The Impact of Sex-Separate Toilets on School Participation of Pubescent-Age Girls in India

By

OH, Hyun Ji

THESIS

Submitted to

KDI School of Public Policy and Management

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ABSTRACT

The issue of sanitation is related to the academic achievement of students in developing countries. Above all, sex-separate sanitation facilities in schools play a crucial role when it comes to students' ability to focus on their studies, particularly for girls just at the beginning of puberty. This paper examines the association between girls' toilets and school participation by adolescent girls in India using a state-level panel data set. To control for potential omitted variables bias, I adopt state fixed effects among control variables. I have two major findings. First, schools with sex-separate toilets are associated with a higher level of girls' enrolment at the secondary and the higher secondary level. Second, schools with sex-separate toilets are also associated with a higher level of school attendance by girls at the secondary level.

Keywords: sanitation, education, gender parity, India, sex-separate toilets, puberty, development, school facilities

INTRODUCTION

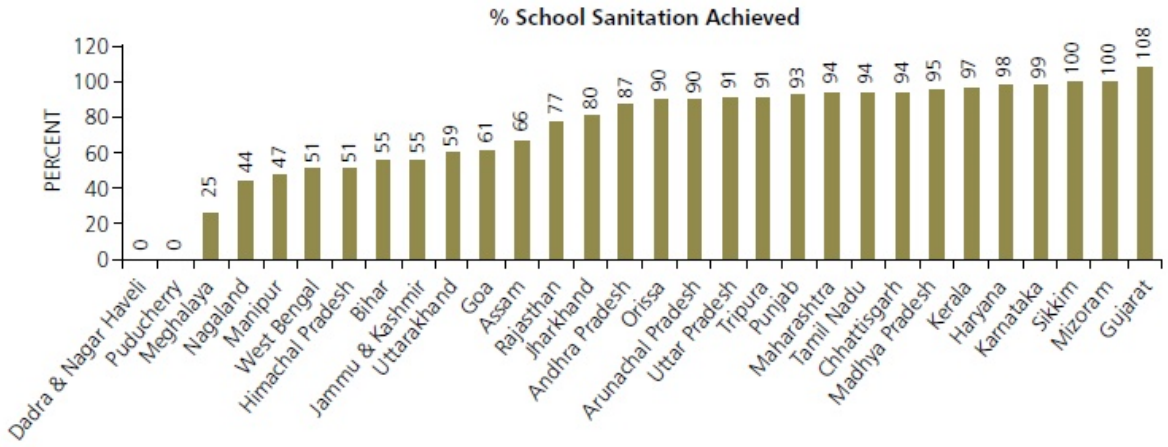
Despite the significant progress in the education sector since the promulgation of the Millennium Development Goals (MDGs) in 2000, gender parity in education remains a significant challenge around the world. On top of that, gender parity and education are still very pressing issues. It has been argued that adolescent girls in developing countries do not go to school even though they are full of enthusiasm for learning. Multiple reasons prevent them from going to school such as the lack of female teachers, poor infrastructure, the absence of curriculum that can attract girls' attention to the school, unsafe feeling, lack of sanitation facilities for girls in menstrual period, sexual harassment and so on (Kirk & Sommer, 2006). Among them, school infrastructures and facilities are the critical issue of concern because these are essentially germane to student's pleasant and safe school life and academic achievement. Generally, inadequate basic school facilities often hinder students' ability to continue studying especially in developing countries. Around half of the population - 2.5 billion people - in developing countries still lack decent sanitation facilities (FAO, 2012). Along with this matter, girls are deprived of the right to education.

Recently, education has become increasingly significant, especially given the rise in demand for high-skilled workers; an availability that is critical for the development of a country like India. A research by Péter (2017) shows that the Indian labor force will account for roughly 25% of the world's labor force by 2020. Accordingly, a huge reform of education policy has been implemented by the government of India; having spent approximately 6% of its GDP on education since the 1980s (Péter, 2017). Moreover, the government of India intended to invest more in ways to reduce the apparent gender inequality problem in its education sector. Since the government of India has tried to change people's behavior toward sanitation by launching

the program Total Sanitation Campaign (TSC) in 1999, the educational expenditure for every student at primary level increased $284 to $308 and $300 to $306 for students at the secondary level during 2003 to 2010 (Ray & Datta, 2017).

Figure 1

The percentage of school toilets constructed against the target of Total Sanitation Campaign (TSC)



Note. Source from the Department of Drinking Water Supply (http://dddws.nic.in), Government of India. (Water and Sanitation Program (WSP), 2010, p. 30)

Figure 1 shows an output: the percentage of school toilets built under the Total Sanitation Campaign (TSC) by the government of India. As a result, a significant increase in children's attendance at school is a recent trend in Indian society (International Institute for Population Sciences (IIPS) and ICF, 2017).

The government of India improved the quality of school facilities for the sake of adolescent girls' having better educational opportunities and a better school environment in the last few decades. However, social customs such as gender segregation, the stereotype of gender roles and the caste system deeply seated in Indian society continue to be a stumbling block. Still, about 30 percent of girls have never attended school, notwithstanding the compulsory primary education (International Institute for Population Sciences (IIPS) and ICF, 2017).

Additionally, the rate at which adolescent girls drop out of school is still high (Kirk & Sommer, 2006). In India, one of the top three main reasons for children not attending school is the lack of proper school facilities for girls (International Institute for Population Sciences (IIPS) and ICF, 2017). Some of the examples show that girls often miss exams during their monthly period, or feel humiliation when male students watch while they are urinating outside (Adukia, 2017). Even though the number of schools with a sex-separate toilet has increased by around fifty percent within ten years (2005 to 2013), there still have been serious problems with poor function of dilapidated sanitation facilities (UNICEF India). Still, seven percent (about a million students) of students lack access to sex-separate toilets in India. Due to the high dropout rate of adolescent girls, constructing more sex-separate toilets is essential in reducing the rate of dropout (Government of India, 2005).

Unlike in the past the government of India has focused on the improvement of elementary education and the policy reform on education has shifted to a higher level of schools within a decade (Péter, 2017). Previous studies have argued over the association of separate female toilets with gender parity indices of enrollment at the primary school level (Ray & Datta, 2017; Chatterjee, Li, & Robitaille, 2018). Yet there is lack of studies, particularly for female students at the secondary level. Some reviews point out that current studies have paid little attention to adolescent girls at the beginning of puberty, and it is still in an early stage (Kirk & Sommer, 2006; Lloyd & Young, 2009). Therefore, this paper examines the impact of sex-separate sanitation facilities on school participation of pubescent-age girls at the secondary level across the states and union territories in India. I begin by measuring the relationship between schools having girls' toilets and the rate of girls' enrolment and further analyze whether girls at secondary level rigorously participate in the classes of schools having girls' toilets. To estimate the school participation of girls, I use the ratio of the number of girls who enrolled secondary

and higher secondary level (grade 9~12) every new semester to the total number of female populations age between 14 and 17; the other indicator for attendance is the ratio of the number of girls who attend secondary level (grade 9~10) for the whole academic year, excluding repeaters, promotees and dropped-out students, to the total number of female populations age between 14 and 15.

This paper is organized as follows: in the following section, there will be some evaluation of two studies on the significance of sanitation facilities and education with recent contributions. The research questions of this paper will be stated in the following chapter. In the Methods section, this paper will turn to present the definition of variables with econometric specifications. The next section will analyze the findings from statistical estimations. The last section will conclude with some findings and identify the limitations of this study. It will also include some suggestions of alternatives that researchers and policy makers should consider for future studies.

THEORY AND RESEARCH QUESTIONS

In this section, I briefly map out the process of intervention on sanitation by the government of India for preliminary information and review research studies about sanitation and girls' education. In the last part of this section, I also introduce my research questions by explaining the importance of this research being conducted.

Since the issue of sanitation has been a matter of concern in India since the 1980s, the government of India introduced Total Sanitation Campaign (TSC) to increase sanitation coverage across the country, particularly in the rural areas since 1999 (Irigoyen, 2017). This program's objective was to intensify hygiene education and improve sanitation facilities in villages and schools. According to the online monitoring of TSC, by 2001, toilet coverage had increased by more than 40 percent in India (Water and Sanitation Program, 2010). Though this program made some progress, there were some limitations in terms of unequal coverage of toilets. After launching the program School Sanitation and Hygiene Education (SSHE) as part of TSC program, the government of India started to fund school latrine construction in 2003, and subsequently initiated the Swachh Bharat (Clean India) Mission for achieving the goal Open Defecation Free and universal sanitation coverage by Prime Minister Narendra Modi (SanitationDepartment, 2014).

In defining the sex-separate toilet first, it is helpful to note a notion made by Definitions (n.d.). Sex segregation is defined as the physical, legal, and cultural separation of people according to their biological sex. This is distinct from gender segregation, which is the separation of people according to social constructions of what it means to be male versus female (Anonymous, n.d.). The description of sex-separate toilet is that people be allowed to

use only the public restroom that corresponds to the sex on their birth certificates or based on a biological sex. (Kogan, 2016). Also, the definition of puberty is the time in life when a boy or girl becomes sexually mature. It is a process that usually happens between ages 10 and 14 for girls and ages 12 and 16 for boys. It causes physical changes and affects boys and girls differently (National Institute of Child Health and Human Development, 2019). Thus, this paper follows the age range of puberty from 10 to 16.

Some of the recent studies maintain that several factors impede pubescent girls from equally accessing education in developing countries (UNICEF, 2001; World Bank, 2018). On one side are those who have suggested that the main factors which keep pubescent girls from going to school are extraneous to the problem of school itself such as unaffordable tuition fees for most of the poor, lack of interest in school, and pregnancy and childrearing due to early marriages (World Bank, 2018). Likewise, the role of a wife from early marriage forms a part of the reasons for pubescent girls dropping out of school (UNICEF, 2001). From this stance, the financial difficulty of households and the prevalence of early marriage could be the main factors that prevent adolescent girls from regularly attending school. On the other hand, some researchers argue that the low quality of sanitation and hygiene education provided by schools can negatively influence the learning capacity of children, especially girls (Eshun, Acquah, & Acquaye, 2014; Egbinola & Amanambu, 2015). From the case study of Nigeria, less than a half percent of schools provide hygiene education and inculcate students with daily hygiene practices in their curriculum (Egbinola & Amanambu, 2015). Egbinola and Amanambu (2015) adopt a different approach to both unawareness of public sanitation and poor hygiene. They also argue that it can cause preventable diseases which can eventually negatively affect the learning ability of the students since they are not healthy enough to learn rigorously. In sum, these researchers adopt a similar understanding of the factors which affect the school

participation of girls. However, they disregard the fact that the poor sanitation facilities in school may hinder pubescent girls from attending school.

Admittedly, pubescent girls face challenges in their education for many reasons as other research studies asserted above. However, on top of that, it is worthwhile to pay attention to the emphasis on the necessity of sanitation facilities in the schools, especially the sex-separate toilets. In recent studies concerning the importance of school facilities, scholars have worried about whether the absence of sex-separate toilets can negatively affect the educational achievement of pubescent girls in developing countries (Adukia, 2017). A common finding from other studies is that a lack of school facilities is one of the serious causes that makes it difficult for adolescent girls to keep attending school (Lidonde, 2004; Kirk & Sommer, 2006; Ray & Datta, 2017). In other words, inaccessibility to sanitation facilities negatively impact adolescent girls school attendance and academic performance. To mention some of the proponents' argument, the absence of sex-separate sanitation facilities primarily leads adolescent girls to drop out of school (Lidonde, 2004). In the words of one of this view's leading proponents, where the lack of adequate sanitary protection makes movement away from home physically impossible, the onset of menses will inevitably have an impact on girls access to education (Kirk & Sommer, 2006, p. 4). The presence of sex-separate sanitation facility in school seems to be indispensable for the participation of adolescent girls.

Ray and Datta (2017) rightly draw attention to the association between female toilets and girls' primary school attendance. Gender inequality issue is further complicated by the deeply rooted caste system in Indian society. The research by Ray and Datta (2017) presents that the government of India has extended its intervention to reduce open defecation and increase toilet coverage in all levels of government schools and preschools across the nation since 1980. This campaign, now called Swachh Bharat Mission, was successful to some extent, but could not

totally change Indians sanitation behavior. Ray and Datta (2017) contributes to analyzing whether sex-separate toilets improve girls school attendance for all castes combined and for scheduled-caste students. They conclude that sex-separate toilets are positively associated with school participation of pubescent girls but find no significant evidence with scheduled-caste students. I take a similar position on this issue. The examination from Ray and Datta (2017) provides a useful framework for thinking about discrimination against the caste system and its impact on education in Indian society. They reveal that any of improved school infrastructures are worth nothing under the discrimination against scheduled-caste students. Nevertheless, Ray and Datta (2017) fail to focus on the impact of girls' toilets particularly on female students at the secondary level.

Another research paper written by Adukia (2017) estimates the association between school sanitation facilities and educational attainment of pubescent female students. It measures the impact of sex-separate school toilets on enrolment of pubescent-age girls in India. Explaining the intervention for constructing school latrines by the government of India in 2003, Adukia (2017) analyzes by comparing between two groups: latrine received treatment schools and those of controlled without latrine and estimates potential impact of school latrine before and after the construction. On top of that, a convincing approach she takes is to analyze the impact of different types of latrine on pubescent-age students. She reveals that sex-specific latrines greatly benefit pubescent girls than unisex latrines do. In contrast, unisex latrines affect the school attendance of younger children and pubescent-age boys where school latrines are scarce. She also applies her estimation for the impact of school latrines on others: child learning and change in the share of teachers by gender. Adukia (2017) highlights the significance of sex-separate latrines; however, she did not fully consider some societal problems deeply rooted in Indian society in her empirical models. Discrimination, particularly against women, should

be considered in further studies to examine how seriously it influences students' educational achievement and economic outcomes in the future. Moreover, there has been little attempt to evaluate the impact of sex-separate latrines on the students in upper grades.

Despite the fact that all these works add significantly to the body of literature in the development sector and represent some of the most comprehensive examinations of gender equality in education as well, prior studies have paid little attention to female students at the beginning of puberty and it is still in early stage. This makes the certainty of characterizing decision conditions highly ambiguous. Hence, in order to assess the impacts of the presence of sanitation facilities at schools on the participation of adolescent girls attending secondary and higher secondary schools, this thesis uses an explanatory research approach. This thesis will attempt to answer the following research questions: 1) How do sex-separate toilets affect school participation of pubescent aged girls at secondary and higher secondary level? 2) What other factors have a strong influence on adolescent girls' going to school?

The purpose of this research is to draw further attention to the significance of school sanitation facilities in ensuring the right to education for pubescent-age girls. This research will be of interest to policy makers not only in the government of India but those in other developing countries, including many NGO workers and stakeholders in the field of development and the education sector. Moreover, this study will contribute to our understanding of gender parity in educational opportunity and social prejudices related to gender bias with which girls face.

METHODS

In this section, I provide the source of data and explain the variables. I also introduce this paper's empirical methodology in the last subsection.

a. Source of data

The major source of dataset is from the District Information System for Education (DISE) which provides educational outcomes by National Institute of Educational Planning and Administration (NIEPA), and the Department of School Education and Literacy and Ministry of Human Resource Development (MHRD). Statistical publications include some basic national census, information of school infrastructures, enrolment and educational achievement of students and status of teachers by academic years and gender. These data are available at national, state and district level. The source for the projected population in the age group of 14 to 17 (corresponding to secondary and higher secondary standardized level) is the Ministry of Human Resource Development (MHRD) of India.

The state-wise per capita income data are available on the Indian government website of Economic and Statistical Organization of Punjab (ESOPB). The source of data for female literacy by state is the Office of the Registrar General and Census Commissioner, Ministry of Home Affairs, Government of India.

b. System of education in India

The official system of education in India includes pre-primary to higher secondary levels. Unlike the types of the school that are generally separated into standardized levels in many countries, different standardized levels occur simultaneously within a school in India (British Council, 2019). For example, twelve-year old students can enter either a school with an upper primary and secondary level curriculum or a school with only an upper primary level curriculum. This makes it impossible to divide each school precisely into standardized levels, whereas the number of students in each grade can be. Figure 2 shows the structure of educational standardized level in India, according to the British Council (2019).

Figure 2

Current and proposed structure of education in India

Age (typical)	Current (2019)	Grade	Proposed in revised National Education Policy*
17–18	Higher secondary	12	High stage
16–17		11	
15–16	Secondary	10	
14–15		9	
13–14	Upper primary	8	Middle stage
12–13		7	
11–12		6	
10–11	Primary	5	Preparatory stage
9–10		4	
8–9		3	
7–8		2	Foundational stage
6–7		1	
5–6	Pre-primary		
4–5			
3–4			

*Based on Draft NEP.

c. Definitions of variables

Schools having girls' toilets and other infrastructure – School infrastructure plays a significant role in school participation for students. Schools with buildings, having sex-separate toilets, drinking water facility and electricity are selected as important infrastructural indicators for estimation. School data with having facilities are classified into different school types and academic years in DISE. For my measurement, all observations in raw data are calculated into ratio. For example, the total number of schools having girls' toilets is divided by the total number of schools for all types of schools from primary to higher secondary grade, except schools where secondary and higher secondary students cannot enter. For data of schools having other facilities – schools with buildings, having drinking water facility and electricity – I adopt the same method used to create the share of schools having girls' toilets.

Enrolment and Attendance – Enrolment indicates the number of students who officially registered in a specific level of any institutions classified as a school on the last day of September in India, regardless of age (Aggarwal & Thakur, 2013). I create the gross enrolment rate of female students dividing the number of girls who enrolled in nine to twelve standardized levels by female population age group 14 to 17, corresponding to the standardized level of secondary and higher secondary. However, it is frequently happening that any students who already enrolled are not currently at school anymore. Accordingly, I also narrow the scope of predicted variable down to school attendance of female students at secondary level (9~10) to measure whether girls toilets have a positive impact on continuing their study. Since the data for students' attendance is not available, I calculate the attendance rate of pupil-cohort in the secondary grade in each year by subtracting the number of dropped-out students using dropout rate data available in State Report Cards in DISE. A dropout rate indicates students who voluntarily left the school before their completing standardized level in successive year,

excluding repeaters and promotees (Aggarwal & Thakur, 2013). While dropout rate for students in higher secondary is unavailable, this research only focuses on measuring the impact on attendance of girls at secondary level. The number of schools only for higher secondary level is kept out of denominators in all control variables related to the school facilities.

Teacher – Toilets for female are likely to be built depending on the number of female teachers regularly working at a school. Data for the number of teachers are available by school types in DISE. The female teacher is expressed by the ratio of female to male teachers in schools with a secondary level curriculum for measurement of impact on attendance and in schools with a secondary and higher secondary level curriculum for measurement of impact on enrolment.

School – A nearby school affects children's access to schooling, and it can be an important factor for children's educational participation. The DISE provides the total number of schools regardless of school types. The school is expressed by the ratio of the total number of schools to the total projected population in the age group of six to 17 – the school-age children.

Female literacy & Per capita income – Economic growth and female literacy competency are highly associated with improvement in educational outcomes of children. I consider the female literacy rate and per capita income as a proxy for rigorous participation of girls in school. In general, as a national census report is taken every decade, literacy rate censuses taken in 2001 and 2010 are available. To measure the female literacy rate for five years between 2012 and 2016, the interpolation method is applied to extrapolate the missing data, supposing that women literacy rate can show a steady rate of increase. State-wise per capita income data for five years are applied at current price and changed in log.

This paper investigates the association of girls' toilets with not only enrolment of adolescent girls in secondary (9~10) and higher secondary (11~12) level but also the attendance of girls in secondary (9~10) level, using a five-year balanced panel dataset. Among a total of 36 entities, 26 states and 8 union territories are selected. Two states – Andhra Pradesh and Telangana – were excluded due to the bifurcation in 2014.

d. Descriptive statistics

The summary statistics are reported in Table 1. For measurement, all variables are expressed as a percentage.

Table 1

Summary statistics

VARIABLES	(1) Obs.	(2) Mean	(3) Std. Dev	(4) Min	(5) Max
Per capita income (current price)	155	112,834	65,563	24,487	382,140
Per capita income_log	155	11.48	0.555	10.11	12.85
Female literacy (%)	170	80.68	8.040	63.28	95.57
Ratio of schools to school-age population (aged 6 to 17, %)	170	0.621	0.359	0.0728	1.814
Sample A (Enrolment): For Secondary & Higher Secondary level (9~12)					
Girls' enrolment (%)	170	72.20	16.42	38.82	106.0
Schools having girls' toilets (%)	170	93.33	9.797	18.48	100

Schools having drinking water facility (%)	170	97.43	4.534	77.66	100
Schools with buildings (%)	170	98.97	2.137	85.20	100
Schools having electricity (%)	170	88.50	14.26	31.14	100
Female teachers in schools with secondary & Hr. secondary level (%)	170	45.64	14.48	21.58	79.89
Sample B (Attendance): For Secondary level (9~10)					
Girls' attendance (%)	136	72.61	17.09	36.57	127.8
Schools having girls' toilets (%)	170	93.50	9.837	18.48	106.4
Schools having drinking water facility (%)	170	97.42	4.639	77.23	100
Schools with buildings (%)	170	99.00	2.138	85.19	100
Schools having electricity (%)	170	88.32	14.58	30.26	100
Female teachers in schools with secondary level (%)	170	45.63	14.54	22.40	79.89

Notes. Two samples are set according to the standardized level of female students. Sample A reports the ratio of enrolment of female students and school-related facilities at schools providing secondary and higher secondary level curriculum; Schools of 1. primary with upper primary and secondary and higher secondary, 2. upper primary with secondary and Hr. secondary, 3. primary with upper primary and secondary, 4. upper primary with secondary, 5. secondary only, 6. secondary with Hr. secondary and 7. Hr. Secondary only. All the ratio reported in sample B is expressed using schools providing secondary level curriculum – schools of 1. primary with upper primary and secondary and Hr. secondary, 2. upper primary with secondary and Hr. secondary, 3. primary with upper primary and secondary, 4. upper primary with secondary, 5. secondary only and 6. secondary with Hr. secondary – as denominators.

Since the values of schools having girls' toilets observed in the academic year 2012-13 is presented by percentage in raw data, I figure out the raw number of schools having girls' toilets with secondary level using these percentage values and the total number of schools with all grades, then rounding all the numbers up. In detail, the number of schools having girls' toilets only with higher secondary level is excluded from the total number of schools having girls' toilets with all grades (this is equal to the number of all school types which include a curriculum of secondary level). As a result, two states, Andaman & Nicobar Islands and Puducherry observed in 2012 contains some errors which result in the values of the share of school having girls' toilets in sample B being more than a hundred percent. For the shares of school having girls' toilets in sample A, I use the same raw values to those observed in the academic year 2012-13. In this case, however, it does not contain an error from computation because I do not need to exclude the values of schools with only higher secondary level curriculum. Thus, in the same way, I calculate the raw number of schools having girls' toilets with secondary and higher secondary level using percentage values of schools having girls' toilets with all grades and the total number of schools.

For the values of girls' enrolment and attendance rate in both sample A and B, some values of the number of girls who enroll do not correspond to the total female population in age 14 to 17. For example, it is an error if the number of female enrollees is bigger than the number of the total female population in the corresponding age group. In Delhi, Himachal Pradesh and Lakshadweep, some values of girls' enrolment rate for secondary and higher secondary level are over a hundred percent, obviously caused by entry errors. Likewise, some values of the girls' attendance rate observed in sample B contain errors for the reasons mentioned above. States having this problem are Delhi, Himachal Pradesh, Lakshadweep and Sikkim, similar to

those having errors in girls' enrolment rate. The values of girls' attendance rate observed in 2012 are missing due to the unavailability of girls' dropout rate in 9~10 level.

In brief, the maximum values over a hundred percent for girls' enrolment rate in sample A, girls' attendance rate and share of schools having girls' toilet in sample B, occurred from data entry errors and the process of calculation, are excluded from all estimations.

e. Empirical methodology

To measure the impact of sex-separate toilets on school enrolment and attendance of pubescent girls, two econometric specifications are used:

$$(1)\ GE_{it}^{sh} = \beta_0 GT_{it}^{sh} + \beta_1 GT_{i(t-1)}^{sh} + \beta_2 GT_{i(t-2)}^{sh} + \gamma X'_{it} + \delta F_{it}^{sh} + \alpha_i + \gamma_t + \varepsilon_{it}$$

$$(2)\ GA_{it}^{s} = \beta_3 GT_{it}^{s} + \beta_4 GT_{i(t-1)}^{s} + \beta_5 GT_{i(t-2)}^{s} + \theta X'_{it} + \vartheta F_{it}^{s} + \alpha_i + \gamma_t + \varepsilon_{it}$$

Where the outcome, GE_{it}^{sh} is the girls' enrolment rate for secondary s and higher secondary level h in a state i and year t. X'_{it} represents the control variables for the ratio of schools to population of school-age children (aged six to 17), per capita income and female literacy. GT_{it}^{sh} is the share of schools having girls' toilets (the main regressor) for secondary s and higher secondary level h. The following two terms $GT_{i(t-1)}^{sh}$ and $GT_{i(t-2)}^{sh}$ are one-year lagged and two-years lagged main regressors, respectively. F_{it}^{sh} includes the explanatory variables for school-related infrastructures: share of schools with buildings, having drinking water facility and electricity and the ratio of male to female teachers for the secondary and higher secondary level. α_i and γ_t are state and year fixed effects for both equations, respectively.

In similar ways, the empirical specification in equation (2) shows the potential impact of girls' toilets on girls' attendance as well. The outcome GA_{it}^{s} represents the rate of girls' attendance for secondary level. F_{it}^{s} includes the same variables – share of schools with buildings, having drinking water facility and electricity and male-female ratio of teachers – to those above in equation (1), but schools except for higher secondary level. GT_{it}^{s} is the share of schools having girls' toilet for all secondary level, the main explanatory variables. $GT_{i(t-1)}^{s}$ and $GT_{i(t-2)}^{s}$ are identically used, as shown in equation (1). For the rest part of the empirical specification, I also take the same methodology stated in equation (1). The three estimated β coefficients, β_0, β_1, β_2 reflect the impact of schools having girls' toilets on female enrolment in equation (1) and β_3, β_4, β_5 on female attendance in equation (2).

In the beginning, I regress the outcome GE_{it}^{sh} on main explanatory variables, the share of school having girls' toilets for secondary and higher secondary level (GT_{it}^{sh} and $GT_{i(t-1)}^{sh}$) with other control variables (F_{it}^{sh} and X'_{it}). The estimated coefficient β reflects the change in the enrolment rate of girls in the secondary and higher secondary level. As considering the timing of the major effect to take place, I use one-year lagged main regressor to predict the lag values (β_n, where $n = 0, 1, 2$ in equation (1) and $n = 3, 4, 5$ in equation (2)) which measure the effect of changes in past action. The identification assumption is that the decision for registering school is hardly made instantaneously right after the school toilets are newly built in a specific point in that year. Accordingly, it is reasonable that newly built toilets are possibly able to contribute to increasing the enrolment of students for the next admission period, on the assumption that school toilets have a significant impact on their school life and influence the decision to enroll in school. I take the same structure of econometric specifications in equation (2) for all the stage in estimating the attendance of female students (GA_{it}^{s}) in secondary grade.

FINDINGS

a. State fixed effects

To estimate the impact of sex-separate toilets, I employ state fixed effects as baseline specifications. Table 2 shows the estimation results for the impact of sex-separate toilets on the enrolment rate of girls at the secondary and higher secondary levels and the impact on the attendance rate of girls at the secondary level. The initial measurement uses one-year lagged main regressors. All fixed effects estimators apply a heteroskedasticity-robust test for correcting biased and serially correlated errors.

Table 2

Estimation results for the impact of girls' toilets on school enrolment and attendance rate of female students in secondary and higher secondary level

VARIABLES	Girls' enrolment (level 9~12) (1)	Girls' enrolment (level 9~12) (2)	Girls' attendance (level 9~10) (3)	Girls' attendance (level 9~10) (4)
Schools having girls' toilets	0.0883***	0.225***	0.253***	0.313***
	(0.0216)	(0.0272)	(0.0725)	(0.0565)
Schools having girls' toilets_one-year lag		0.184***		0.172*
		(0.0428)		(0.0880)
Per capita income log	6.195	7.951	-0.489	4.523
	(6.150)	(7.094)	(9.583)	(9.677)

Female literacy rate	2.082***	0.937	0.358	-0.0822
	(0.712)	(0.886)	(1.214)	(1.188)
Ratio of schools to school-age population	42.15**	30.42*	16.83	4.275
	(18.80)	(16.37)	(20.67)	(19.47)
Schools having drinking water facility	-0.188	-0.250	-0.415	-0.517
	(0.289)	(0.272)	(0.647)	(0.620)
Schools with buildings	0.161	0.0290	0.0614	0.210
	(0.380)	(0.243)	(0.484)	(0.464)
Schools having electricity	0.122	-0.0294	-0.0338	-0.122
	(0.0930)	(0.0963)	(0.137)	(0.149)
Ratio of male to female teachers	-0.399***	-0.502**	-0.501*	-0.511*
	(0.135)	(0.212)	(0.255)	(0.264)
Constant	-192.0***	-104.9*	73.66	41.13
	(61.32)	(60.91)	(59.25)	(65.72)
Observations	152	122	121	119
R^2 statistics	0.582	0.516	0.181	0.218
Number of State/UT	31	31	31	31
State/UT FE	YES	YES	YES	YES

Note. Specification controls for state fixed effects in all columns. Heteroskedasticity-robust standard errors clustered by states are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

The statistically significant estimated coefficients for girls' toilets show high associations with both the enrolment and attendance of girls at the secondary and higher secondary levels, shown in all columns. To show the impact of girls' toilets in the following year, the estimated results for the impact of one-year lagged main regressors on girls' enrolment and attendance are presented in columns (2) and (4). The impact of sex-separate toilets on girls' school participation is still in effect in the following year. The estimation result for the impact of two-years lagged main regressors on girls' enrolment and attendance are not statistically significant as reported in Appendix A.

Particularly, the coefficients of the ratio of schools to school-age population and female literacy are statistically significant to decide school enrolment as shown in column (1). It is plausible that when schools are located far from villages, children face difficulties in attending school (Limaye, 2016). The girls are sent to schools nearby when it comes to higher studies. Similarly, women literacy rate does appear to positively affect educational participation among female students. This result may indicate that women literacy level and educated mothers have a great effect on education of her children, particularly her daughter (UNESCO, 2012).

b. Year fixed effects

Concerning the unobservable factors that change over time but are not attributed to other explanatory variables, year fixed effects are adopted for measurement. The estimation results of year fixed effects are shown in table 3.

Table 3

Estimation results for the impact of girls' toilets on school enrolment and attendance rate of female students in secondary and higher secondary level

VARIABLES	Girls' enrolment (level 9~12) (1)	Girls' attendance (level 9~10) (2)
Schools having girls' toilets	0.192***	0.262***
	(0.0211)	(0.0485)
Schools having girls' toilets_one-year lag	0.217***	0.217***
	(0.0307)	(0.0725)
Per capita income log	5.342	1.333
	(9.143)	(13.61)
Female literacy	0.330	-0.912
	(1.127)	(1.460)
Ratio of schools to school-age population	34.34**	8.413
	(16.37)	(18.72)
Schools having drinking water facility	-0.227	-0.466
	(0.291)	(0.620)
Schools with buildings	-0.00181	0.152
	(0.220)	(0.429)
Schools having electricity	0.0199	-0.0438
	(0.0798)	(0.138)

Ratio of male to female teachers	-0.183 (0.226)	0.0229 (0.306)
Academic year 2014-15	2.246 (1.411)	3.117 (2.498)
Academic year 2015-16	2.427 (2.576)	3.513 (3.737)
Academic year 2016-17	-0.0258 (3.996)	-0.783 (6.060)
Constant	-48.11 (128.9)	110.0 (169.8)
Observations	122	119
R^2 statistics	0.576	0.310
Number of State/UT	31	31
State/UT FE	YES	YES
Year FE	YES	YES

Note. Specification controls for state by year fixed effects in all columns. Heteroskedasticity-robust standard errors clustered by states are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

The coefficients for the schools having girls' toilets are also not only positive but also statistically significant for both enrolment and attendance of female students in secondary and senior secondary level. The schools that have girls' toilets saw an increase in enrolment and enhanced attendance of female students in the academic year 2012-13 and the following year. The coefficient for the share of schools per school-age population is statistically significant for the enrolment rate, contrary to the attendance rate of girls. It seems plausible that, at secondary level, a girls' keeping up with her academics corresponds to whether schools have more girls' toilets than how easy it is to commute to schools. For the rest of the following academic years from 2014-15 to 2016-17, the coefficients for the schools that have girls' toilets seem to not be

statistically significant. The estimation result using year fixed effects and two-year lagged main regressors is reported in Appendix B.

c. Hausman Test and validity of using fixed effects

One of the hypotheses for choosing the correct model in panel data is testing whether fixed or random effects model is proper. The Hausman test is useful for selecting between both of two models by identifying the presence of endogeneity in control variables. The probability of obtaining the statistic of chi-square from equation (1) is 0.0008, which is significant (<0.05), shows the validity of using fixed effects model. Similarly, that from equation (2) is 0.0000, which rejects the null hypotheses – state fixed effects are not correlated with the regressors. Therefore, using fixed effect model is appropriate for two models to estimate the impact of sex-separate toilets on school enrolment and attendance for adolescent girls.

CONCLUSION

a. Summary of findings

The absence of sex-separate toilets for girls in school is a primary reason for parents to keep their daughters from attending and deterring adolescent girls from attending school (UNICEF, 2012). It is undeniable that the importance of sanitation facilities and sex-separate toilets for girls in school has been underestimated (UNICEF, 2011). In recognition of the importance of toilets for girls in school, the recent studies have continued to bring more attention to this issue ever since the government of India initiated the School Sanitation and Hygiene Education (SSHE) program. To determine the effectiveness of government intervention for increasing toilet coverage in both households and schools across the nation, this paper measures the impact of sex-separate toilets in school on attending of female students in the age of puberty. This paper finds that the girls' toilet has a positive influence on overall school participation (both enrolment and attendance) of girls at the secondary and higher secondary level. The result also shows that the school enrolment of pubescent girls is positively affected by educational level of mother and the presence of schools nearby. The salient point of these findings is that the presence of sex-separate toilets in schools encourages adolescent girls to continue their study while attending school.

The government of India is still making a constant effort to achieve total sanitation in the country. The national flagship mission called Swachh Bharat Mission (Clean India) has targeted not only the improvement of sanitation conditions but also the eradication of the practice of open defecation since 2014 (Central Public Health and Environmental Engineering Organisation, 2018). The physical achievement of this mission is roughly a 37% increase in

the coverage of sanitation (Chopra, 2018, pp. 41-42). This mission may have been successful in terms of achieving public toilet coverage across the nation. However, Indian people, particularly in the rural areas, still prefer open defecation because they think that using toilet is unsanitary. The Bollywood movie title Ek Prem Katha (Toilet), released in 2017, shows this current circumstance of Indian society by depicting a couple struggling against the reality of having no access to a toilet. This movie intends to deliver lessons on a range of issues regarding gender equality and the importance of education for women.

Still, roughly 27% of girls drop out of schools during their class at the secondary level (Kaushik, 2018). That is, nearly 23 million of girls who just reach puberty have difficulty in progressing to the secondary level of education and thus subsequently drop out due to the lack of decent sanitation facilities in schools (Dutta, 2018). A high percentage of pubescent girls also remain unaware of menstrual hygiene practice. Under the ongoing Swachh Bharat Mission, it is necessary to increase awareness of menstruation and understand the motivation of female students dropping out of school. Moreover, providing well-maintained school toilets is required to maximize safe access to toilets for all students.

b. Limitations and future research

Faced with several challenges, this research suggests different aspects of examination for further studies regarding this issue.

First, the data on schools having girls' toilets, provided by DISE, are available only in a combined from different standardized levels in one school, due to the characteristics of school types in India. It is likely that some girls attending schools which provide primary to secondary level curricula continuously advance into a higher grade without transferring to another school.

In this case, regardless of whether a school has girls' toilets or not, she attends classes for secondary level. However, these cases are irrelevant to the impact of sex-separate toilets in school. Using data currently available on DISE, the estimated impacts of girls' toilets are not accurate. Therefore, data on schools having sex-separate toilets need to be broken down according to each standardized level for estimating the impact of sex-separate toilets with higher accuracy in further studies.

Next, there are some errors in the original data which can undermine the reliability of the outcomes from the measurement. As mentioned in the note of summary statistics in Table 1, all the values of enrolment rate of female students in samples A and B and the share of school having girls' toilets in sample B exceeding one hundred percent are excluded from all estimations.

Third, there is still a lack of data indicating the availability of usable toilets in schools. Although it shows that the availability of functional and in use girls' toilets increased by roughly 47% to 56% between 2010 and 2014, the remaining toilets are still neglected and not usable (WaterAid, 2016, p. 8). The schools face difficulty in managing their toilets for maintenance (WaterAid, 2016) and many public toilets are not still properly working in India (Ray & Datta, 2017). The available reports released from Annual Status of Education Report (ASER) India, collaborating with local organizations and volunteers to facilitate the annual household survey, provide information of schools meeting selected The Right of Children to Free and Compulsory Education (RTE) Act norms every two years (Parliament of India, 2009). The School Report Cards categorize girls' toilets into four different conditions – 1. no separate provision for girls' toilets, 2. separate provision but locked, 3. A separate provision, unlocked but not usable, 4. A separate provision, unlocked and usable. The thing is, these reports do not

describe the conditions of girls' toilets by different school types. The availability of data regarding functional girls' toilets by school types will produce better results.

Fourth, this thesis does not consider the number of female ministers serving in Indian state governments; this is an idiosyncrasy that can be captured by error terms. Female political leaders play a great role in contributing to the progress of girls' education and sanitation, particularly in India (Bucur, 2018). While the Narendra Modi-led government has been promoting women's participation in education over the years, the importance of women in leadership roles should not be obscured in future studies.

Lastly, this research does not fully consider the status of women within the Hindu caste system deeply rooted in Indian society. It has been thousands of years that the caste system has been a huge part of Hindu culture (Deka, 2015). Though this system appears to be falling apart in Indian society after amending of legislation to abolish it, the caste system is still taken seriously by people in rural areas and villages. For children from scheduled caste, called Untouchable or Dalit, discrimination is an ever-present fear in school. Untouchable children are often unfairly treated during the class, during their lunch time and among peers from upper castes. As a result, many untouchable children drop out of school when they are in the early stage of primary level (Vijapur, 2007). Many children are forced to clean latrines by teachers (The International Dalit Solidarity Network (IDSN), 2012) or even not allowed to use the toilet before getting permission from a teacher (Klasing, 2017). It is necessary to consider that school toilets may have limited impact on the overall academic achievement of untouchable students.

APPENDIX A

Estimation results for the impact of girls' toilets on school enrolment and attendance rate of female students in secondary and higher secondary level

VARIABLES	Girls' enrolment (level 9~12) (1)	Girls' attendance (level 9~10) (2)
Schools having girls' toilets	0.387*	0.502*
	(0.209)	(0.283)
Schools having girls' toilets_one-year lag	0.267***	0.328***
	(0.0243)	(0.0428)
Schools having girls' toilets_two-years lag	-0.0129	-0.0427
	(0.0396)	(0.0881)
Per capita income log	12.07	17.12
	(7.628)	(12.47)
Female literacy rate	-1.858*	-3.098**
	(0.987)	(1.505)
Ratio of schools to school-age population	4.385	-129.5***
	(25.74)	(46.93)
Schools having drinking water facility	1.187	0.879
	(0.807)	(1.075)
Schools with buildings	0.243	-0.166
	(0.343)	(0.365)

Schools having electricity	-0.119	-0.243
	(0.127)	(0.182)
Ratio of male to female teachers	-0.214	-0.263
	(0.165)	(0.237)
Constant	-98.67	99.37
	(104.8)	(143.0)
Observations	92	89
Number of State/UT	31	31
R^2 statistics	0.488	0.483
State/UT FE	YES	YES

Note. Specification controls for state fixed effects in all columns. Heteroskedasticity-robust standard errors clustered by states are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

APPENDIX B

Estimation results for the impact of girls' toilets on school enrolment and attendance rate of female students in secondary and higher secondary level

VARIABLES	Girls' enrolment (level 9~12) (1)	Girls' attendance (level 9~10) (2)
Schools having girls' toilets	0.326	0.281
	(0.210)	(0.250)
Schools having girls' toilets _one-year lag	0.268***	0.336***
	(0.0241)	(0.0417)
Schools having girls' toilets _two-years lag	0.00420	0.0137
	(0.0402)	(0.0758)
Per capita income log	7.950	7.225
	(9.429)	(18.30)
Female literacy rate	-2.139	-3.882**
	(1.323)	(1.859)
Ratio of schools to school-age population	6.083	-124.8**
	(26.84)	(47.55)
Schools having drinking water facility	1.011	0.277
	(0.926)	(1.150)
Schools with buildings	0.157	-0.422
	(0.337)	(0.361)

Schools having electricity	-0.0920	-0.139
	(0.125)	(0.143)
Ratio of male to female teachers	-0.157	0.0144
	(0.264)	(0.343)
Academic year 2015-16	1.118	3.424
	(1.458)	(2.280)
Academic year 2016-17	0.933	1.659
	(3.520)	(5.239)
Constant	-5.274	349.1
	(170.1)	(274.1)
Observations	92	89
Number of State/UT	31	31
R^2 statistics	0.494	0.517
State/UT FE	YES	YES
Year FE	YES	YES

Note. Specification controls for state by year fixed effects in all columns. Heteroskedasticity-robust standard errors clustered by states are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

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