The Role of Basic Needs in Decision-Making: Sanitation and Education

Anjali Adukia
University of Chicago

Gender Inequality in Education in Developing Countries

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The "Menstruation Hypothesis": menstruation is an obstacle to schooling, contributing to high drop-out of pubescent-age girls

- Motivates efforts to provide school sanitation, which could improve girls' health, privacy and safety at school

Research Questions

Are educational decisions influenced by improving the health, privacy, and safety of the school environment?

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- Impacts on achievement
- Persistence of effects

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Are estimates consistent with the "Menstruation Hypothesis?"

- Differential impacts by student sex and age
- Exploration of potential mechanisms

Estimating Impacts of School Sanitation on Education

In India, many resources have been devoted to a national school-latrine-construction initiative in an effort to improve education outcomes

- School-level variation in latrine construction
- Annual census of Indian schools (DISE)

Differences-in-differences empirical methodology

- Compare schools that receive latrines to similar schools
- Verify robustness to controls, matching, alternative comparison groups, etc.

Exploring Possible Mechanisms

Effect on female teachers

- Female teachers may be less absent from school
- Female teachers may be more likely to work at schools with sanitation facilities (Chaudhury *et al.* 2005; Moojiman *et al.* 2005)

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Differential impacts by latrine type (sex-specific vs. unisex)

- Helps illustrate potential mechanisms like privacy and health
- Important in deciding where to direct scarce resources

Extending external validity

Using variation across states and districts

- Gender parity
- Income: sample variation comparable to countries between 5th and 25th percentiles of world income distribution (Rwanda, Nepal vs. Georgia, Ukraine)

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Limited systematic data

- Direct link between menstruation and pubescent-age female drop-out may be overstated (*e.g.*, Oster & Thornton 2011)
- Broader relationship between school sanitation and education
  - Pubescent-age girls face everyday concerns for health, privacy, and safety
  - School sanitation may also impact pubescent-age boys and younger children

Preview of Results

School sanitation substantially impacts educational outcomes of girls and boys, both younger and older children

- Increased school enrollment, lower drop-out
- Higher number of students passing state board exams
- Persistent effects over time
- Similar impacts across states and districts

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Privacy and safety matter for pubescent-age girls

- No benefit from unisex latrines
- Substantial benefits from separate-sex specific latrines
- Potential benefits from increased share of female teachers

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- Potential benefits from increased share of female teachers

But, broader view needed of factors influencing education decisions

- Substantial impacts on younger children from unisex latrines
- Important for directing scarce resources
- Illustrates varying importance of health, privacy, and safety

Outline

- Background on Indian School Sanitation Initiative
- Data from Census of Indian Schools
- Methodology: Differences-in-Differences
- Main Results
- Exploring Mechanisms
- Summary and Implications

School Sanitation and Hygiene Education Programme (SSHE)

Goal of eradicating open defecation

- Started in 1999 by the Government of India to encourage schools to provide sanitation facilities
- Bolstered by Millennium Development Goals (MDGs)
  - MDG Goals 2 & 3: increase school participation and promote gender equality
  - MDG Goals 6 & 7: combat disease and encourage environmental sustainability

Following low take-up, the government began to increase financial support in 2003

- Large increase in school-latrine construction followed

Large increase in school latrines

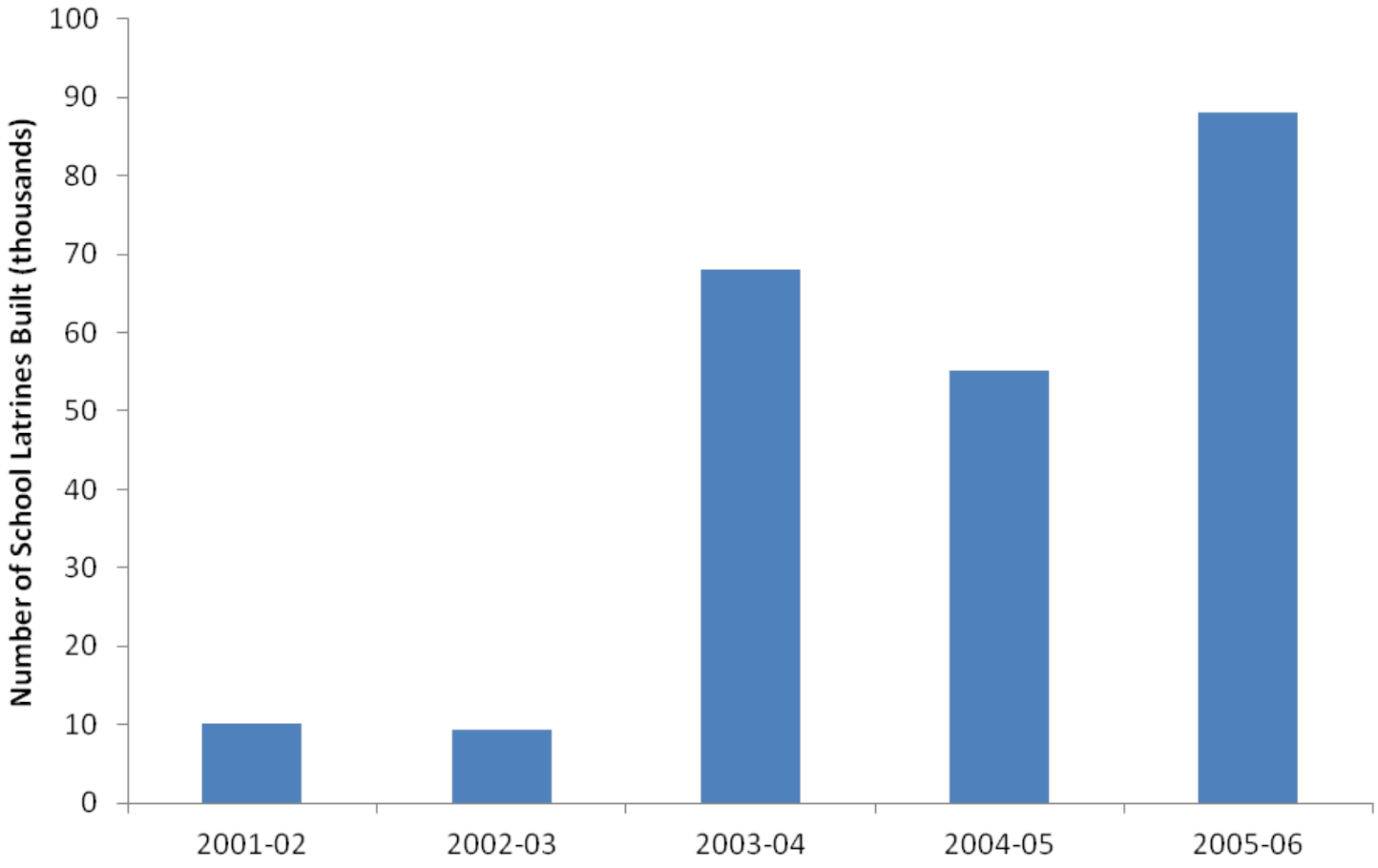

Figure: Number of Indian School Latrines Built Over Time

Source: Ministry of Drinking Water and Sanitation, NIC-MDWS Informatics System Cell

SSHE Implementation

Managed by Ministry of Drinking Water and Sanitation, not education officials

- Roll-out varied by district
- No explicit tradeoff in receiving a latrine for other inputs
- Not likely to have information on initial school characteristics

Latrine construction was main component of SSHE

- Other components: hygiene education and other small-scale investments (*e.g.* bucket for water)

SSHE programs initially in 7 countries (Snel 2003)

- Burkina Faso, Colombia, India, Nepal, Nicaragua, Vietnam, and Zambia

Potential Mechanisms

Girls may miss or leave school

- Latrines can provide privacy for girls, make school a safer place, and encourage parents to enroll their daughters
- (Fentiman *et al.* 1999; Burgers 2000; Human Rights Watch 2001; Leach *et al.* 2003; UNICEF 2005; WaterAid Ethiopia 2005; Kirk & Sommer 2006; etc.)

School Sanitation Options

School Sanitation Options

Open Space

School Sanitation Options

Open Space

Unisex Latrine

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Open Space

Unisex Latrine

Separate Latrine

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Boys may be concerned about safety and privacy

- Children most likely to be victims of bullying (Njuguna *et al.* 2009), especially younger boys (Boulton & Underwood 1992; Whitney & Smith 1993)

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Poor sanitation can reduce education through health impacts

- (Hellstrom *et al.* 1991; Taylor 2000; Crompton & Nesheim 2002; Vernon *et al.* 2003; Emerson *et al.* 2004; Miguel & Kremer 2004; WHO 2004)

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Poor sanitation can reduce education through health impacts

- (Hellstrom *et al.* 1991; Taylor 2000; Crompton & Nesheim 2002; Vernon *et al.* 2003; Emerson *et al.* 2004; Miguel & Kremer 2004; WHO 2004)

Female teachers may be less likely to attend (Burrows *et al.* 2004; Chaudhury *et al.* 2005; WaterAid Ethiopia 2005)

- The presence of female teachers may increase girls' enrollment (Herz *et al.* 1991; Rugh 2000; World Bank 2001)

Data: Census of Indian Schools

Annual census of Indian primary and upper-primary schools registered with the government

- District Information System for Education (DISE)

Main Variables Collected in DISE:

- School-level outcome by student grade and sex
  - Enrollment, measured 3-4 months into the academic year
  - Achievement, measured as number of students who appeared for, passed, and scored high marks on state board exam
- Presence of latrines (by type: sex-specific or unisex latrine)
- School-level characteristics (infrastructure, etc.)
- Teacher information (number of teachers, by sex)

Data Construction

DISE data publicly-available for years after 2005

- Initiated as a pilot in 1995
- Systematic data-collection established in 2001

Fluctuations in the early-year DISE data

- Constructed large, continuous panel for 2002, 2003, 2005
- 140,000 schools in sample
- Most of the data from 2004 lost due to server error

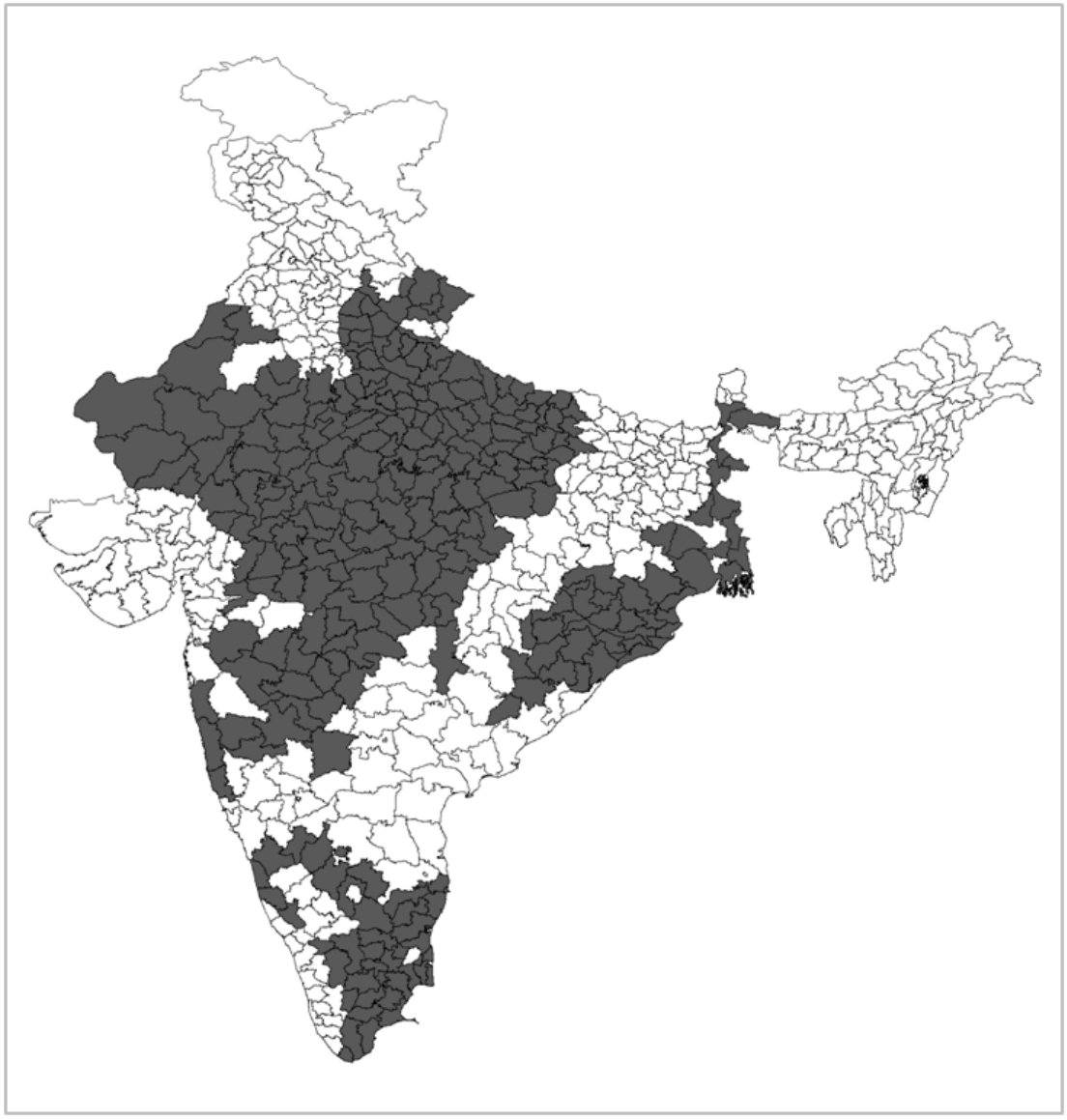
DISE reflects careful multi-state data-collection process

- Independent post-enumeration surveys conducted annually

Other sources of data

- Census of India (2001), Planning Commission (2005)

Indian Districts in Sample



Research Design: Differences-in-Differences

Treatment schools construct a latrine for AY 2003-04

Control schools do not have a latrine in any year

Basic differences-in-differences research design:

- Comparing post-treatment outcomes of the treatment group to pre-treatment outcomes of the treatment group, adjusting for changes in the control group that may have taken place in the treatment group in the absence of latrine construction

Basic identification assumption:

- Treatment schools and control schools would have changed similarly, on average, if not for the construction of latrines in treatment schools

Average Baseline Characteristics

	Upper-Primary Schools (6th - 8th)		Primary Schools (1st - 5th)	
	Treatment (1)	Comparison (2)	Treatment (3)	Comparison (4)
# of Schools	7,625	10,171	32,820	88,386
Total Enrollment	119.74	88.63	143.70	100.59
Girls' Enrollment	51.88	35.59	69.47	48.17
Boys' Enrollment	67.86	53.04	74.23	52.42
Electricity	0.352	0.196	0.163	0.076
Tap Water	0.235	0.109	0.150	0.082
Blackboard	0.956	0.953	0.963	0.946
Library	0.395	0.446	0.517	0.487
Computer	0.065	0.075	0.036	0.040
Medical Checkup	0.645	0.610	0.645	0.616

Notes: Comparison group includes schools that never have a latrine.

Empirical Strategy

Initial regression:

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

- Outcome Y : Log(Enrollment + 1), Level enrollment, Fraction drop-out, Exam outcome
- School s, District d, Year t
- Presence of a latrine L_{st}
- Control for baseline school characteristics, interacted with year

Identification assumption: schools receiving a latrine would have changed similarly to schools not receiving a latrine, within the same district and with similar initial characteristics

β reports the average effect of a school having a latrine on outcomes across all student sexes and grades

Empirical Strategy: by Student Sex

Student sex-specific regression equation:

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

- School s, Student sex g, District d, Year t

Identification assumption: for each student sex, schools would have changed similarly within districts and within similar initial characteristics

Compare effect on girls and boys

- β_f and β_m report the average effect of a school having a latrine on outcomes for female and male students.
- Can be compared to test whether effect is higher among girls

Estimation Notes

Regression details

- Balanced panel of schools
- Cluster standard errors at school level
- Two samples: primary- and upper-primary-school students

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Robustness checks

- Matching on initial school characteristics
- Sample-selection sensitivity: Alternative comparison groups
- Control for changes in school infrastructure after 2002
- Restrict sample to villages with only one school
- Functional form of outcome variable ($\log(x + 1)$, log, levels)
  - Coeducational schools
- Control for linear time trend (rather than flexible)
- Cluster standard errors at the district level
- Quantify potential mean-reversion bias

Increase in Total Enrollment

	Upper-Primary (6^{th} - 8^{th})
	(1)
Panel A: Log(Enrollment + 1)	
Built a Latrine	0.079**
	(0.008)
R^2 statistic	0.326
Number of observations	53,388
Number of schools	17,796

Notes: Regression controls for year-district fixed effects, school fixed effects, and initial school characteristics interacted with year. Robust standard errors clustered at the school level are reported in parentheses with "**" denoting statistical significance at the 1% level.

Increase in Total Enrollment

	Upper-Primary (6^{th} - 8^{th}) (1)	Primary (1^{st} - 5^{th}) (2)
Panel A: Log(Enrollment + 1)		
Built a Latrine	0.079**	0.121**
	(0.008)	(0.003)
R^2 statistic	0.326	0.154
Number of observations	53,388	363,618
Number of schools	17,796	121,206

Notes: Regression controls for year-district fixed effects, school fixed effects, and initial school characteristics interacted with year. Robust standard errors clustered at the school level are reported in parentheses with "**" denoting statistical significance at the 1% level.

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Panel B: Enrollment in levels		
Built a Latrine	5.252**	11.809**
	(0.846)	(0.476)
R^2 statistic	0.147	0.149
Number of observations	53,388	363,618
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Enrollment Effect by Student Sex

Dependent Variable: Log(Enrollment + 1)	Upper-Primary (6^{th} – 8^{th}) (1)
Built a Latrine * Girls	0.071**
	(0.011)
Built a Latrine * Boys	0.047**
	(0.010)
R^2 statistic	0.246
Number of observations	106,776
Number of schools	17,796

Notes: Outcome is the logarithm of enrollment plus one. Regressions control for year-district-student sex fixed effects, school-student sex fixed effects, and initial school characteristics interacted with year and student sex. Robust standard errors clustered at the school level are reported in parentheses with "**" denoting statistical significance at the 1% level.

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Built a Latrine * Girls	0.071**	0.111**
	(0.011)	(0.004)
Built a Latrine * Boys	0.047**	0.097**
	(0.010)	(0.004)
R^2 statistic	0.246	0.130
Number of observations	106,776	727,236
Number of schools	17,796	121,206

Notes: Outcome is the logarithm of enrollment plus one. Regressions control for year-district-student sex fixed effects, school-student sex fixed effects, and initial school characteristics interacted with year and student sex. Robust standard errors clustered at the school level are reported in parentheses with "**" denoting statistical significance at the 1% level.

Outcome: Drop-Out

Cohort-based measure of drop-out:
$(Enrollment_{gs(c-1)(t-1)} - Enrollment_{gsct})/Enrollment_{gs(c-1)(t-1)}$

Negative coefficient indicates a decrease in the fraction of students who drop out.

Measure of net drop-out

- This could reflect new students in an area in addition to previously-enrolled students who drop out from school.

School Latrines Decrease Drop-Out

	Upper-Primary (6^{th} – 8^{th})		Primary (1^{st} – 5^{th})	
	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: Regressions in columns 1 and 3 control for year-district fixed effects, school fixed effects, and initial school characteristics interacted with year. Regressions in columns 2 and 4 control for year-district-student sex fixed effects, school-student sex fixed effects, and initial school characteristics interacted with year and student sex. Robust standard errors clustered at the school level are reported in parentheses with "**" denoting statistical significance at the 1% level.

Enrollment Effect Persists Over Time

	Upper-Primary (6^{th} – 8^{th}) (1)	Primary (1^{st} – 5^{th}) (2)
Panel A: Log(Enrollment + 1)		
Built a Latrine * 1 year after	0.073**	0.119**
	(0.008)	(0.003)
Built a Latrine * 3 years after	0.086**	0.122**
	(0.010)	(0.004)
R^2 statistic	0.326	0.154
Panel B: Enrollment in levels		
Built a Latrine * 1 year after	4.385**	11.723**
	(0.828)	(0.501)
Built a Latrine * 3 years after	6.119**	11.895**
	(1.090)	(0.579)
R^2 statistic	0.147	0.149
Number of observations	53,388	363,618
Number of schools	17,796	121,206

Notes: Regression controls for year-district fixed effects, school fixed effects, and initial school characteristics interacted with year. Robust standard errors clustered at the school level are reported in parentheses with "**" denoting statistical significance at the 1% level.

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Outcome: Academic Measures

Measure academic achievement in terms of outcomes on a statewide Middle-School board exam (8th grade):

- How many students appeared for the exam?
- How many students passed the exam?
- How many students scored high marks on the exam?

The first two outcomes as measures of effective enrollment, proxies for attendance

- Exam administered 9 months into school year

Mean Exam Outcomes at Baseline

	AY 2002-03		
	8th Grade	Girls	Boys
Enrolled	51.8	22.2	29.7
	(66.6)	(34.3)	(37.2)
Appeared	49.8	21.2	28.6
	(61.7)	(28.6)	(37.1)
Passed	44.6	19.2	25.4
	(52.0)	(23.5)	(30.8)
Scored high marks	15.6	6.9	8.7
	(27.3)	(12.1)	(16.3)

Effect on Exam Outcomes

	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	0.056	0.060
Number of schools	3,751	3,751	3,751	3,751	3,751	3,751

Notes: 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 interacted with whether the year was after AY 2002-03, an academic year-district fixed effect, a school fixed effect, 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 sex. 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 Uttar Pradesh Middle School board examination. 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 sex-year. Robust standard errors clustered by school are reported in parentheses with ** denoting statistical significance at the 1 percent level. For comparison, the introduction of a latrine increases UP 8th-grade enrollment by 1.476 students (SE: 0.755).

Estimates reflect net impact of latrines on achievement

Estimates do not indicate what would have happened to achievement for students who would have gone to school in absence of the intervention

Effect may be due to either

- Existing students performing better and/or new students performing well due to healthier, better school environment
- Existing students performing worse due to crowding, shortages in materials, diffused teacher attention

Alternative Comparison Groups

	Main Control Group: No latrine from 02-03 through 05-06 (1)	Alt. Comparison 1: Built latrine between 03-04 & 05-06 (2)	Alt. Comparison 2: No latrine built between 02-03 & 05-06 (3)
Panel A: Upper-Primary Schools (6^{th} – 8^{th})			
Built a Latrine	0.073**	0.045**	0.029**
	(0.008)	(0.007)	(0.005)
R^2 statistic	0.343	0.335	0.236
Number of schools	17,796	17,169	59,075
Panel B: Primary Schools (1^{st} – 5^{th})			
Built a Latrine	0.119**	0.054**	0.093**
	(0.003)	(0.003)	(0.002)
R^2 statistic	0.153	0.165	0.109
Number of schools	121,206	88,740	238,341

Notes: This table reports the results using alternative comparison groups. The comparison group in column 2 includes schools that did not have a latrine in AYs 2002-04 but that did have a latrine by AY 2005-06. In column 3, 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 interacted with whether the time period is after the policy push (after AY 2002-03), an academic year-district fixed effect, a school fixed effect, and a vector of controls of baseline school characteristics interacted with academic year. The analysis is drawn from AY 2002-03 and AY 2003-04. 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.

Robustness Checks

	Matching, Nearest Neighbor (1)	Matching, Coarsened Exact Match (2)	Controls for Changes in Initial Chars (3)	Villages with Only One School (4)	Coed Schools: Log(Enroll) (5)
Panel A: Upper-Primary Schools (6^{th} – 8^{th})					
Built a Latrine	0.069**	0.067**	0.077**	0.076**	0.068**
	(0.011)	(0.008)	(0.008)	(0.008)	(0.008)
R^2 statistic	0.300	0.310	0.356	0.338	0.317
# of schools	11,048	17,136	17,796	16,556	16,336
Panel B: Primary Schools (1^{st} – 5^{th})					
Built a Latrine	0.108**	0.116**	0.107**	0.124**	0.122**
	(0.006)	(0.004)	(0.003)	(0.004)	(0.003)
R^2 statistic	0.171	0.155	0.196	0.171	0.155
# of schools	43,013	120,595	121,206	92,196	117,087

Notes: Robust standard errors clustered at the school level are reported in parentheses with "**" denoting statistical significance at the 1% level.

Quantifying Potential Mean-Reversion Bias

Measurement error would typically increase standard errors, but potential concern about mean reversion in the data.

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Theory: A treatment and comparison school may have had the same initial *measured* number of students. However, the treatment school may have had a larger *actual* number of students, known by the decision-maker who targets larger schools.

- Thus, we might expect the treatment school to show a higher number of measured students in later years when the school gets a new draw from the measurement-error distribution.

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Practice: Officials unlikely to have had information on schools, so less likely that targeted decisions could have been made

- Many did not know number of schools in their districts

Quantifying Potential Mean-Reversion Bias

To quantify potential noise in the measurement:

- Test-taking data as independent measure of enrollment
- Estimate cross-sectional differences in 2002 for outcome:

$$\log(\#\text{ test-takers}) - \log(\#\text{ enrolled})$$

- Mean reversion would be reflected in a positive coefficient on the treatment variable in the year 2002
- Assumes the two measures are *i.i.d.*

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- Assumes the two measures are *i.i.d.*

Small and statistically-insignificant effect for

- All students (0.004, standard error of 0.004)
- Female students (0.002, standard error of 0.004)
- Male students (0.004, standard error of 0.004)

Estimates reject mean-reversion bias contributing more than a 1.2% increase in school enrollment

Exploring Possible Mechanisms

Latrine type:

- Does it matter if girls and boys share the same facilities?

Female teachers

- Share of female teachers?
- Increase in female-teacher attendance?

Geographic heterogeneity in districts

- Cultural norms (gender parity)
- Economic development (per-capita income)

Enrollment Outcomes by Latrine Type

Schools built three different latrine situations

- Sex-specific (separate latrines for boys and girls)
- Unisex (shared among boys and girls)
- Girls' only (no latrine for boys)

Number of Schools in Sample

	Primary Schools (1^{st} - 5^{th}) (1)	Upper-Primary Schools (6^{th} - 8^{th}) (2)
Built any latrine in 2003	32,820	7,625
- Only unisex latrines	*15,725*	*2,954*
- Only girls' latrines	*1,993*	*849*
- Separate latrines for girls and boys	*15,102*	*3,822*
No latrine in AY 2002-03 or AY 2003-04	88,386	10,171
Total number of schools in sample	121,206	17,796

Enrollment Outcomes by Latrine Type

Schools built three different latrine situations

- Sex-specific (separate latrines for boys and girls)
- Unisex (shared among boys and girls)
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There may be differential effects by latrine type

- If privacy concerns are most important, children may not benefit from unisex latrines
- If health concerns are most important, children may benefit from either type of latrine

Useful in understanding factors that influence education decision-making and in deciding where to direct limited resources

Enrollment Outcomes by Latrine Type

Regression Equation:

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

- Presence of a unisex latrine only L_{st}^U
- Presence of sex-specific, separate latrines L_{st}^S
- Presence of a girls' latrine only L_{st}^F
- Two estimated β parameters for each type of latrine to capture average effect on females and males

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Can compare parameters to test various hypotheses:

- Are girls more affected by sex-specific latrines than boys? H_0: $\beta_f^S = \beta_m^S$
- Are girls more affected by sex-specific latrines than by unisex latrines? H_0: $\beta_f^S = \beta_f^U$
- Is the impact of providing sex-specific latrines over unisex latrines greater for girls than for boys? H_0: $(\beta_f^S - \beta_f^U) = (\beta_m^S - \beta_m^U)$

Effect by Latrine Type

	Upper-Primary (6^{th} – 8^{th})	
Dependent Variable:	Girls	Boys
Log(Enrollment + 1)	(1)	(2)
Built separate, sex-specific latrines	0.099**	0.058**
	(0.012)	(0.012)
Built unisex latrines only	0.022+	0.044**
	(0.013)	(0.012)
Built girls' latrines only	0.111**	0.013
	(0.016)	(0.017)
R^2 statistic	0.247	
Number of observations	106,776	
Number of schools	17,796	

Notes: Regressions control for year-district-student sex fixed effects, school-student sex fixed effects, and initial school characteristics interacted with year and student sex. Columns 1 & 2 are one specification split into two columns to facilitate comparison. Robust standard errors clustered at the school level are reported in parentheses with "**" denoting statistical significance at the 1% level, "*" at the 5% level., "+" at the 10% level.

Effect by Latrine Type

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Dependent Variable:	Girls	Boys	Difference
Log(Enrollment + 1)	(1)	(2)	(3)
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Effect by Latrine Type

	Upper-Primary (6th – 8th)			Primary (1st – 5th)		
Dependent Variable:	Girls	Boys	Difference	Girls	Boys	Difference
Log(Enrollment + 1)	(1)	(2)	(3)	(4)	(5)	(6)
Built separate, sex-specific latrines	0.099**	0.058**	0.041**	0.121**	0.101**	0.020**
	(0.012)	(0.012)	(0.014)	(0.005)	(0.005)	(0.005)
Built unisex latrines only	0.022+	0.044**	-0.022	0.094**	0.095**	-0.001
	(0.013)	(0.012)	(0.014)	(0.004)	(0.004)	(0.004)
Built girls' latrines only	0.111**	0.013	0.098**	0.156**	0.085**	0.071**
	(0.016)	(0.017)	(0.022)	(0.008)	(0.009)	(0.011)
R^2 statistic	0.247			0.130		
Number of observations	106,776			727,236		
Number of schools	17,796			121,206		

Notes: Regressions control for year-district-student sex fixed effects, school-student sex fixed effects, and initial school characteristics interacted with year and student sex. Columns 1 & 2 and 4 & 5 are each one specification split into two columns to facilitate comparison. Columns 3 and 6 report the differences and related standard errors between girls and boys. Robust standard errors clustered at the school level are reported in parentheses with "**" denoting statistical significance at the 1% level, "*" at the 5% level., "+" at the 10% level.

Effect by Latrine Type

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Presence of Female Teachers

Teacher data available for two states

- Madhya Pradesh and Rajasthan (8,003 schools)

Does latrine construction increase the fraction of teachers at a school that are female? Are female teachers more likely to teach at a school with a latrine (or a female-only latrine)?

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- Schools that constructed a latrine had a 1.8% increase ($p<0.01$) in the proportion of female teachers, on average
- Smaller effect in schools that only built a unisex latrine (1.1%, $p<0.10$)
- Larger effect from building female-only latrines (4.4%, $p<0.01$) or separate latrines (2.3%, $p<0.01$)

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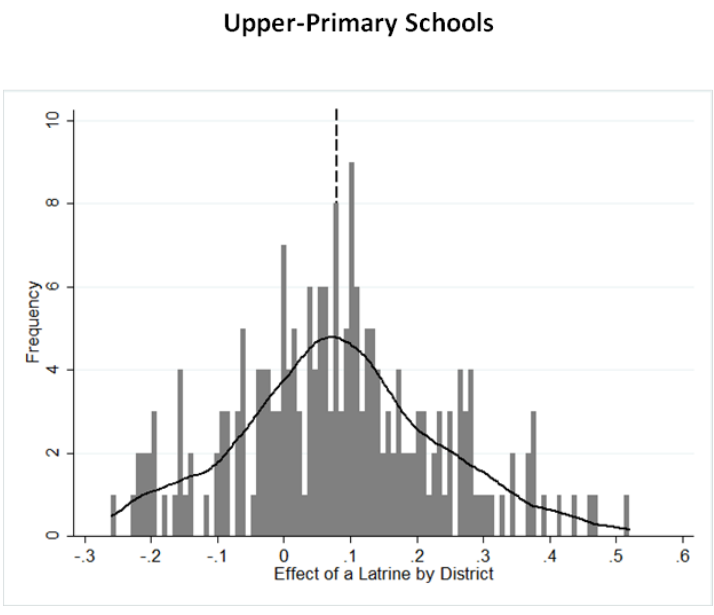
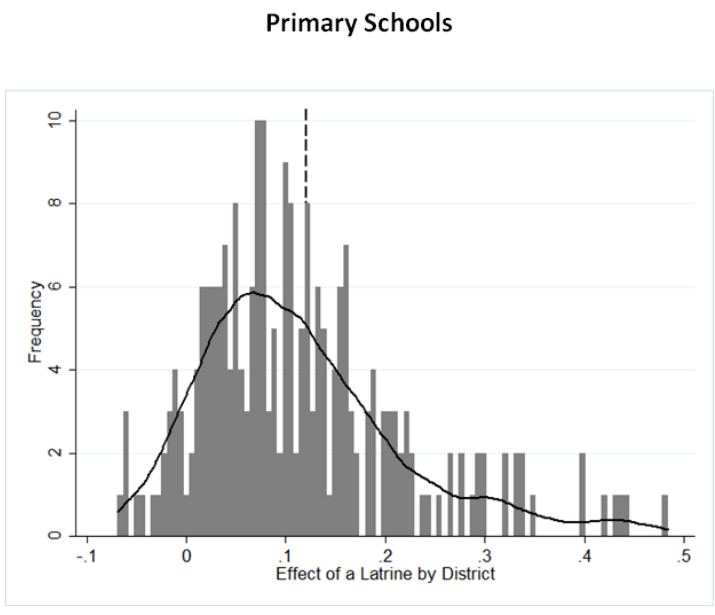
- Larger effect from building female-only latrines (4.4%, $p<0.01$) or separate latrines (2.3%, $p<0.01$)
- By contrast, latrine construction had no impact on the share of teachers from any particular caste or socioeconomic background
- No change in the average total number of teachers

Histogram of Effect Across Districts





Substantial variation around the average effect of a latrine

- Could reflect random noise or be systematically correlated with district characteristics

Gender Parity and Income across States

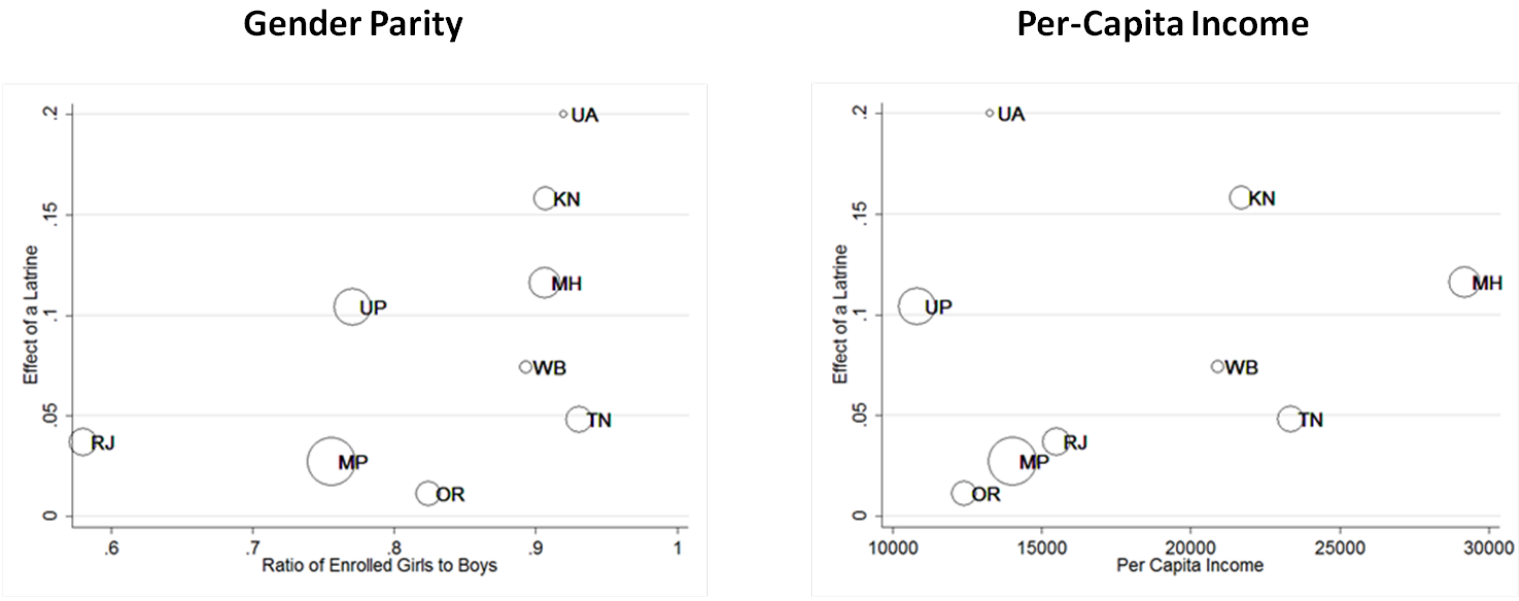


Figure: Estimated Effect of a Latrine by State Characteristics

Similar Effect of a Latrine across Districts

	Upper-Primary (6^{th} – 8^{th}) (1)	Primary (1^{st} – 5^{th}) (2)
Panel A: Gender parity		
Built a Latrine	0.078**	0.116**
	(0.011)	(0.014)
Built a Latrine * Gender Parity	0.015	0.020+
	(0.010)	(0.011)
R^2 statistic	0.326	0.154
Number of schools	17,796	121,206
Panel B: Income		
Built a Latrine	0.076**	0.156**
	(0.015)	(0.022)
Built a Latrine * Income	-0.010	0.014
	(0.014)	(0.014)
R^2 statistic	0.324	0.160
Number of schools	12,579	78,400

Notes: Robust standard errors clustered at the district level are reported in parentheses with "**" denoting statistical significance at the 1% level, "+" at the 10% level.

Cost-Effectiveness

Intervention (1)	Country of Study (2)	Cost per additional student (2008 USD) (3)	Source (4)
Deworming	Kenya	$4.36	Miguel & Kremer (2004)
School-latrine construction	India	$11.17	Adukia (2014)
Village-based schools	Afghanistan	$39.57	Burde & Linden (2011)
School meals	Kenya	$43.34	Vermeersch & Kremer (2005)
Teacher incentives	India	$67.64	Duflo, Hanna, & Ryan (2007)
"Girl-friendly" schools	Burkina Faso	$69.77	Kazianga *et al.* (2013)
School construction	Indonesia	$83.77	Duflo (2001)

Notes: Source of estimates: Kazianga *et al.* (2013). Column 3 reports the cost per additional student (in 2008 US dollars) due to the intervention listed in column 1.

Summary of Results

School sanitation substantially impacts educational outcomes of girls and boys, both younger and older children

- Increased school enrollment, lower drop-out
- Higher number of students passing state board exams
- Persistent effects over time
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But, broader view needed of factors influencing education decisions

- Substantial impacts on younger children from unisex latrines
- Important for directing scarce resources
- Illustrates varying importance of health, privacy, and safety