just increase the standard errors on the estimates, but there is another potential concern about mean reversion in the data. If district governments have independent information in allocating latrines to schools with higher initial enrollment, and schools' initial enrollment is measured with error in my data, then treatment schools may tend to have more initial students in reality than do comparison schools with the same measured initial enrollment. In this case, treatment schools would experience a relative increase in measured enrollment in the next period after their new measurement.

One way to quantify the potential bias uses the data from eighth-grade state-board exams in Uttar Pradesh as an independent measure of student enrollment. I replicate my main estimating equation but for estimating cross-sectional differences in 2002 for an outcome variable defined as: log(number of students appearing for the exam) – log(number of students enrolled). If these are two independent measurements of school enrollment, then mean reversion would be reflected in a positive coefficient on the treatment variable in the year 2002. I estimate a small and statistically-insignificant effect for all students (0.004 with a standard error of 0.004), female students (0.002 with a standard error of 0.004), and male students (0.004 with a standard error of 0.004). These estimates reject mean-reversion bias contributing more than a 1.2 percent increase in school enrollment, under the assumption that the two measures of enrollment are independent and identically-distributed draws.

IV.C Impacts by Latrine Type

The previous results show only moderate evidence that school latrines impact girls more than boys, but the average impact of any latrine might obscure important differences by latrine type. In Table 6, I report the estimated enrollment impacts on girls and boys from the three different latrine types (sex-specific, unisex, girls-only). I also report the difference in estimated effects for females and males (in Columns 4 and 8), and the statistical significance of the differences in estimated impacts by latrine type (p-values reported below for the indicated difference between rows).

For upper-primary schools, I find that the construction of sex-specific latrines substantially increases female enrollment. By contrast, the construction of unisex latrines only slightly increases female enrollment. The difference in these effects is highly statistically significant, corresponding to the p-value reported below for the difference in estimated coefficients by latrine type. Construction of girls-only latrines (where there is no latrine for boys) have similar impacts on female enrollment as the construction of sex-specific latrines, though I generally do not focus on this category as schools receiving solely girls-only latrines are comparatively rare and more different from schools not receiving latrines.

Male enrollment also increased in upper-primary schools with the construction of sex-specific latrines, though by less than the increase in female enrollment. Male enrollment increased similarly with the construction of a unisex latrine and sex-specific latrines, particularly in contrast to the difference for females in enrollment effects by latrine type. That is, increasing female enrollment was more heavily dependent on the provision of separate sex-specific latrines.

In primary-schools, by contrast, the construction of sex-specific latrines had more similar impacts to the construction of a unisex latrine for both females and males. Sex-specific latrines have a statistically greater impact on female enrollment than unisex latrines, but the estimates are more similar in magnitude because primary-school girls benefit substantially from unisex latrines. Girls-only latrines appear to have moderately greater impact on primary-school girls than sex-specific latrines.[13] Schools receiving girls-only latrines represent only 6 percent of all treatment schools, however, and there are concerns that schools designating their one latrine to be girls-only might otherwise be experiencing greater increases in female enrollment.

An important caveat, for interpreting these estimates, is that the determination of latrine type may be more endogenous than the selection of schools to receive any latrine. In emphasizing a comparison between sex-specific latrines and unisex latrines, I focus on variation in the overall level of support received by schools rather than variation from whether one constructed latrine was designated as girls-only or unisex. Whereas girls-only latrines were relatively rare, and these upper-primary schools were larger in particular, the schools receiving sex-specific latrines and unisex latrines were also more similar along baseline characteristics (Appendix Tables 9 and 10). Further, the empirical analysis continues to consider relative changes in these schools, controlling for differential changes associated with these schools' initial characteristics.

The estimated impacts by latrine type are generally insensitive to the previous robustness checks reported for impacts of any latrine. I report similar estimates in Appendix Table 11 when grouping children by age (10 – 16 and 5 – 9) instead of school type (upper-primary and primary). In Appendix Table 12, I report similar estimates when controlling for changes in other school infrastructure.

The estimated differential impacts by latrine types are suggestive about the mechanisms

[13]It may seem surprising that girls-only latrines also impact male primary-school enrollment, but, in practice, younger boys would likely be directed to the only available latrine even if it were officially reported as being girls-only. In upper-primary schools, by contrast, girls-only latrines benefit girls but not boys.

driving the impacts of school latrines. In upper-primary schools, the importance of sex-specific latrines suggests that privacy and sexual safety may be important channels. In primary schools, the relative sufficiency of unisex latrines suggests that child health may be the most important channel.

These estimates are also useful, from a pure policy-design perspective, in directing resources toward what types of latrines might be built in what contexts. Sex-specific latrines have moderate additional benefits for children at younger ages, but unisex latrines may be sufficient for younger children when resources are scarce. By contrast, school latrines only improve gender parity among older children when sex-specific latrines are constructed, as pubescent-age girls benefit little from the construction of a unisex latrine.

IV.D Estimated Impacts using ASER Data

An important concern with the previous estimates, which use administrative data from DISE, is that schools may feel pressure to over-report enrollment after receiving a latrine. The reported increases in enrollment continue for three years after latrine construction, so these reporting biases would need to persist through later years' reports.

To further explore this concern, I use data from the Annual Survey of Education Rural (ASER). These data are based on direct observation, rather than partially-audited self-reports for DISE. While the ASER sample design is supposed to include a rotating panel of villages, in which each village is surveyed three years in a row, it appears that 93.5 percent of villages appear only once in the data. The remaining 6.5 percent of villages mostly appear twice in the data, and mostly in 2009 and 2011. Thus, the identifying variation will come predominately from relative changes in schools that receive a latrine between 2009 and 2011. To make clear the effective sample sizes, I limit the regression sample to schools that appear at least twice in the ASER data.

I estimate school-level empirical specifications, which are analogous to the previous estimating equations (1) and (3). These specifications estimate the impact of school-latrine presence on school-level outcomes (enrollment or attendance), conditional on school fixed effects and district-by-year fixed effects. I report standard errors clustered at the village level.

In Table 7, I report the estimated impacts of school-latrine presence on school enrollment (Columns 1 and 2) and school attendance (Columns 3 and 4). Panel A reports the impact of access to any school latrine, and Panel B reports the impact by latrine type (separate sex-specific latrines, girls-only latrines, unisex latrines). ASER data only include information on primary-school outcomes and primary-school latrine presence, and so these estimates should be compared to the DISE estimates for primary schools only.

The estimated increases in primary-school enrollment, both in levels and in logs, are consistent with estimated increases in school enrollment in the DISE data. Indeed, the estimates using ASER data are larger in magnitude than the baseline estimates in the DISE data. The ASER data also indicate substantial increases in primary-school attendance on the day of the survey, whereas attendance data are unavailable in DISE.

When considering the estimated impacts by latrine type, the impacts on school enrollment and school attendance are greatest from the presence of sex-specific latrines or girls-only latrines. The estimated impacts of unisex latrines are sensitive, however, to whether estimated in logs or levels. The ASER school-level data do not allow for the impacts to be estimated separately by child gender, though primary-school impacts were fairly similar across genders in the DISE data.

Drawing on these ASER data, the estimated increases in school enrollment and attendance also suggest that the estimated impacts in DISE data are not being driven solely by reporting biases. These ASER data are only available for primary schools, however, and for a smaller sample of schools.

IV.E Impacts on Student Achievement

Impacts using ASER Data. ASER also surveys children at home in the sampled villages, and measures math and reading ability for both in-school children and out-of-school children. Using these ASER data, I regress child test scores (in math and reading, separately) on the presence of a latrine in the village's largest government-run primary school, child age-by-gender fixed effects, school fixed effects, and district-by-year fixed effects.[14] I report standard errors clustered at the village level.

Table 8 reports small and statistically insignificant impacts of primary-school latrine construction on children's reading and math scores.[15] These estimates are similar for boys and girls.[16]

Impacts using DISE Data. DISE includes consistent data on state-board exam results for eighth-grade students in Uttar Pradesh. Almost all enrolled students appear for the exam (98 percent) and pass the exam (96 percent), so these initial variables mainly serve as separate

[14]The ASER household survey data include math and reading test scores for each child, which children attend the surveyed government-run primary school, and the age and gender of each child. Math scores range between 0 and 3, and reading scores range between 0 and 4, with each level indicating an absolute level of proficiency unadjusted by age.

[15]I limit the sample to primary-school-age children between the ages of 5 and 9, though the estimates are similar when including all children between the ages of 5 and 14.

[16]When estimating these impacts by latrine type, there is some indication of higher test scores with the presence of girls-only latrines, though only 38 schools received girls-only latrines in the child-level regression sample. By contrast, 822 schools received sex-specific latrines and 149 schools received unisex latrines in the child-level sample (and roughly 1.7 times that number in the school-level sample).

measures of school enrollment.[17] In Table 9, I report estimated increases in the number of students appearing for the exam (Columns 1 and 2) and the number of students passing the exam (Columns 3 and 4), which are not statistically distinguishable from estimated increases in enrollment for these same schools.[18] These estimates are further indication that enrollment effects in DISE data are not driven by reporting biases, as state-board exam results are retrospectively reported by schools the following year.

In Table 9, Columns 5 and 6, I report that latrine construction had no impact on the number of students scoring high marks on the exam. Only 34 percent of students score high marks on the examination, which sets a relatively high bar for traditionally-disadvantaged students from rural areas. Student test scores may be increasing at other points in the test score distribution, but data limitations preclude such analysis.

These estimates reflect the net impact of latrines on student achievement, which could reflect no impacts or could reflect a combination of positive and negative impacts. Latrine construction increased enrollment between 8 percent and 12 percent; without a corresponding increase in other school inputs, the estimated net effect might potentially include indirect negative effects due to classroom crowding or shortages in learning materials. These negative effects might be counterbalanced by improved student performance because of a better school environment, though this interpretation is merely speculative.

Using both ASER data and DISE data, I find no indication of increased student achievement despite increased school participation. These estimates suggest caution against an exclusive focus on bringing more children into school, through greater investment in school infrastructure, without complementary investments in student learning. Schooling interventions can lead to later benefits, however, even in the absence of contemporaneous increases in academic achievement (*e.g.*, Chetty et al., 2011; Baird et al., 2015).

IV.F Impacts through Female Teachers

As an additional exercise to explore the potential mechanisms underlying the increases in student enrollment, and particularly girls' enrollment, I explore whether school-latrine construction increases the presence of female teachers. If female teachers are more willing to work at schools with latrines, or more willing to show up for work, this may disproportionately encourage girls' educational attainment.

First, I estimate whether latrines impact the share of female teachers. I estimate versions of the previous estimating equations (1) and (3), where the outcome variable is now defined

[17] On average, 41.59 students are enrolled in eighth grade, 40.59 students appear for the board exam, 39.87 students pass the exam, and 14.08 students score high marks on the exam.

[18] As a comparison, the introduction of a latrine increases these same schools' eighth-grade student enrollment by 1.476 students, with a standard error of 0.755. Enrollment increases by 1.351 females (standard error of 0.374) and by 0.202 males (standard error of 0.554).

as the fraction of teachers in each school that are female. In Table 10, Column 1, I show that school-latrine construction moderately increases the share of female teachers at schools. In Column 2, I show that this impact is greatest from the construction of sex-specific latrines and girls-only latrines, though girls-only latrines are relatively rare. In Columns 3 – 6, I report placebo estimates that show latrines did not also impact the share of teachers from particular disadvantaged castes. As other studies often find that female children especially benefit from having female teachers (Fentiman, Hall and Bundy, 1999; Nixon and Robinson, 1999; World Bank, 2001; Kirk and Sommer, 2006), these estimates suggest one potential channel through which latrines may impact female students in particular.

Second, I estimate whether latrines impact student enrollment more in schools that initially had more female teachers. If the absence of sanitation facilities discourages female teachers from showing up for work, as indicated in survey responses collected by Kremer et al. (2005), then schools with more female teachers may exhibit gains in teacher attendance and student educational attainment. I extend equation (2) to include an additional interaction term between latrine presence and the school's initial female share, and report the estimated main effect of latrine presence and the estimated interaction effect. In Appendix Table 13, I show that the impact of latrines is not generally higher in schools that had a higher initial share of female teachers. These estimates suggest that either female teachers did not reduce their absenteeism relative to male teachers, or that female teachers' work attendance did not impact student enrollment. Teacher data are only available for two states, however, so these small sample sizes may fail to detect important effects.

IV.G Geographic Heterogeneity in the Impacts

The impact of latrines may vary across India, reflecting differences in underlying social factors or local economic opportunities. An important advantage to studying a national policy initiative, in combination with a large administrative dataset, is the opportunity to explore geographic heterogeneity in the effects across states and districts. By using the substantial variation in district characteristics across India, I can also explore how the relationship between sanitation and education might vary across developing contexts. Indeed, the variation across Indian districts in my sample, comparing districts with average income at the 10th and 90th percentiles, is comparable to variation across countries between the 5th and 25th percentiles of the world income distribution in 2002 (*e.g.*, Rwanda and Nepal vs. Georgia and Ukraine) (World Bank, 2002).

There is substantial variation across districts in the estimated impacts from school latrines. In Appendix Figure 1, I show the distributions of estimated impacts by district for upper-primary and primary schools. This substantial variation could reflect random noise, however, or be systematically correlated with district characteristics. In Appendix Figure 2, I show suggestive indications that the impact of latrines is increasing in states' income per capita and in states' gender parity (defined as the ratio of the number of female students to the number of male students in 2002).

To explore further this potential heterogeneity in the impacts of school latrines, I extend equation (2) to include an interaction term between latrines and some district-specific characteristic (D_d), such as average district income or gender parity:

$$Y_{gsdt} = \beta_g L_{st} + \beta_g^I L_{st} \times D_d + \alpha_{gs} + \lambda_{gdt} + \gamma_{gt} X_s + \epsilon_{gsdt}. \tag{4}$$

Each district characteristic D is normalized to have a mean of zero and a standard deviation of one, so the estimated β_g parameters reflect the impact of a latrine in an average district. The estimated parameters β_g^I capture whether the impact of latrines is different in districts with a one standard deviation higher measure of D.[19] Because income and gender parity are district-level measures, I cluster the standard errors by district.

In Table 11, Panel A, I report the average impact of a latrine and how the impact changes for districts with a one standard deviation higher measure of gender parity. In Panel B, I report how the impact of latrines varies with districts' per capita income. In Panel C, I report how the impact of latrines varies when including both district measures.

The estimated impact of latrines does not vary substantially with districts' gender parity. Some estimates show higher impacts in districts with higher gender parity, though the magnitudes are fairly small and the estimates are not consistently statistically significant.[20] While the impact of latrines might have been larger in areas with greater gender parity, where females might otherwise be encouraged to enroll in school, the areas with lowest gender parity may also have the most unfulfilled potential for latrines to increase female educational attainment.

[19]The mean of the pre-normalized per capita income variable is Rs. 17,955 (standard deviation of Rs. 6,757) in the upper-primary-school sample and Rs. 16,887 (standard deviation of Rs. 6,496) in the primary-school sample. The mean of the pre-normalized gender parity index is 0.79 (with a standard deviation of 0.14) in the upper-primary-school sample and 0.78 (with a standard deviation of 0.16) in the primary-school sample. That is, the average ratio of enrolled upper-primary girls to enrolled upper-primary boys in a district is seventy-nine percent, and one standard deviation in the data is fourteen percent.

[20]For example, interpreting the estimates from Column 1 of Panel A, the impact of a latrine is 2 percentage points higher in a district with gender parity at the 75th percentile than in a district with gender parity at the 25th percentile (with a 1.4 standard deviation difference in their gender parity). The difference in the effect of a latrine when going from a district with very low gender parity (10th percentile) to a district with very high gender parity (90th percentile) is 2.6 standard deviations, or a difference in effect of 4 percentage points. That is, the implied total enrollment effect of a latrine in an upper-primary school in a 90th-percentile district is 0.09, and the implied effect of a latrine in an upper-primary school in a 10th-percentile district is 0.05.

Similarly, the estimated impact of latrines does not vary substantially with districts' average per capita income. While there is substantial variation across districts' average per capita income, this variation does not appear to be strongly correlated with the observed variation across district-specific impacts from latrines. The estimated impacts by latrine type also do not vary substantially with districts' average per capita income or gender parity.

One implication, following from this geographic consistency in the estimates, is the average in-sample estimated impact of school latrines is more likely to reflect the average impact across all of India. DISE data from 2002, 2003, and 2005 included only a subset of Indian districts (Figure 2), which skewed slightly poorer than average districts across the country (Rs. 16,120 vs. Rs. 17,953). Indeed, the estimated impacts of latrines are similar when reweighting sample districts to reflect the national distribution of district per capita income (Appendix Table 14).

Further, these estimates suggest that the educational impacts of school sanitation may be similar across a range of less-developed contexts. India was home to 20 percent of the world's out-of-school children in 2000, and 11 percent in 2013, which makes it an important case to study (UNESCO, 2015). In the absence of direct quantitative studies on sanitation and education in other countries, however, the substantial heterogeneity in conditions within India can be used to extend the external validity of this analysis to other countries.

V Conclusion

In 2015, one-third of all schools worldwide lacked a latrine (UNICEF and WHO, 2015). While attention is often given toward improving infrastructure in developing countries, the most basic of human needs are often overlooked. The recent Indian government has brought more attention to this issue, running on a campaign slogan of "toilets before temples" and launching the *Swachh Bharat: Swachh Vidyalaya* ("Clean India: Clean Schools") initiative to provide universal access to sex-specific latrines in all government schools. This recent initiative echos the earlier SSHE program, which also sought to provide universal access to latrines in all government schools.

I explore impacts on schools that received a latrine in 2003, during the first large wave of school-latrine construction through the SSHE program, using as a comparison group initially-similar schools that did not receive a latrine. School-latrine construction increases enrollment of girls and boys in both upper-primary and primary schools. The estimated impacts of latrines are similar across Indian districts that differ substantially in average per capita income, suggesting the observed relationship between sanitation and education may extend across a range of developing contexts that make up the one-third of schools worldwide that lack latrines.

These average increases in enrollment include substantial heterogeneity by latrine type. Pubescent-age girls benefit substantially from the construction of sex-specific latrines, but benefit little from a unisex latrine. Privacy and safety matter sufficiently for girls at older ages that school sanitation only reduces gender disparities with the construction of sex-specific latrines. By contrast, unisex latrines are mostly sufficient at younger ages. Indeed, school latrines have substantial impacts on younger children, who are most vulnerable to sickness from lack of waste containment. These estimates suggest a more general link between school sanitation and education, in contrast to the sometimes narrow focus on menstruation and pubescent-age girls.

As governments continue to devote resources to improving school sanitation, these estimates have implications for how scarce resources might be directed to greater effect. While younger children benefit substantially from latrines, unisex latrines may be sufficient for younger children when resources are scarce. By contrast, addressing gender inequality at older ages requires the construction of separate sex-specific latrines. School-latrine construction represents an opportunity to address the Millennium Development Goals, both by expanding access to education and by reducing a gender gap in enrollment that is particularly pronounced among adolescents.

With an increasing policy emphasis on school infrastructure investment, with school-latrine construction as a prominent example, an important note of caution is that increased school participation may not be accompanied by increased academic achievement. I do not estimate increases in student test scores following school-latrine construction, despite increases in school participation. Schooling interventions have led to later benefits, even in the absence of contemporaneous increases in academic achievement. Yet, infrastructure investments that encourage school participation may have limited impact if complementary investments are not made in making schools more effective sites of learning.

While there are many deep roots to problems of gender inequality in developing countries, improving school sanitation provides one mechanism to increase gender equality by targeting disproportionately high dropout rates among pubescent-age girls. In considering the importance of school sanitation, however, these impacts on pubescent-age girls should not obscure the importance of sanitation for boys and younger girls. Societal inequality is exacerbated when one in five children worldwide do not complete upper-primary school. Understanding children's motivations to drop out from school is important for influencing their behavior and subsequent educational and economic outcomes, and the estimated impacts of school latrines suggest how girls and boys of different ages are impacted by threats to their health, privacy, and safety.

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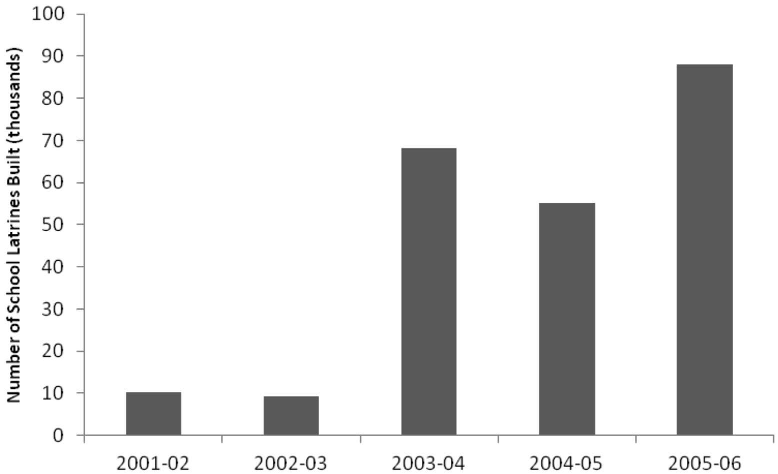
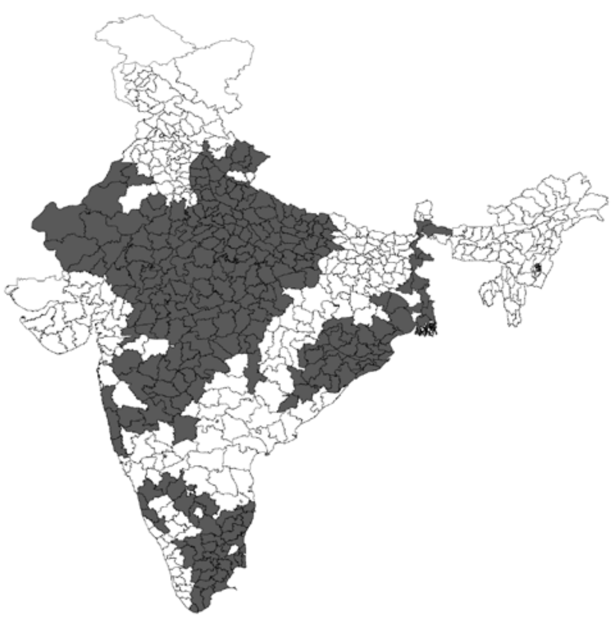
Figure 1. Number of School Latrines Built, by Academic Year



Notes: This figure shows the number of school latrines built each academic year, according to the Ministry of Drinking Water and Sanitation, NIC-MDWS Informatics System Cell (2013).

Figure 2. Map of Indian States in Sample



Notes: The gray areas mark the districts in India included in the main sample.

Table 1. Baseline School Characteristics in 2002, Upper-Primary Schools (6th - 8th Grades)

	Treatment Group: Built Latrine Between 02-03 and 03-04	Main Control Group: No Latrine From 02-03 through 05-06	Alternative Control Groups: Built Latrine Between 03-04 and 05-06	No Latrine Built Between 02-03 and 03-04	Within-District Differences: (1) - (2)	(1) - (3)	(1) - (4)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Number of Schools	7,625	10,171	9,544	51,450			
Total Enrollment	119.7	88.6	104.1	150.8	21.9**	13.4**	-21.5**
	(124.1)	(81.6)	(103.5)	(166.3)	(1.79)	(1.67)	(1.49)
Female Enrollment	51.9	35.6	42.6	67.8	11.3**	6.81**	-11.7**
	(61.8)	(37.2)	(49.8)	(97.9)	(0.889)	(0.839)	(0.800)
Male Enrollment	67.9	53.0	61.5	83.0	10.6**	6.63**	-9.79**
	(83.2)	(56.4)	(68.1)	(106.0)	(1.29)	(1.16)	(1.04)
Presence of:							
Blackboard	0.956	0.953	0.949	0.971	-0.000	0.005	-0.012**
Computer	0.065	0.075	0.061	0.176	0.013*	0.010**	-0.098**
Electricity	0.352	0.196	0.261	0.547	0.067**	0.047**	-0.184**
Library	0.395	0.446	0.388	0.539	0.016+	0.006	-0.088**
Medical Checkups	0.645	0.610	0.639	0.641	0.010	-0.005	-0.003
Playground	0.574	0.466	0.543	0.682	0.065**	0.025**	-0.110**
Ramps	0.041	0.058	0.046	0.059	0.012**	0.004	-0.012**
Water Source: Pump	0.445	0.542	0.505	0.442	0.017*	-0.010	0.016**
Water Source: Tap	0.235	0.109	0.174	0.315	0.040**	0.033**	-0.087**
Water Source: Well	0.046	0.066	0.042	0.077	-0.000	0.006+	-0.019**

Notes: In column 1, I report the average values of the treatment schools at baseline. In column 2, I report the average values of the main comparison schools at baseline (AY 2002-03). In columns 3 and 4, I report the average values of the alternative comparison schools at baseline (AY 2002-03). In column 5, I report the within-district difference between the average values of the treatment and main comparison school characteristics at baseline. In columns 6 and 7, I report the within-district difference between the average values of the treatment and alternative comparison schools characteristics at baseline. Robust standard errors are reported with ** denoting statistical significance at the 1 percent level, * at the 5 percent level, and + at the 10 percent level.

Table 2. Baseline School Characteristics in 2002, Primary Schools (1st - 5th Grades)

	Treatment Group: Built Latrine Between 02-03 and 03-04	Main Control Group: No Latrine From 02-03 through 05-06	Alternative Control Groups: Built Latrine Between 03-04 and 05-06	No Latrine Built Between 02-03 and 03-04	Within-District Differences: (1) - (2)	(1) - (3)	(1) - (4)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Number of Schools	32,820	88,386	55,920	205,521			
Total Enrollment	143.7	100.6	123.5	143.0	32.6**	17.6**	-7.42**
	(106.8)	(79.5)	(94.7)	(123.9)	(0.713)	(0.733)	(0.649)
Female Enrollment	69.5	48.2	59.0	68.2	15.8**	8.80**	-2.96**
	(54.2)	(40.6)	(47.0)	(63.2)	(0.365)	(0.373)	(0.331)
Male Enrollment	74.2	52.4	64.5	74.8	16.7**	8.80**	-4.46**
	(58.8)	(44.6)	(52.9)	(69.1)	(0.399)	(0.410)	(0.363)
Presence of:							
Blackboard	0.963	0.946	0.961	0.965	0.010**	0.003+	-0.002+
Computer	0.036	0.040	0.035	0.066	0.008**	0.005**	-0.031**
Electricity	0.163	0.076	0.120	0.220	0.072**	0.043**	-0.091**
Library	0.517	0.487	0.501	0.552	0.021**	0.010**	-0.032**
Medical Checkups	0.645	0.616	0.637	0.621	0.020**	0.005+	-0.004
Playground	0.500	0.393	0.460	0.524	0.063**	0.026**	-0.046**
Ramps	0.044	0.059	0.051	0.055	0.008**	0.005**	-0.004**
Water Source: Pump	0.558	0.520	0.517	0.572	0.032**	0.005+	0.008**
Water Source: Tap	0.150	0.082	0.135	0.156	0.038**	0.020**	-0.039**
Water Source: Well	0.038	0.049	0.038	0.047	0.004**	0.005**	-0.004**

Notes: In column 1, I report the average values of the treatment schools at baseline. In column 2, I report the average values of the main comparison schools at baseline (AY 2002-03). In columns 3 and 4, I report the average values of the alternative comparison schools at baseline (AY 2002-03). In column 5, I report the within-district difference between the average values of the treatment and main comparison school characteristics at baseline. In columns 6 and 7, I report the within-district difference between the average values of the treatment and alternative comparison schools characteristics at baseline. Robust standard errors are reported with ** denoting statistical significance at the 1 percent level, * at the 5 percent level, and + at the 10 percent level.

Table 3. Effect of a School Latrine on Student Enrollment, by Student Sex and Grade

	Upper-Primary Schools (6th-8th)		Primary Schools (1st-5th)	
	All Students	By Student Sex	All Students	By Student Sex
	(1)	(2)	(3)	(4)
Panel A. Dependent Variable: Log (Enrollment + 1)				
Built a Latrine	0.079**		0.121**	
	(0.008)		(0.003)	
Built a Latrine * Females		0.071**		0.111**
		(0.011)		(0.004)
Built a Latrine * Males		0.047**		0.097**
		(0.010)		(0.004)
p-value of the Difference		0.057		0.000
R^2 Statistic	0.326	0.246	0.154	0.130
Panel B. Dependent Variable: Enrollment Levels				
Built a Latrine	5.252**		11.809**	
	(0.844)		(0.476)	
Built a Latrine * Females		2.953**		5.851**
		(0.485)		(0.246)
Built a Latrine * Males		2.243**		6.026**
		(0.553)		(0.251)
p-value of the Difference		0.242		0.338
R^2 Statistic	0.147	0.152	0.149	0.147
Number of Observations	53,388	106,776	363,618	727,236
Number of Schools	17,796	17,796	121,206	121,206

Notes: The sample includes schools that first received a latrine in AY 2003-04 and schools that never received a latrine. Columns 1 and 3 report the average enrollment effect on all upper-primary-school and primary-school students respectively, in which the dependent variable for each school is regressed on a dichotomous variable for whether a school had a latrine, year-by-district fixed effects, school fixed effects, and a vector of controls of baseline school characteristics interacted with academic year (including initial enrollment, presence of electricity, a school library, water by source, ramps, regular medical checkups, and a playground in AY 2002-03). In Columns 2 and 4, all right-hand-side variables are interacted with student sex. Below the estimates by student sex, p-values are reported for the difference in estimated coefficients for girls and boys.

The dependent variable in Panel A is the natural logarithm of enrollment plus one. The dependent variable in Panel B is enrollment in levels. The estimates are drawn from AY 2002-03, AY 2003-04, and AY 2005-06. The unit of observation in Columns 1 and 3 is school-year; thus, there are three observations per school. The unit of observation in Columns 2 and 4 is school - student sex - year; thus, there are six observations per school. Robust standard errors clustered by school are reported in parentheses with ** denoting statistical significance at the 1 percent level, * at the 5 percent level, and + at the 10 percent level.

Table 4. Effect of a School Latrine over Time

	Upper-Primary Schools (6th-8th)			Primary Schools (1st-5th)		
	All	Females	Males	All	Females	Males
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Dependent Variable: Log (Enrollment + 1)						
Built a Latrine * 1 year after	0.073**	0.063**	0.041**	0.119**	0.110**	0.099**
	(0.008)	(0.011)	(0.011)	(0.003)	(0.004)	(0.004)
Built a Latrine * 3 years after	0.086**	0.079**	0.053**	0.122**	0.112**	0.096**
	(0.010)	(0.013)	(0.013)	(0.004)	(0.004)	(0.004)
R^2 Statistic	0.326	0.246		0.154	0.130	
Number of Observations	53,388	106,776		363,618	727,236	
Number of Schools	17,796	17,796		121,206	121,206	
Panel B. Dependent Variable: Enrollment Levels						
Built a Latrine * 1 year after	4.385**	2.409**	1.902**	11.723**	5.824**	6.028**
	(0.828)	(0.474)	(0.550)	(0.501)	(0.261)	(0.265)
Built a Latrine * 3 years after	6.119**	3.496**	2.584**	11.895**	5.879**	6.024**
	(1.090)	(0.604)	(0.697)	(0.579)	(0.295)	(0.302)
R^2 Statistic	0.147	0.152		0.149	0.147	
Number of Observations	53,388	106,776		363,618	727,236	
Number of Schools	17,796	17,796		121,206	121,206	

Notes: Columns 1 and 4 report the average enrollment effect on all upper-primary-school and primary-school students respectively, in which the dependent variable for each school is regressed on presence of a latrine interacted with whether the year is 2003 (the year after larine construction) or 2005 (3 years after latrine construction), year-by-district fixed effects, school fixed effects, and a vector of controls of baseline school characteristics interacted with academic year (including initial enrollment, presence of electricity, a school library, water by source, ramps, regular medical checkups, and a playground in AY 2002-03). Columns 2 & 3 and 5 & 6 report the average effect on females and males from upper-primary school and primary school respectively, estimated from a single regression. In these regressions, all right-hand-side variables are interacted with student sex.

The dependent variable in Panel A is the natural logarithm of enrollment plus one. The dependent variable in Panel B is enrollment in levels. Robust standard errors clustered by school are reported in parentheses with ** denoting statistical significance at the 1 percent level, * at the 5 percent level, and + at the 10 percent level.

Table 5. Effect of a School Latrine on Student Dropout

	Upper-Primary Schools (6th-8th)		Primary Schools (1st-5th)	
	All Students	By Student Sex	All Students	By Student Sex
	(1)	(2)	(3)	(4)
Built a Latrine	-0.053**		-0.122**	
	(0.015)		(0.005)	
Built a Latrine * Females		-0.054**		-0.125**
		(0.016)		(0.005)
Built a Latrine * Males		-0.046**		-0.112**
		(0.016)		(0.005)
R^2 Statistic	0.067	0.067	0.036	0.036
Number of Schools	17,796	17,796	121,206	121,206

Notes: Columns 1 and 3 report the average effect on the dropout of all upper-primary-school and primary-school students respectively, in which the dependent variable for each school is regressed on a dichotomous variable for whether a school had a latrine, year-by-district fixed effects, school fixed effects, and a vector of controls of baseline school characteristics interacted with academic year (including initial enrollment, presence of electricity, a school library, water by source, ramps, regular medical checkups, and a playground in AY 2002-03). In Columns 2 and 4, all right-hand-side variables are interacted with student sex.

The dependent variable is defined as the fraction of students who drop out as the expected enrollment (derived from the previous year's enrollment) minus the current year's enrollment, divided by the expected enrollment. Robust standard errors clustered by school are reported in parentheses with ** denoting statistical significance at the 1 percent level, * at the 5 percent level, and + at the 10 percent level.

Table 6. Effect of a School Latrine by Latrine Type

	Upper-Primary Schools (6th-8th)				Primary Schools (1st-5th)			
	All	Females	Males	(2) – (3)	All	Females	Males	(6) – (7)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. Dependent Variable: Log(Enrollment + 1)								
Built separate latrines for both boys and girls	0.096**	0.099**	0.058**	0.041**	0.129**	0.121**	0.101**	0.020**
	(0.009)	(0.012)	(0.012)	(0.014)	(0.004)	(0.005)	(0.005)	(0.005)
Only built a girls-only latrine	0.092**	0.111**	0.013	0.098**	0.152**	0.156**	0.085**	0.071**
	(0.012)	(0.016)	(0.017)	(0.022)	(0.007)	(0.008)	(0.009)	(0.011)
Only built a unisex latrine	0.053**	0.022+	0.044**	-0.022	0.107**	0.094**	0.095**	-0.001
	(0.009)	(0.013)	(0.012)	(0.014)	(0.004)	(0.004)	(0.004)	(0.004)
p-value (Row 1 - Row 3)	0.000	0.000	0.152	0.000	0.000	0.000	0.153	0.000
p-value (Row 1 - Row 2)	0.644	0.414	0.003	0.005	0.000	0.000	0.075	0.000
p-value (Row 2 - Row 3)	0.000	0.000	0.053	0.000	0.000	0.000	0.264	0.000
R^2 Statistic	0.327	0.247			0.155	0.130		
Panel B. Dependent Variable: Enrollment Levels								
Built separate latrines for both boys and girls	7.096**	4.130**	2.912**	1.218+	13.528**	6.732**	6.865**	-0.133
	(1.067)	(0.600)	(0.673)	(0.692)	(0.576)	(0.292)	(0.312)	(0.219)
Only built a girls-only latrine	5.100**	4.048**	0.928	3.120*	15.041**	8.375**	6.704**	1.671**
	(1.603)	(1.044)	(1.060)	(1.369)	(1.014)	(0.598)	(0.543)	(0.543)
Only built a unisex latrine	2.861**	1.070*	1.779**	-0.709	9.627**	4.604**	5.097**	-0.493*
	(0.945)	(0.501)	(0.632)	(0.635)	(0.510)	(0.266)	(0.272)	(0.199)
p-value (Row 1 - Row 3)	0.000	0.000	0.072	0.001	0.000	0.000	0.000	0.092
p-value (Row 1 - Row 2)	0.259	0.939	0.083	0.148	0.122	0.005	0.764	0.001
p-value (Row 2 - Row 3)	0.153	0.002	0.431	0.004	0.000	0.000	0.002	0.000
R^2 Statistic	0.148	0.152			0.149	0.148		
Number of Observations	53,388	106,776			363,618	727,236		
Number of Schools	17,796	17,796			121,206	121,206		

Notes: Reported estimates are analogous to those reported in Table 3, but separated by latrine type: the presence of a girls-only latrine and no unisex latrine, the presence of a unisex latrine and no girls-only latrine, and the presence of separate sex-specific latrines. Columns 1 and 5 report the average enrollment effect on all students. Columns 2 and 3 represent a single regression, and Columns 6 and 7 represent a single regression, which report the effect on females and males when interacting all right-hand-side variables with student sex. Columns 4 and 8 report the difference in the estimated effect for females and males. Below the estimates, p-values are reported for the indicated difference in estimated coefficients across rows. Robust standard errors clustered by school are reported in parentheses with ** denoting statistical significance at the 1 percent level, * at the 5 percent level, and + at the 10 percent level.

Table 7. ASER Data: Estimated Impact of Latrines on School Participation Outcomes

	School Enrollment	Log School Enrollment	School Attendance	Log School Attendance
	(1)	(2)	(3)	(4)
Panel A. Effects of any school latrine				
School latrine	18.892**	0.400**	12.116**	0.356**
	(3.547)	(0.046)	(2.581)	(0.045)
R^2 Statistic	0.132	0.190	0.156	0.181
Panel B. Effects by latrine type				
Separate, sex-specific	21.088**	0.416**	14.032**	0.375**
latrines for boys and girls	(3.846)	(0.049)	(2.807)	(0.048)
Girls-only latrine only	20.491+	0.386**	15.660+	0.366**
	(11.913)	(0.121)	(8.545)	(0.123)
Unisex latrine only	8.703	0.333**	2.681	0.266**
	(5.610)	(0.075)	(4.145)	(0.074)
R^2 Statistic	0.133	0.190	0.158	0.182
Number of Observations	6,079	6,079	6,079	6,079
Number of Villages	2,996	2,996	2,996	2,996

Notes: These specifications draw on school data from the Annual Status of Education Report (India). Specifications control for district-by-year fixed effects and school fixed effects. Robust standard errors clustered at the school-level in parentheses. ** p<0.01, * p<0.05, + p<0.1

Table 8. ASER Data: Estimated Impact of School Latrines on Child Learning

	Child Math Score			Child Reading Score		
	All Children	Girls	Boys	All Children	Girls	Boys
	(1)	(2)	(3)	(4)	(5)	(6)
School latrine	0.004	0.002	-0.001	0.030	0.048	0.011
	(0.019)	(0.022)	(0.021)	(0.030)	(0.034)	(0.034)
R^2 Statistic	0.218	0.222	0.221	0.265	0.268	0.269
Number of Observations	53,069	23,730	29,339	53,521	23,957	29,564
Number of Villages	1,752	1,751	1,751	1,752	1,751	1,751

Notes: These specifications draw on school and household data from the Annual Status of Education Report (India). Columns 1 and 4 report estimates for all children. Columns 2 and 5 report estimates for female children. Columns 3 and 6 report estimates for male children. Specifications control for student gender - by - age fixed effects, district-by-year fixed effects, and school fixed effects. The sample is limited to primary-school-aged children between the ages of 5 to 9. Robust standard errors clustered at the school-level in parentheses. ** p<0.01, * p<0.05, + p<0.1

Table 9. Effect of a School Latrine on Student Achievement in Uttar Pradesh, by Student Sex

	Change in Number of Enrolled Students Who					
	Appeared for Exam		Passed the Exam		Scored High Marks	
	All	By Sex	All	By Sex	All	By Sex
	(1)	(2)	(3)	(4)	(5)	(6)
Built a Latrine	2.045**		2.097**		-0.039	
	(0.719)		(0.736)		(0.587)	
Built a Latrine * Females		1.086**		1.152**		-0.044
		(0.376)		(0.382)		(0.281)
Built a Latrine * Males		1.199**		1.163*		0.065
		(0.447)		(0.455)		(0.372)
R^2 Statistic	0.184	0.178	0.177	0.176	0.061	0.060
Number of Observations	7,502	15,004	7,502	15,004	7,502	15,004
Number of Schools	3,751	3,751	3,751	3,751	3,751	3,751

Notes: The sample in this table includes schools in Uttar Pradesh, in AY 2002-03 and AY 2003-04, that first received a latrine in AY 2003-04 and schools that never received a latrine. Columns 1, 3, and 5 report the average achievement effect on all students, in which the dependent variable for each school is regressed on a dichotomous variable for whether a school had a latrine, year-by-district fixed effects, school fixed effects, and a vector of controls of baseline school characteristics interacted with academic year. In Columns 2, 4, and 6, all right-hand-side variables are interacted with student gender.

The dependent variables are the number of enrolled students who appeared for the examination (columns 1 and 2), who passed the examination (columns 3 and 4), and who scored high marks (columns 5 and 6) on the middle school examination in Uttar Pradesh, India. The unit of observation in Columns 1, 3, and 5 is school-year. The unit of observation in Columns 2, 4, and 6 is school - student gender - year. Robust standard errors clustered by school are reported in parentheses with ** denoting statistical significance at the 1 percent level, * at the 5 percent level, and + at the 10 percent level.

Table 10. Estimated Change in Teacher Share by Teacher Gender and Caste as a Result of School-Latrine Construction

	Female	Female	General Caste	Scheduled Caste	Scheduled Tribe	"Other Backwards Classes"
	(1)	(2)	(3)	(4)	(5)	(6)
Built a Latrine	0.018**		0.006	-0.005	-0.003	0.003
	(0.005)		(0.007)	(0.007)	(0.006)	(0.008)
Built separate latrines for both boys and girls		0.023**				
		(0.007)				
Only built a girls-only latrine		0.044**				
		(0.012)				
Only built a unisex latrine		0.011+				
		(0.006)				
R^2 Statistic	0.084	0.084	0.009	0.027	0.037	0.008
Number of Observations	24,009	24,009	24,009	24,009	24,009	24,009
Number of Schools	8,003	8,003	8,003	8,003	8,003	8,003

Notes: The sample in this table includes schools in Madhya Pradesh and Rajasthan that first received a latrine in AY 2003-04 and schools that never received a latrine. Column 1 reports the average effect of a school having a latrine on the share of female teachers at a school, in which the dependent variable for each school is regressed on a dichotomous variable for whether a school had a latrine, year-by-district fixed effects, school fixed effects, and a vector of controls of baseline school characteristics interacted with academic year. Column 2 reports the average effect on the share of female teachers, in which the dependent variable for each school is regressed on a dichotomous variable for the presence of a female-only latrine and no unisex latrine, the presence of a unisex latrine and no female-only latrine, the presence of separate sex-specific latrines, year-by-district fixed effects, school fixed effects, and the vector of controls for baseline school characteristics interacted with year. Columns 3-6 report the average effect of a school having a latrine on the share of teachers by caste at a school, in which the dependent variable for each school is regressed on a dichotomous variable for whether a school had a latrine, year-by-district fixed effects, school fixed effects, and the vector of baseline school characteristics interacted with academic year.

The dependent variable in columns 1 and 2 is the share of female teachers at a school (the number of female teachers divided by the total number of teachers at a school). The dependent variable in columns 3-6 is the share of teachers by caste at a school (the number of teachers by caste divided by the total number of teachers at a school). Categorization of caste is defined by the Government of India. Robust standard errors clustered by school are reported in parentheses with ** denoting statistical significance at the 1 percent level, * at the 5 percent level, and + at the 10 percent level.

Table 11. Effect of a Latrine by Districts' Baseline Gender Parity and Per Capita Income

	Upper-Primary Schools (6th-8th)			Primary Schools (1st-5th)		
	All	Females	Males	All	Females	Males
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A.Gender Parity						
Built a Latrine	0.078**	0.068**	0.047**	0.116**	0.106**	0.093**
	(0.011)	(0.014)	(0.014)	(0.014)	(0.013)	(0.012)
Built a Latrine * Gender Parity Measure	0.015	0.022	0.003	0.020+	0.023*	0.021+
	(0.010)	(0.014)	(0.015)	(0.011)	(0.010)	(0.011)
R^2 Statistic	0.326	0.246		0.154	0.130	
Number of Observations	53,388	106,776		363,618	727,236	
Number of Schools	17,796	17,796		121,206	121,206	
Panel B.Income Measure						
Built a Latrine	0.076**	0.067**	0.043**	0.156**	0.143**	0.124**
	(0.015)	(0.021)	(0.018)	(0.022)	(0.021)	(0.020)
Built a Latrine * Income Measure	-0.010	-0.008	0.006	0.014	0.017	0.015
	(0.014)	(0.022)	(0.018)	(0.014)	(0.014)	(0.013)
R^2 Statistic	0.324	0.240		0.160	0.128	
Number of Observations	37,737	75,474		235,200	470,400	
Number of Schools	12,579	12,579		78,400	78,400	
Panel C. Gender Parity and Income						
Built a Latrine	0.064**	0.051+	0.021	0.153**	0.139**	0.115**
	(0.020)	(0.026)	(0.023)	(0.024)	(0.022)	(0.024)
Built a Latrine * Gender Parity Measure	0.024	0.032	0.044	0.007	0.008	0.019
	(0.023)	(0.030)	(0.028)	(0.028)	(0.026)	(0.031)
Built a Latrine * Income Measure	-0.018	-0.018	-0.008	0.012	0.015	0.009
	(0.016)	(0.023)	(0.019)	(0.015)	(0.015)	(0.014)
R^2 Statistic	0.324	0.240		0.160	0.128	
Number of Observations	37,737	75,474		235,200	470,400	
Number of Schools	12,579	12,579		78,400	78,400	

Notes: The gender parity measure in this table is a continuous normalized ratio of enrolled upper-primary-school girls to boys in 2002, calculated as the ratio of the average number of enrolled upper-primary girls in a district at baseline to the average number of enrolled upper-primary boys in a district at baseline minus the mean ratio divided by the standard deviation of the ratio. Income is defined as the normalized average per capita income in each district in 2002. Panel A reports the average impact of a latrine and how the impact changes for districts with a one standard deviation higher measure of gender parity. Panel B reports how the impact of latrines varies with a one standard deviation higher measure of districts' per capita income. Panel C reports how the impact of latrines varies when including both district measures. Columns 1 and 4 report the average enrollment effect on all upper-primary-school and primary-school students, respectively, in which the dependent variable for each school is regressed on presence of a latrine, presence of a latrine interacted with the gender parity measure (in Panels A and C), presence of a latrine interacted with the per-capita income measure (in Panels B and C), year-by-district fixed effect, school fixed effects, and a vector of controls of baseline school characteristics interacted with academic year (including initial enrollment, presence of electricity, a school library, water by source, ramps, regular medical checkups, and a playground in AY 2002-03). Columns 2&3 and 5&6 report the average effect on females and males from upper-primary school and primary school, respectively, estimated from a single regression. In these regressions, all right-hand-side variables are interacted with student sex.

The dependent variable is the natural logarithm of enrollment plus one. Robust standard errors clustered by district are reported in parentheses with ** denoting statistical significance at the 1 percent level, * at the 5 percent level, and + at the 10 percent level.

Qualitative Data Appendix

This research project developed, in part, from a set of interviews that I conducted from 2007 – 2009 to explore broadly what factors might be influencing educational decisions in India. Out of these interviews, with families and service providers, there arose parallels to a broader research literature that outlines reasons why school latrines may impact educational outcomes. These interviews help to relate that broader research literature to the Indian context of my quantitative analysis. In this Appendix, I describe the interview methodology and main findings.

Interview Sampling and Structure

I conducted structured interviews primarily in four states in India: Madhya Pradesh (MP), Andhra Pradesh (AP), Tamil Nadu (TN), and Uttar Pradesh (UP). The estimated per capita income of MP and UP are comparable to other major North Indian states (Rs. 7,000-10,000), just as the estimated per capita income of TN and AP are comparable to other major South Indian states (Rs. 10,000-13,000) (Census of India 2001).

Research participants were drawn from an arbitrary and convenient sample found in fields (farmers, fieldworkers), households (parents, children), schools (principals, children), and roadside shops (shop owner, customers). In MP, research participants were located in the rural districts of Sehore (population of 1.1 million) and Vidisha (population of 1.2 million). The sample included 53 private citizens (farmers, fieldworkers, shop keepers, mothers, fathers, etc.), 20 government officials, 6 school officials, and 1 bank manager. The research participants in AP were located in the rural Nalgonda district (population of 3.2 million). The sample included 34 private citizens and 6 school officials. In UP, 8 private citizens and 3 school officials were interviewed in the rural Bhakshi Ka Talab area outside of Lucknow (population of 2.1 million). In TN, interviewees were 10 private citizens who resided in the rural Tiruvallur District (population of 2.7 million). In addition to the interviews, I conducted a survey of 133 households in this district of TN, which included questions about financial decisions families would make if their budgets were less constrained.

Interview lengths ranged from five minutes to two hours, guided by interview methodologies discussed by Seidman (1998) and Emerson, Fretz and Shaw (1995). Participants answered questions about educational and financial decisions and sometimes gave tours of their schools, homes, or villages. The interviews were usually conducted in participants' homes, classrooms, office spaces, or in public places such as restaurants, cafes, camel carts, and roadside shops. For children, the questions included: whether they attended school, whether they liked school and why, what they wished was different about school, what were the reasons they did or did not attend school, and similar questions about their peers. For parents, the questions included: whether they send their children to school, why they send their children to school, and what factors dissuade them from sending their children to school. For school headmasters, the questions included their satisfaction in their jobs, what innovations they were excited about in their schools, what they would do with additional money for the school, how they motivate the teachers in the school, what they wish was different about the school, why they think that children attend or do not attend school, and the importance of existing or possible school infrastructure (including latrines). For government officials, the questions included: their understanding of the local school situation, how they thought schools could be improved, what they would do if given extra money to improve schools, and why they think children do or not attend school.

I also conducted less-structured interviews and site visits, in which I embedded myself in the community (Emerson, Fretz and Shaw, 1995). I worked on community sanitation projects with the Environmental Sanitation Institute (ESI) and Safai Vidyalaya, two NGOs in Gujarat, to better understand understand the perspectives of beneficiaries and service providers (engineers, NGOs, government officials). I also accompanied ESI on a Nandini Sanitation and Health on Wheels project, in which volunteers traveled to villages to provide sanitation-related education. During this time, I participated in latrine construction, assisted with hygiene-education provision, and conducted interviews and participant observations in three villages. This included living with local families during the visits. I also assisted with household interviews in a large slum in the city of Ahmedabad to better understand sanitation in an urban setting. As part of these interviews, we asked parents and guardians about factors that influence the education decisions they make for their children.

Main Findings

One theme that emerged through this work was that girls highlighted a connection between their educational attainment and their concerns for safety and privacy at school. One 12-year-old discussed her passion for school but that she failed out because of her absence due to monthly menses during mandatory exams that could not be retaken. Another girl recounted a story of a friend who was sexually assaulted while urinating behind bushes, and described an atmosphere of fear where males would target females who were isolated from view. She said that this fear discouraged her and her friends from eating, drinking, and relieving themselves during the school day. Indeed, my school visits often revealed an absence of private locations for children to relieve themselves. In these cases, when I asked about where students could go to the restroom, students often pointed to various places on the school premises such as behind a school sign, next to the building, or behind trees.

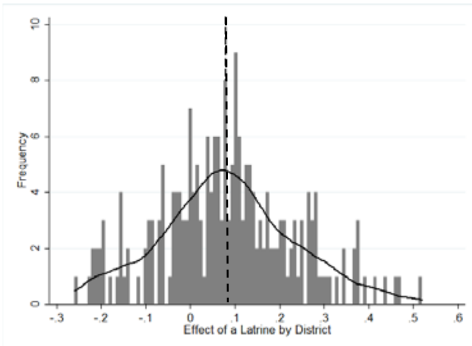
By contrast, over the course of my interviews, boys never indicated "safety," "privacy," or “sanitation” as reasons for dropping out of school. Boys’ responses were typically related to working, moving, health problems, or family responsibilities. These responses may reflect boys’ unwillingness to acknowledge these concerns, particularly in combination with interviewer bias because I am a female. Boys (and girls) were more willing to share anecdotes about boys they knew being harassed or assaulted, either by other boys or by teachers. Incidents of sexual assault are vastly under-reported, especially when children are the victims, and so these accounts should be expected to only provide a glimpse into the problem.

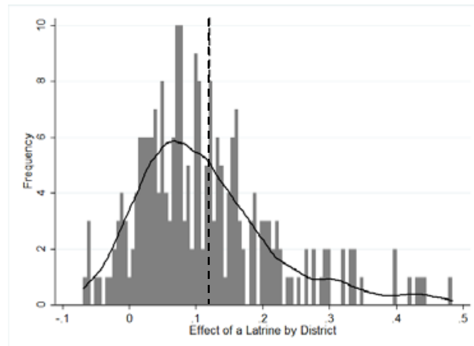
School headmasters expressed a common sentiment that children followed regimented hygiene routines that did not require them to use sanitation facilities during the school day. This sentiment may help explain why a majority of my visited schools did not have sanitation facilities available to students. This sentiment contrasts the views of children I interviews, for whom access to school sanitation facilities was an important issue. In the absence of centralized government support and the provision of resources, local schools may not be particularly responsive to the needs of traditionally-disadvantaged children.

For Online Publication

Appendix Figure 1. Histogram of Effect by District

Upper-Primary Schools (6th-8th Grades) | Primary Schools (1st-5th Grades)



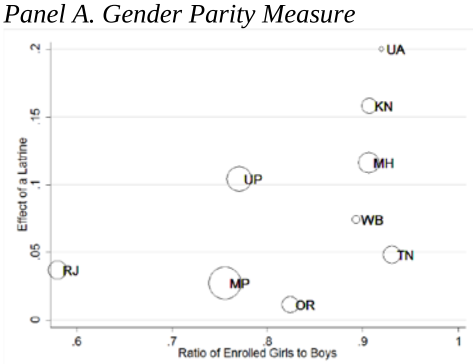


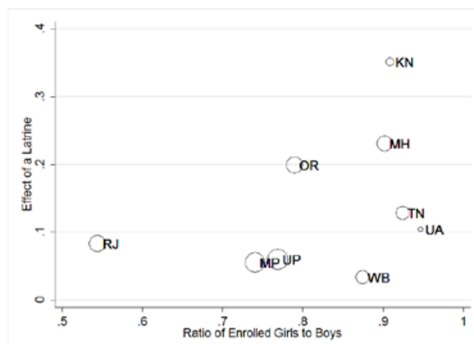
Notes: This is a histogram plotting the average effect of the introduction of a latrine in each district. Overlaid is a kernel density plot. For clarity, the districts in the upper and lower five percent of the distribution have been omitted. The vertical dashed line represents the estimated average effect of a latrine in the entire sample region.

Appendix Figure 2. Relationship between Enrollment Effect from a Latrine and Gender Norms and Income, by State

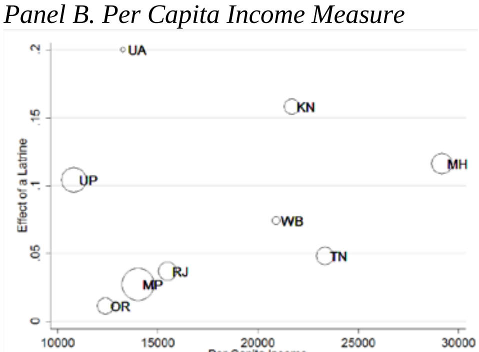
Upper-Primary Schools (6th-8th Grades) | Primary Schools (1st-5th Grades)

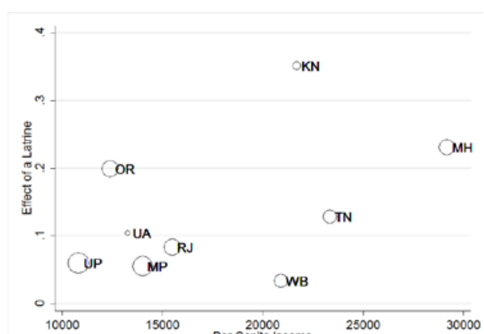
Panel A. Gender Parity Measure





Panel B. Per Capita Income Measure





Notes: The gender parity measure in this table is a continuous ratio of the average number of enrolled upper-primary girls in a district at baseline to the average number of enrolled upper-primary boys in a district at baseline, calculated from DISE. The income measure is a per capita income measure, calculated from Census of India 2001 and Economic Survey 2005. The Y-axis signifies the estimated enrollment effect of a latrine by state. Each circle represents one state in India. The size of the circle is weighted by the number of schools in that state, in the sample.

Appendix Table 1. Characteristics of Matched Schools in 2002, and Differences from Unmatched Schools

	Average in Matched Schools (1)	Difference from Unmatched Schools (2)	Number of Observations (3)
Total enrollment	149.351	0.316	842,072
	(152.765)	(0.616)	
Any latrine	0.392	0.059**	802,251
	(0.488)	(0.002)	
Sex-specific latrines	0.183	0.050**	842,072
	(0.387)	(0.001)	
Girls-only latrine	0.029	0.005**	842,072
	(0.169)	(0.001)	
Unisex latrine only	0.151	-0.026**	842,072
	(0.358)	(0.001)	
Blackboard	0.911	-0.067**	842,072
	(0.285)	(0.001)	
Library	0.446	-0.016**	785,081
	(0.497)	(0.002)	
Computers	0.063	0.039**	842,072
	(0.243)	(0.001)	
Playground	0.495	0.039**	795,157
	(0.500)	(0.002)	
Water source: Pump	0.510	-0.037**	779,054
	(0.500)	(0.002)	
Water source: Well	0.059	0.012**	779,054
	(0.235)	(0.001)	
Water source: Tap	0.162	0.043**	779,054
	(0.369)	(0.001)	
Electricity	0.213	0.085**	797,872
	(0.410)	(0.002)	
Medical checkups	0.574	-0.018**	783,580
	(0.494)	(0.002)	
Ramps	0.052	0.002**	751,773
	(0.222)	(0.001)	

Notes: Column 1 reports the average value of the indicated variable in 2002, for a given row, for the sample of schools matched in the data for both 2002 and 2003. Column 2 reports the estimated difference in 2002 for schools that did not match to data from 2003, controlling for district fixed effects. Column 3 reports the number of observations. Robust standard errors are reported in parentheses with ** denoting statistical significance at the 1 percent level, * at the 5 percent level, and + at the 10 percent level.

Appendix Table 2. Effect of a School Latrine on Student Enrollment, by Student Sex and Age

	Children between Ages 10 to 16		Children between Ages 5 to 9	
	All Students	By Student Sex	All Students	By Student Sex
	(1)	(2)	(3)	(4)
Built a Latrine	0.076**		0.116**	
	(0.008)		(0.004)	
Built a Latrine * Females		0.065**		0.105**
		(0.010)		(0.004)
Built a Latrine * Males		0.039**		0.093**
		(0.010)		(0.004)
p-value of the Difference		0.033		0.003
R^2 Statistic	0.279	0.209	0.159	0.138
Number of Observations	53,321	106,642	363,258	726,516
Number of Schools	17,796	17,796	121,206	121,206

Notes: Columns 1 and 3 report the average enrollment effect on all students between the ages of 10 to 16 and 5 to 9, respectively, in which the dependent variable for each school is regressed on a dichotomous variable for whether a school had a latrine, year-by-district fixed effects, school fixed effects, and a vector of controls of baseline school characteristics interacted with academic year (including initial enrollment, presence of electricity, a school library, water by source, ramps, regular medical checkups, and a playground in AY 2002-03). In Columns 2 and 4, all right-hand-side variables are interacted with student sex. Below the estimates by student sex, p-values are reported for the difference in estimated coefficients for girls and boys.

The dependent variable is the natural logarithm of enrollment plus one. The estimates are drawn from AY 2002-03, AY 2003-04, and AY 2005-06. The unit of observation in Columns 1 and 3 is school-year; thus, there are three observations per school. The unit of observation in Columns 2 and 4 is school - student sex - year; thus, there are six observations per school. Robust standard errors clustered by school are reported in parentheses with ** denoting statistical significance at the 1 percent level, * at the 5 percent level, and + at the 10 percent level.

Appendix Table 3. Effect of a Latrine on Total Enrollment, Robustness to Matching Techniques

	Main Specification	Nearest Neighbor Matching	Coarsened Exact Matching	Nearest Neighbor, No Replacement	Kernel-Based Matching	Mahalanobois Matching	Radius Matching
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A. Upper-Primary Schools (6th-8th Grades)							
Built a Latrine	0.079**	0.069**	0.067**	0.074**	0.062**	0.058**	0.068**
	(0.008)	(0.011)	(0.008)	(0.008)	(0.008)	(0.010)	(0.011)
R^2 Statistic	0.326	0.300	0.310	0.303	0.298	0.306	0.333
Number of Observations	53,388	45,750	51,408	45,750	53,388	45,750	53,388
Number of Schools	17,796	11,048	17,136	15,250	17,796	11,279	17,796
Panel B: Primary Schools (1st-5th Grades)							
Built a Latrine	0.121**	0.108**	0.116**	0.109**	0.109**	0.108**	0.125**
	(0.003)	(0.006)	(0.004)	(0.004)	(0.003)	(0.007)	(0.004)
R^2 Statistic	0.154	0.171	0.155	0.161	0.162	0.170	0.180
Number of Observations	363,618	196,920	361,785	196,920	363,618	196,920	363,618
Number of Schools	121,206	43,013	120,595	65,640	121,206	43,863	121,206

Notes: The dependent variable is the natural logarithm of enrollment plus one. These estimates correspond to those reported in Table 3, but instead use matching techniques to estimate the effect of a latrine (as noted in the column headings). Robust standard errors clustered by school are reported in parentheses with ** denoting statistical significance at the 1 percent level, * at the 5 percent level, and + at the 10 percent level.

Appendix Table 4. Effect of a School Latrine, Using Alternative Comparison Groups

	No Latrine From 2002 through 2005		Built Latrine Between 2003 and 2005		No Latrine Built Between 2002 and 2003	
	All Students	By Student Sex	All Students	By Student Sex	All Students	By Student Sex
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Upper-Primary Schools (6th-8th Grades)						
Built a Latrine	0.073**		0.045**		0.029**	
	(0.008)		(0.007)		(0.005)	
Built a Latrine * Females		0.063**		0.034**		0.027**
		(0.011)		(0.009)		(0.007)
Built a Latrine * Males		0.041**		0.025**		-0.004
		(0.011)		(0.009)		(0.007)
R^2 Statistic	0.343	0.238	0.335	0.226	0.236	0.135
Number of Observations	35,592	71,184	34,338	68,676	118,150	236,300
Number of Schools	17,796	17,796	17,169	17,169	59,075	59,075
Panel B. Primary Schools (1st-5th Grades)						
Built a Latrine	0.119**		0.054**		0.093**	
	(0.003)		(0.003)		(0.002)	
Built a Latrine * Females		0.110**		0.053**		0.085**
		(0.004)		(0.004)		(0.003)
Built a Latrine * Males		0.099**		0.041**		0.070**
		(0.004)		(0.004)		(0.003)
R^2 Statistic	0.153	0.134	0.165	0.140	0.128	0.109
Number of Observations	242,412	484,824	177,480	354,960	476,682	953,364
Number of Schools	121,206	121,206	88,740	88,740	238,341	238,341

Notes: This table reports the results using alternative comparison groups, on a sample of schools in AY 2002-03 and 2003-04. The comparison group in Columns 3 and 4 includes schools that did not have a latrine in AYs 2002-04 but that did have a latrine by AY 2005-06. In Columns 5 and 6, the comparison group includes schools that had a latrine every year between AYs 2002-06 and schools that never had a latrine between AYs 2002-06. The table reports the average enrollment effect in which the dependent variable for each school is regressed on presence of a latrine, year-by-district fixed effects, school fixed effects, and a vector of controls of baseline school characteristics interacted with academic year. All right-hand-side variables in Columns 2, 4, and 6 are interacted with student sex.

The dependent variable is the natural logarithm of enrollment plus one. Robust standard errors clustered by school are reported in parentheses with ** denoting statistical significance at the 1 percent level, * at the 5 percent level, and + at the 10 percent level.

Appendix Table 5. Effect of a School Latrine on Student Enrollment, Controlling for Changes in School Infrastructure

	Upper-Primary Schools (6th-8th)		Primary Schools (1st-5th)	
	All Students	By Student Sex	All Students	By Student Sex
	(1)	(2)	(3)	(4)
Built a Latrine	0.067**		0.100**	
	(0.008)		(0.003)	
Built a Latrine * Females		0.066**		0.095**
		(0.011)		(0.004)
Built a Latrine * Males		0.036**		0.077**
		(0.010)		(0.004)
p-value of the Difference		0.016		0.000
R^2 Statistic	0.331	0.247	0.164	0.135
Number of Observations	53,388	106,776	363,618	727,236
Number of Schools	17,796	17,796	121,206	121,206

Notes: The sample includes schools that first received a latrine in AY 2003-04 and schools that never received a latrine. Columns 1 and 3 report the average enrollment effect on all upper-primary-school and primary-school students respectively, in which the dependent variable for each school is regressed on a dichotomous variable for whether a school had a latrine, time-varying measures of the presence of each infrastructure type, year-by-district fixed effects, school fixed effects, a vector of controls of baseline school characteristics interacted with academic year (including initial enrollment, presence of electricity, a school library, water by source, ramps, regular medical checkups, and a playground in AY 2002-03). In Columns 2 and 4, all right-hand-side variables are interacted with student sex. Below the estimates by student sex, p-values are reported for the difference in estimated coefficients for girls and boys.

The dependent variable is the natural logarithm of enrollment plus one. The estimates are drawn from AY 2002-03, AY 2003-04, and AY 2005-06. The unit of observation in Columns 1 and 3 is school-year; thus, there are three observations per school. The unit of observation in Columns 2 and 4 is school-student sex-year; thus, there are six observations per school. Robust standard errors clustered by school are reported in parentheses with ** denoting statistical significance at the 1 percent level, * at the 5 percent level, and + at the 10 percent level.

Appendix Table 6. Latrine Construction and Changes in Other School Infrastructure

	Upper-Primary Schools	Primary Schools
	(1)	(2)
Blackboard	0.016**	0.008**
	(0.003)	(0.001)
Computer	0.024**	0.016**
	(0.004)	(0.001)
Electricity	0.093**	0.094**
	(0.006)	(0.002)
Library	0.051**	0.045**
	(0.006)	(0.002)
Medical Checkups	0.028**	0.030**
	(0.006)	(0.002)
Playground	0.067**	0.078**
	(0.007)	(0.003)
Ramps	0.042**	0.038**
	(0.005)	(0.002)
Pumped Water	0.025**	0.037**
	(0.006)	(0.002)
Tap Water	0.060**	0.050**
	(0.005)	(0.002)
Well Water	-0.002	-0.000
	(0.003)	(0.001)

Notes: This table reports the estimated relationship between latrine construction and changes in each type of other school infrastructure, from regressing the presence of each infrastructure measure on: latrine presence, district-by-year fixed effects, school fixed effects, and a vector of controls of baseline school characteristics interacted with academic year (including initial enrollment, presence of electricity, a school library, water by source, ramps, regular medical checkups, and a playground in AY 2002-03). Column 1 reports estimates for the upper-primary-school sample and Column 2 reports estimates for the primary-school sample. For each row, the sample includes schools that first received a latrine in AY 2003-04 and schools that never received a latrine, for which that particular infrastructure variable is observed. Robust standard errors clustered by school are reported in parentheses with ** denoting statistical significance at the 1 percent level, * at the 5 percent level, and + at the 10 percent level.

Appendix Table 7. Interaction Effects between Latrines and Other Infrastructure

	Upper-Primary Schools	Primary Schools
	(1)	(2)
Built Latrine	0.066**	0.100**
	(0.008)	(0.003)
Built Latrine * Blackboard	0.012	-0.031*
	(0.031)	(0.014)
Built Latrine * Computer	0.039*	0.032**
	(0.019)	(0.012)
Built Latrine * Electricity	-0.007	0.023**
	(0.014)	(0.007)
Built Latrine * Library	0.016	0.000
	(0.010)	(0.004)
Built Latrine * Medical Checkups	0.001	0.007
	(0.011)	(0.004)
Built Latrine * Playground	0.004	-0.007+
	(0.011)	(0.004)
Built Latrine * Ramps	0.013	0.018**
	(0.013)	(0.005)
Built Latrine * Pumped Water	0.007	-0.034**
	(0.014)	(0.006)
Built Latrine * Tap Water	0.023	0.003
	(0.016)	(0.007)
Built Latrine * Well Water	-0.043	0.006
	(0.030)	(0.013)
R^2 Statistic	0.343	0.170
Number of Observations	51,476	348,416
Number of Schools	17,796	121,206

Notes: The sample includes schools that first received a latrine in AY 2003-04 and schools that never received a latrine, for which all infrastructure variables are observed. Columns 1 and 2 report the average enrollment effect on all upper-primary-school and primary-school students, respectively, in which log school enrollment (plus one) is regressed on a dichotomous variable for whether a school had a latrine, interaction terms between latrine presence and the presence of each other type of infrastructure (normalized to have mean zero), the presence of each other type of infrastructure, year-by-district fixed effects, school fixed effects, and a vector of controls of baseline school characteristics interacted with academic year (including initial enrollment, presence of electricity, a school library, water by source, ramps, regular medical checkups, and a playground in AY 2002-03). Robust standard errors clustered by school are reported in parentheses with ** denoting statistical significance at the 1 percent level, * at the 5 percent level, and + at the 10 percent level.

Appendix Table 8. Effect of a Latrine on Total Enrollment, Further Robustness Checks

	Main Specification	Villages with Only One School	Coeducational Sample	Coed Sample: Log(Enrollment)	Baseline Controls Interacted with Linear Time Trend	Clustering Standard Errors at the District Level
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Upper-Primary Schools (6th-8th Grades)						
Built a Latrine	0.079**	0.076**	0.066**	0.068**	0.079**	0.079**
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.011)
R^2 Statistic	0.326	0.338	0.313	0.317	0.326	0.326
Number of Observations	53,388	49,668	49,008	49,008	53,388	53,388
Number of Schools	17,796	16,556	16,336	16,336	17,796	17,796
Panel B: Primary Schools (1st-5th Grades)						
Built a Latrine	0.121**	0.124**	0.119**	0.122**	0.121**	0.121**
	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)	(0.014)
R^2 Statistic	0.154	0.171	0.155	0.155	0.154	0.154
Number of Observations	363,618	276,588	351,261	351,261	363,618	363,618
Number of Schools	121,206	92,196	117,087	117,087	121,206	121,206

Notes: The dependent variable is the natural logarithm of enrollment plus one. The main specifications report the average enrollment effect on all upper-primary-school and primary-school students respectively, in which the dependent variable for each school is regressed on a dichotomous variable for whether a school had a latrine, year-by-district fixed effects, school fixed effects, and a vector of controls of baseline school characteristics interacted with academic year (including initial enrollment, presence of electricity, a school library, water by source, ramps, regular medical checkups, and a playground in AY 2002-03). Column 1 shows the estimates from the main specification. Column 2 limits the sample to schools that are in villages with only one school. Columns 3 and 4 limit the sample to schools with positive enrollments of boys and girls with the logarithm of enrollment as the dependent variable in column 4. In Column 5, the controls are interacted with a linear time trend instead of a flexible time trend. In Column 6, the standard errors are clustered at the district level instead of at the school level. Robust standard errors clustered by school are reported in parentheses with ** denoting statistical significance at the 1 percent level, * at the 5 percent level, and + at the 10 percent level.

Appendix Table 9. Baseline Upper-Primary-School Characteristics in 2002, by Type of Latrine Built

	Built Latrines for Both Sexes Between 02-03 and 03-04	Treatment Group: Built Only Unisex Latrine Between 02-03 and 03-04	Built Only Girls' Latrine Between 02-03 and 03-04	Main Control Group: No Latrine From 02-03 through 05-06	Within-District Differences: (1) - (4)	(2) - (4)	(3) - (4)	(1) - (2)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Number of Schools	3,822	2,954	849	10,171				
Total Enrollment	117.553	107.106	173.509	88.633	15.365**	0.249	32.321**	8.790**
	(1.926)	(1.997)	(5.938)	(0.809)	(2.110)	(2.118)	(5.278)	(2.672)
Female Enrollment	50.730	43.152	87.400	35.592	8.296**	-3.243**	25.508**	7.805**
	(0.944)	(0.858)	(3.415)	(0.369)	(1.053)	(0.967)	(3.017)	(1.271)
Male Enrollment	66.823	63.954	86.108	53.041	7.069**	3.492*	6.813+	0.985
	(1.230)	(1.528)	(3.728)	(0.559)	(1.457)	(1.638)	(3.632)	(1.973)
Presence of:								
Blackboard	0.949	0.961	0.965	0.953	-0.002	0.006	-0.010	-0.007
Computer	0.064	0.052	0.119	0.075	0.014**	-0.013**	0.039**	0.021**
Electricity	0.316	0.339	0.559	0.196	0.037**	0.016+	0.084**	0.016
Library	0.372	0.405	0.469	0.446	0.017*	-0.005	0.018	0.025*
Medical Checkups	0.594	0.685	0.734	0.610	-0.019*	0.038**	-0.014	-0.040**
Playground	0.588	0.544	0.619	0.466	0.054**	0.012	0.036*	0.024+
Ramps	0.037	0.046	0.047	0.058	0.004	0.011*	0.002	-0.004
Water Source: Pump	0.467	0.454	0.324	0.542	-0.003	0.028**	-0.008	-0.022*
Water Source: Tap	0.221	0.223	0.335	0.109	0.041**	0.004	0.006	0.028**
Water Source: Well	0.042	0.043	0.073	0.066	0.002	-0.007+	0.015	0.008

Notes: In Column 1, I report the average characteristics in AY 2002-03 of the treatment schools that built latrines for both boys and girls between AY 2002-03 and AY 2003-04. In Column 2, I report the average characteristics in AY 2002-03 of the treatment schools that built only unisex latrines between AY 2002-03 and AY 2003-04. In Column 3, I report the average characteristics in AY 2002-03 of the treatment schools that built only girls' latrines between AY 2002-03 and AY 2003-04. In Column 4, I report the average characteristics in AY 2002-03 of the comparison schools that had no latrine between AY 2002-03 and AY 2005-06. In Columns 5 - 7, I report the estimated within-district difference between the average baseline characteristics of schools in columns 1 -- 3 and comparison schools in Column 4. Robust standard errors are reported with ** denoting statistical significance at the 1 percent level, * at the 5 percent level, and + at the 10 percent level.

Appendix Table 10. Baseline Primary-School Characteristics in 2002, by Type of Latrine Built

	Treatment Group: Built Latrines for Both Sexes Between 02-03 and 03-04	Built Only Unisex Latrine Between 02-03 and 03-04	Built Only Girls' Latrine Between 02-03 and 03-04	Main Control Group: No Latrine From 02-03 through 05-06	Within-District Differences: (1) - (4)	(2) - (4)	(3) - (4)	(1) - (2)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Number of Schools	15,102	15,725	1,993	88,386				
Total Enrollment	153.692	134.873	137.649	100.590	28.008**	18.083**	26.938**	7.384**
	(0.914)	(0.800)	(2.406)	(0.267)	(0.981)	(0.843)	(2.308)	(1.237)
Female Enrollment	74.443	64.625	69.962	48.169	13.953**	7.927**	16.516**	4.806**
	(0.465)	(0.398)	(1.337)	(0.136)	(0.505)	(0.420)	(1.304)	(0.633)
Male Enrollment	79.249	70.248	67.687	52.422	14.055**	10.156**	10.422**	2.578**
	(0.498)	(0.445)	(1.339)	(0.150)	(0.540)	(0.480)	(1.294)	(0.695)
Presence of:								
Blackboard	0.959	0.965	0.972	0.946	0.003	0.012**	-0.003	-0.007**
Computer	0.036	0.035	0.055	0.040	0.009**	0.000	0.022**	0.009**
Electricity	0.140	0.163	0.337	0.076	0.053**	0.039**	0.113**	0.017**
Library	0.545	0.495	0.482	0.487	0.012**	0.025**	-0.029**	-0.007
Medical Checkups	0.619	0.657	0.739	0.616	0.011**	0.021**	-0.013+	-0.011*
Playground	0.547	0.452	0.531	0.393	0.064**	0.028**	0.046**	0.032**
Ramps	0.043	0.043	0.059	0.059	0.010**	0.001	0.014**	0.007**
Water Source: Pump	0.623	0.520	0.356	0.520	0.015**	0.033**	0.001	-0.010*
Water Source: Tap	0.123	0.159	0.287	0.082	0.033**	0.018**	0.041**	0.015**
Water Source: Well	0.031	0.042	0.058	0.049	0.004*	-0.000	0.011*	0.005+

Notes: In Column 1, I report the average characteristics in AY 2002-03 of the treatment schools that built latrines for both boys and girls between AY 2002-03 and AY 2003-04. In Column 2, I report the average characteristics in AY 2002-03 of the treatment schools that built only unisex latrines between AY 2002-03 and AY 2003-04. In Column 3, I report the average characteristics in AY 2002-03 of the treatment schools that built only girls' latrines between AY 2002-03 and AY 2003-04. In Column 4, I report the average characteristics in AY 2002-03 of the comparison schools that had no latrine between AY 2002-03 and AY 2005-06. In Columns 5 - 7, I report the estimated within-district difference between the average baseline characteristics of schools in Columns 1 -- 3 and comparison schools in Column 4. Robust standard errors are reported with ** denoting statistical significance at the 1 percent level, * at the 5 percent level, and + at the 10 percent level.

Appendix Table 11. Effect of a School Latrine by Latrine Type, by Student Age

	Children between the Ages of 10 to 16				Children between the Ages of 5 to 9			
		Changes by Student Sex				Changes by Student Sex		
	All	Females	Males	(2) – (3)	All	Females	Males	(6) – (7)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Built separate latrines for both boys and girls	0.090**	0.089**	0.047**	0.042**	0.122**	0.113**	0.095**	0.018**
	(0.009)	(0.011)	(0.011)	(0.014)	(0.005)	(0.005)	(0.005)	(0.005)
Only built a female-only latrine	0.085**	0.098**	0.008	0.090**	0.146**	0.149**	0.083**	0.066**
	(0.011)	(0.016)	(0.017)	(0.021)	(0.009)	(0.010)	(0.011)	(0.010)
Only built a unisex latrine	0.055**	0.023+	0.039**	-0.016	0.105**	0.089**	0.093**	-0.004
	(0.009)	(0.012)	(0.011)	(0.014)	(0.004)	(0.005)	(0.005)	(0.004)
p-value (Row 1 - Row 3)	0.000	0.000	0.455	0.000	0.000	0.000	0.640	0.000
p-value (Row 1 - Row 2)	0.641	0.549	0.012	0.016	0.009	0.000	0.252	0.000
p-value (Row 2 - Row 3)	0.005	0.000	0.050	0.000	0.000	0.000	0.351	0.000
R^2 Statistic	0.279	0.210			0.159	0.138		
Number of Observations	53,321	106,642			363,258	726,516		
Number of Schools	17,796	17,796			121,206	121,206		

Notes: Reported estimates are analogous to those reported in Table 6, but separated by student age group rather than by upper-primary schools and primary schools. The dependent variable is the natural logarithm of enrollment plus one. Columns 1 - 4 report results from the sample of children between the ages of 10 to 16, and Columns 5 - 8 report results from the sample of children between the ages of 10 to 16. Columns 1 and 5 report the average enrollment effect on all students, in which the dependent variable for each school is regressed on the presence of a female-only latrine and no unisex latrine, the presence of a unisex latrine and no female-only latrine, the presence of separate sex-specific latrines, year-by-district fixed effects, school fixed effects, and the baseline school characteristics interacted with year. Columns 2 and 3 represent a single regression, and columns 6 and 7 represent a single regression. They report the average effect on females and males, in which all right-hand-side variables are interacted with student sex. Columns 4 and 8 report the difference in the estimated effect for females and males. Below the estimates, p-values are reported for the indicated difference in estimated coefficients across rows. Robust standard errors clustered by school are reported in parentheses with ** denoting statistical significance at the 1 percent level, * at the 5 percent level, and + at the 10 percent level.

Appendix Table 12. Effect of a School Latrine by Latrine Type, Controlling for Changes in School Infrastructure

	Upper-Primary Schools (6th-8th)				Primary Schools (1st-5th)			
		Changes by Student Sex				Changes by Student Sex		
	All	Females	Males	(2) – (3)	All	Females	Males	(6) – (7)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Built separate latrines for both boys and girls	0.083**	0.094**	0.046**	0.048**	0.106**	0.104**	0.077**	0.027**
	(0.009)	(0.012)	(0.011)	(0.014)	(0.004)	(0.004)	(0.004)	(0.005)
Only built a female-only latrine	0.078**	0.106**	0.001	0.105**	0.126**	0.136**	0.058**	0.078**
	(0.012)	(0.016)	(0.017)	(0.022)	(0.007)	(0.008)	(0.009)	(0.011)
Only built a unisex latrine	0.044**	0.019	0.036**	-0.017	0.092**	0.082**	0.079**	0.003
	(0.009)	(0.013)	(0.011)	(0.014)	(0.004)	(0.004)	(0.004)	(0.004)
p-value (Row 1 - Row 3)	0.000	0.000	0.326	0.000	0.000	0.000	0.633	0.000
p-value (Row 1 - Row 2)	0.660	0.417	0.003	0.005	0.002	0.000	0.031	0.000
p-value (Row 2 - Row 3)	0.002	0.000	0.028	0.000	0.000	0.000	0.015	0.000
R^2 Statistic	0.331	0.248			0.164	0.135		
Number of Observations	53,388	106,776			363,618	727,236		
Number of Schools	17,796	17,796			121,206	121,206		

Notes: Reported estimates are analogous to those reported in Table 6, but control for time-varying measures of other school infrastructure. The dependent variable is the natural logarithm of enrollment plus one. Columns 1-4 represent the results from the upper-primary-school sample. Columns 5-8 represent the results from the primary-school sample. Columns 1 and 5 report the average enrollment effect on all students, in which the dependent variable for each school is regressed on the presence of a female-only latrine and no unisex latrine, the presence of a unisex latrine and no female-only latrine, the presence of separate sex-specific latrines, year-by-district fixed effects, school fixed effects, and the baseline school characteristics interacted with year, . Columns 2 and 3 represent a single regression, and columns 6 and 7 represent a single regression. They report the average effect on females and males, in which all right-hand-side variables are interacted with student sex. Columns 4 and 8 report the difference in the estimated effect for females and males. Below the estimates, p-values are reported for the indicated difference in estimated coefficients across rows. Robust standard errors clustered by school are reported in parentheses with ** denoting statistical significance at the 1 percent level, * at the 5 percent level, and + at the 10 percent level.

Appendix Table 13. Interaction Effect between Latrines and the Initial Share of Female Teachers

	Upper-Primary Schools (6th-8th)			Primary Schools (1st-5th)		
	All	Females	Males	All	Females	Males
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Dependent Variable: Log (Enrollment + 1)						
Built any Latrine * Initial Share of Female Teachers	-0.087	0.036	-0.233+	0.004	0.046	-0.039
	(0.066)	(0.107)	(0.134)	(0.029)	(0.045)	(0.051)
Built any Latrine	0.120**	0.010	0.134*	0.077**	0.069**	0.025
	(0.037)	(0.069)	(0.056)	(0.015)	(0.020)	(0.021)
R^2 Statistic	0.371	0.255		0.122	0.088	
Number of Observations	1,270	2,540		6,087	12,174	
Number of Schools	1,270	1,270		6,087	6,087	
Panel B. Dependent Variable: Enrollment Levels						
Built any Latrine * Initial Share of Female Teachers	-3.890	0.405	-5.515+	-0.514	2.118	-3.356+
	(5.023)	(3.630)	(3.267)	(3.153)	(2.282)	(1.828)
Built any Latrine	6.416*	-0.165	6.456**	6.685**	4.051**	2.279*
	(2.892)	(1.551)	(2.405)	(1.536)	(0.883)	(1.015)
R^2 Statistic	0.170	0.168		0.105	0.095	
Number of Observations	1,270	2,540		6,087	12,174	
Number of Schools	1,270	1,270		6,087	6,087	

Notes: Columns 1 and 4 report the average enrollment effect on all upper-primary-school and primary-school students respectively, in which the dependent variable for each school is regressed on presence of a latrine, the presence of a latrine interacted with the initial share of female teachers in 2002, year-by-district fixed effects, school fixed effects, and a vector of controls of baseline school characteristics interacted with academic year (including initial enrollment, presence of electricity, a school library, water by source, ramps, regular medical checkups, and a playground in AY 2002-03). Columns 2&3 and 5&6 report the average effect on females and males from upper-primary school and -primary school respectively, estimated from a single regression. In these regressions, all right-hand-side variables are interacted with student sex.

The dependent variable is the natural logarithm of enrollment plus one. Robust standard errors clustered by school are reported in parentheses with ** denoting statistical significance at the 1 percent level, * at the 5 percent level, and + at the 10 percent level.

Appendix Table 14. Re-weighting Sample Districts based on District Income Distribution

	Main Specification No weight	Imputing High Income Quintile	Imputing Low Income Quintile
	(1)	(2)	(3)
Panel A: Upper-Primary Schools			
Built Latrine	0.079**	0.086**	0.073**
	(0.008)	(0.010)	(0.010)
R^2 Statistic	0.326	0.326	0.309
Number of Observations	53,388	53,388	53,388
Number of Schools	17,796	17,796	17,796
Panel B: Primary Schools			
Built Latrine	0.121**	0.146**	0.133**
	(0.003)	(0.004)	(0.004)
R^2 Statistic	0.154	0.164	0.140
Number of Observations	363,618	363,618	363,618
Number of Schools	121,206	121,206	121,206

Notes: This table reports estimated impacts of latrines, as in Table 3, but re-weighting sample districts to reflect the national distribution of district per capita income. The dependent variable is the natural logarithm of enrollment plus one. Column 1 reports the main results using no weight. In Columns 2 and 3, I report estimates from imputing income information for districts with missing income information. Column 2 assumes that districts with missing income information are from the highest income quintile. Column 3 assumes that districts with missing income information are from the lowest income quintile. Robust standard errors clustered by school are reported in parentheses with ** denoting statistical significance at the 1 percent level, * at the 5 percent level, and + at the 10 percent level.