

RESEARCH PAPER

Examining the association between toilet access and major depression among older adults in India: a cross-sectional analysis of the Longitudinal Aging Study in India from 2017 to 2018

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Abstract

Inadequate access to toilets, which often results in open defecation, could be a risk factor for depression among India's older and ageing population. Using cross-sectional data from the Longitudinal Aging Study in India from 2017 to 2018, we assessed associations between the lack of a toilet and major depression among 64 082 women and men above the age of 45. In our adjusted multilevel model, we found no association between the lack of a household toilet and the risk of major depression (OR = 0.94, 95% CI: 0.79 to 1.11). We also found no association when we stratified by respondent's sex or age. Finally, we did not find any consistent association between toilet access and major depression across India's states and Union Territories. Despite our results, it is possible that inadequate access to sanitation is associated with acute feelings of anxiety, stress and shame—as has been shown in previous studies—but that this is not associated with major depression. Therefore, more research is required to examine associations between toilet access and other more proximal mental health outcomes.

Keywords: depression; Longitudinal Aging Study in India; sanitation; India; older people; mental health

Key Points

- Ageing and older adults in India often lack access to sanitation in their homes.
 - Inadequate access to household toilets could be a determinant of adverse mental health outcomes, such as depression, in India.
 - We found no association between the lack of a household toilet and the risk of major depression in India.
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Introduction

The burden of depressive disorders is substantial and growing among India's older adults and ageing population: the estimated prevalence of major depression was 8.3% among individuals aged 60 and older in 2018 [1, 2]. Estimates from the Global Burden of Disease Study in India show that while 46 million people above the age of ten had some form of a depressive disorder in 2017, the prevalence was highest among those above the age of 60 [1].

Although many of the risk factors for depression among adults older than 45 identified in high-income countries are also associated with depression in the Indian context [3], it is critical to also explore risk factors unique to people living in low- and middle-income countries (LMICs). For instance, almost 240 million people throughout India lived in homes without a toilet in 2021, and as a result, were defecating in the open [4]. A growing body of evidence highlights the associations between inadequate access to sanitation and mental health outcomes across the life course [5–13] and has motivated researchers to study the impacts of sanitation on these outcomes in a variety of contexts around the world [14, 15]. Women and girls experience persistent feelings of fear, shame and the loss of dignity as a consequence of inadequate sanitation access, which could lead to an elevated risk of depression [5–10, 13]. This is likely true with older adults, too, but there is a dearth of evidence examining this relationship. Evaluating the influence of toilet access on depression is important because building toilets is a highly feasible policy initiative, with millions of toilets provided in India over the past decade [4]. However, older adults and their health needs have not been prioritised as a part of global sanitation movements and policies [16].

Many pathways connecting inadequate toilet access with depression may be unique to or exacerbated among older people. Age-related physical impairments would render travel to a safe place to defecate more difficult and aversive. Faecal incontinence [17] and urinary tract and gastrointestinal infections, common in older age [18–20], would also exacerbate the burden of searching for a safe place to defecate.

Evaluating this link in India is important given that as of 2018, over 30% of people above the age of 60 in India lacked access to a household toilet [21], and the number of people above the age of 60 is expected to more than double in India from 149 million in 2022 to 347 million in 2050 [22]. Furthermore, filling this gap is an important response to calls for a deeper understanding of depression risk factors among older and ageing women and men unique to LMIC contexts such as India [1, 3]. Thus, the aim of this paper is to estimate the association between toilet access and major depression among adults above the age of 45 in India.

Methods

Study design

The Longitudinal Aging Study in India (LASI) is India's first internationally comparable and nationally representative

dataset that tracks the health, economic, social and psychological aspects of ageing, and contains information on household water and sanitation access and depression [2]. The data used for this analysis were collected between 2017 and 2018. Data were collected in each of India's 36 states and Union Territories except Sikkim. In each state and Union Territory, 2439 secondary sampling units (SSU), which are villages in rural communities and wards in urban communities, were selected from sub-districts [2]. Then, 32 households in villages and 35 households in wards were selected from each SSU. Individuals over the age of 65 were oversampled to ensure there would be a sufficient sample at the state level and across socio-economic groups [23]. A full description of the sampling strategy is available in the LASI Executive Summary [2].

Sample weights that account for selection probability and non-response were created and included as a part of the LASI dataset [23]. Individual weights are available to produce representative population estimates at both the national and state levels [23]. We applied these weights in all analyses.

Study population

The LASI study included data from 72 250 individuals above the age of 45 and their spouses (who were included regardless of age) [2]. Of the total sample, 31 464 are above the age of 60, and 6749 are above the age of 75 [2]. In the present study, we included individuals who were above the age of 45 and had complete data on the exposure, outcome and covariates of interest.

Outcome

The primary outcome was the probable diagnosis of a major depressive episode. This is measured with the World Health Organization's (WHO) Composite International Diagnostic Interview-Short Form (CIDI-SF) [24]. This instrument has been widely used in epidemiological studies around the world as a non-clinical tool in contexts where detailed psychiatric diagnostic tests are not feasible [24]. This tool has shown satisfactory reliability and internal consistency [25], has been used in India [26] and has been validated against case definitions of depression using administrative data [27]. The CIDI-SF was translated into 16 different regional languages in India using WHO guidelines [3, 28], and the scale has a Cronbach reliability coefficient of greater than 0.6 indicating its suitability in the Indian context [29]. The LASI CIDI-SF implementation protocol is described in a previously published LASI report [23].

The CIDI-SF identifies major depression by asking two screening questions about either having dysphoric mood or anhedonia for two weeks in a row [25]. If the response to either of these questions is yes, the CIDI-SF follows up with seven symptom-based questions [25]. These symptoms are loss of interest, feeling tired, loss of appetite, trouble concentrating, feeling of worthlessness, thinking about death and trouble falling asleep. Participants who reported experiencing three or more symptoms for two consecutive weeks in the past 12 months are considered to have a probable

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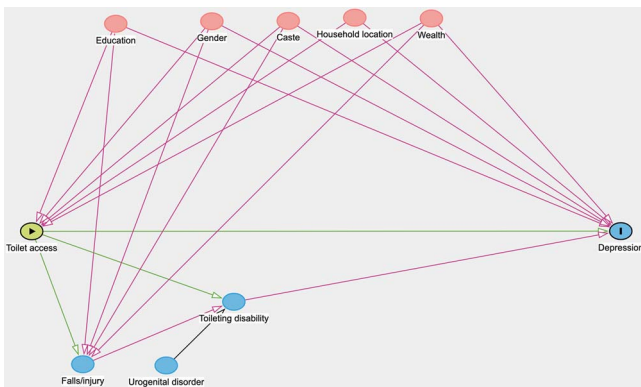


Figure 1. Directed acyclic graph for toilet access and depression among adults above the age of 45 in India.

diagnosis of a major depressive episode [25], referred to as ‘major depression’ hereafter.

Exposures

Household toilet access was the primary exposure. Respondents either had access to a flush/pour flush toilet, pit toilet, twin pit/composting toilet, other or no facility (use open space or field). Pit toilets and twin pit/composting toilets are those in which the waste is stored onsite and must be emptied periodically, while flush toilets flush to an offsite treatment facility. We did not consider whether the toilet was being shared by multiple households. For the purposes of this study, we included all the options except those who responded ‘other’. They were excluded from the analysis because they lacked the information required to construct the exposure. We created one categorical exposure variable in which one category was flush/pour flush toilet (‘flush toilet’), the second was pit latrine/twin pit/composting (‘pit toilet’), and the third was no toilet. Flush toilets were the reference category in our regression models.

Confounders

We identified confounders that plausibly influenced both exposure and outcome with a directed acyclic graph shown in Figure 1 built using DAGitty [30]. We controlled for five possible confounders of the relationship between household toilet access and major depression. These were household wealth quintile, self-reported education, caste, gender and urban/rural place of residence. The wealth quintile variable was created using a principal component analysis of household assets and consumer goods. Education was grouped into four categories: never attended school, less than upper secondary (primary school, first to fifth grade), upper secondary (middle school or more), and tertiary (anything including and after college). The caste categories were Scheduled Caste (ST), Scheduled Tribe (ST), Other Backwards Caste (OBC) and none of the above.

Statistical analysis

We estimated the odds ratio (OR) for the association between toilet access and major depression using multilevel

logistic regression models. Our models were three-level models with random intercepts specified at the community and state levels to adjust for additional residual confounding that might be operating at these two population levels. Our first three-level model was unadjusted while our second one controlled for the set of confounders shown in Figure 1. We estimated these models in an all-India analysis and in sex/age-stratified analyses. For age stratification, we used three age categories, which were 45 to 54, 55 to 64 and above 65.

We also examined the association between toilet access and major depression at the state/Union Territory level using two approaches. First, we specified state-level random slopes for pit toilets and no toilet to our adjusted three-level model to assess how the relationship between toilet access and major depression varies by state/Union Territory. From this model, we interpreted the residual log odds values for pit toilet and no toilet access for each state. Second, we estimated the adjusted model used for the all-India analysis in stratified analyses for each state/Union Territory. In this case, the confounder-outcome association was not constrained to be the same across states/Union Territories and was estimated separately in each stratified model. We interpreted the adjusted log odds for pit toilet and no toilet compared to flush toilet for each state-specific model. We excluded 16 states and Union Territories (highlighted in Supplementary Table 1) in which the prevalence of major depression and/or not having a toilet was below 4% for the state-level analysis.

Finally, all the models were weighted using the LASI weights so that our results are representative at the national and state levels. All analyses were conducted in Stata/MP version 18.0. We derived the random slope residuals using the *runmlwin* command in Stata 18 [31].

Results

Sample characteristics

Among the 66 604 participants above the age of 45 eligible for this analysis, 64 082 (96% of those eligible) who had complete exposure and outcome data (4% missing both, 2% only sanitation, 2% only outcome) were included in the final analytic sample. For the outcome, incomplete data were either marked as not knowing, missing, or refusal. Respondents with severe cognitive or physical disabilities ($n = 705$, 1%) were not asked psychosocial outcomes and were marked as missing. Those missing data tended to be older (mean = 63.5 years [standard deviation (SD) 12.8]) than individuals with complete data [mean = 59.6 years (SD 10.5)] and were more likely to reside in urban areas (45% compared to 35%) (Supplementary Table 2). There were no other substantial differences between the analytical sample and participants excluded due to missing data. A full description of the analytic sample, including by age category, is presented in Table 1.

We estimated the weighted prevalence of each toilet type and experience of a probable major depression episode using the all-India sample. Overall, 27.0% (95% CI: 26.7 to

Table 1. Description of the analytic sample overall, by exposure and by outcome. Data are *n* (%) or mean (SD)

	Exposure			Outcome		
	Overall (<i>n</i> = 64 082)	No toilet (<i>n</i> = 12 255)	Flush toilet (<i>n</i> = 33 577)	Pit toilet (<i>n</i> = 18 250)	No depression (<i>n</i> = 59 508)	Major depression (<i>n</i> = 4574)
Age (continuous)	60.2 (10.7)	60.7 (10.6)	59.8 (10.6)	60.1 (10.8)	60.1 (10.6)	61.0 (11.0)
Household size	5 (2.7)	5 (2.8)	4.9 (2.6)	5.3 (2.8)	5.0 (2.7)	4.9 (2.7)
Age						
45–54	23 800 (37.1%)	4217 (34.4%)	12 632 (37.6%)	6951 (38.1%)	22 254 (37.4%)	1546 (33.8%)
55–64	19 790 (30.9%)	3924 (32%)	10 278 (30.6%)	5588 (30.6%)	18 343 (30.8%)	1447 (31.6%)
65+	20 492 (31.9%)	4114 (33.6%)	10 667 (31.8%)	5711 (31.3%)	18 911 (31.8%)	1581 (34.6%)
Caste						
Scheduled Tribe	11 266 (17.6%)	2106 (17.2%)	5560 (16.6%)	3600 (19.7%)	10 850 (18.2%)	416 (9.1%)
Scheduled Caste	10 776 (16.8%)	3209 (26.2%)	4627 (13.8%)	2940 (16.1%)	9849 (16.6%)	927 (20.3%)
Other Backward Caste	24 379 (38%)	5345 (43.6%)	12 147 (36.2%)	6887 (37.7%)	22 405 (37.7%)	1974 (43.2%)
None of the above	17 661 (27.6%)	1595 (13%)	11 243 (33.5%)	4823 (26.4%)	16 404 (27.6%)	1257 (27.5%)
Gender						
Male	29 834 (46.6%)	5648 (46.1%)	15 567 (46.4%)	8619 (47.2%)	27 984 (47%)	1850 (40.4%)
Female	34 248 (53.4%)	6607 (53.9%)	18 010 (53.6%)	9631 (52.8%)	31 524 (53%)	2724 (59.6%)
Education						
No schooling	30 138 (47%)	8794 (71.8%)	11 920 (35.5%)	9424 (51.6%)	27 654 (46.5%)	2484 (54.3%)
Primary school	15 741 (24.6%)	2288 (18.7%)	8926 (26.6%)	4527 (24.8%)	14 620 (24.6%)	1121 (24.5%)
Upper secondary	14 899 (23.2%)	1097 (9%)	10 102 (30.1%)	3700 (20.3%)	14 075 (23.7%)	824 (18%)
Tertiary	3304 (5.2%)	76 (0.6%)	2629 (7.8%)	599 (3.3%)	3159 (5.3%)	145 (3.2%)
Electricity						
No	3807 (5.9%)	2393 (19.5%)	466 (1.4%)	948 (5.2%)	3385 (5.7%)	422 (9.2%)
Yes	60 275 (94.1%)	9862 (80.5%)	33 111 (98.6%)	17 302 (94.8%)	56 123 (94.3%)	4152 (90.8%)
Piped water ^a						
No	19 398 (30.3%)	6154 (50.2%)	7970 (23.7%)	5274 (28.9%)	17 844 (30%)	1554 (34%)
Yes	44 659 (69.7%)	6093 (49.8%)	25 590 (76.3%)	12 976 (71.1%)	41 639 (70%)	3020 (66%)
Urbanicity						
Rural	41 846 (65.3%)	11 384 (92.9%)	16 709 (49.8%)	13 753 (75.4%)	38 520 (64.7%)	3326 (72.7%)
Urban	22 236 (34.7%)	871 (7.1%)	16 868 (50.2%)	4497 (24.6%)	20 988 (35.3%)	1248 (27.3%)
Wealth quintile						
Lowest	11 630 (18.1%)	7573 (61.8%)	1071 (3.2%)	2986 (16.4%)	10 431 (17.5%)	1199 (26.2%)
Low	12 846 (20%)	3159 (25.8%)	4641 (13.8%)	5046 (27.6%)	11 825 (19.9%)	1021 (22.3%)
Middle	13 131 (20.5%)	1153 (9.4%)	7458 (22.2%)	4520 (24.8%)	12 207 (20.5%)	924 (20.2%)
High	12 921 (20.2%)	308 (2.5%)	9024 (26.9%)	3589 (19.7%)	12 175 (20.5%)	746 (16.3%)
Highest	13 554 (21.2%)	62 (0.5%)	11 383 (33.9%)	2109 (11.6%)	12 870 (21.6%)	684 (15%)

Note: Smaller samples were used for the data as follows. ^a *n* = 64 057.

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Table 2. Description of toilet types (*n* and weighted prevalence) and the weighted prevalence of major depression by toilet type

	Flush toilet	Pit toilet	No toilet
Toilet type <i>n</i>	33 577	18 250	12 255
Toilet type prevalence	47.3%	25.7%	27.0%
Prevalence of major depression	7.1%	8.9%	12.1%

Table 3. Associations between toilet type and probable major depression in all-India analysis (*N* = 64 082)

Toilet type	Unadjusted 3-level OR (95% CI)	Adjusted 3-level OR (95% CI)
No toilet	1.25 (1.03, 1.52)	0.94 (0.79, 1.11)
Pit toilet	1.05 (0.86, 1.28)	0.91 (0.75, 1.1)

Notes: This table presents results from multilevel logistic regression models in which the three levels are individuals, SSU, and states/Union Territories. The adjusted model controlled for participant sex (male/female), age (continuous), education (never attended school, less than upper secondary, upper secondary and tertiary), household wealth quintile, and caste (Scheduled Caste, Scheduled Tribe and Other Backwards Caste). The reference group are those with a flush toilet.

27.3) of adults older than 45 had no toilet access and were defecating in the open. Just over a quarter (25.7%, 95% CI: 25.3 to 26.0) used a pit latrine, while 47.3% (95% CI: 46.9 to 47.7) used a flush toilet. The overall prevalence of major depression was 8.9% (95% CI: 8.7 to 9.1) among adults over the age of 45. The prevalence of major depression was 7.1% (95% CI: 6.7 to 7.3) among those with a flush toilet, 8.9% (95% CI: 8.6 to 9.4) among those with a pit latrine, and 12.1% (95% CI: 11.4 to 12.6) among those with no household toilet. These results are presented in [Table 2](#).

All-India results

When compared to flush toilet access, in the unadjusted three-level model, the OR for major depression among those with no toilet was 1.25 (95% CI: 1.03 to 1.52) and 1.05 (95% CI: 0.86 to 1.28) for those with a pit toilet. In the adjusted three-level model, the OR for major depression among those with no toilet was 0.94 (95% CI: 0.79 to 1.11) and 0.91 (95% CI: 0.75 to 1.10) for those with a pit toilet. These results are presented in [Table 3](#). Sensitivity analysis results for depression as a continuous outcome are presented in [Supplementary Table 3](#).

Stratified results

Among women, in the adjusted three-level model, the OR for major depression among those with no toilet was 0.99 (95% CI: 0.81 to 1.22) and 0.98 (95% CI: 0.82 to 1.17) for those with a pit toilet. For men, the OR for major depression among those with no toilet was 0.92 (95% CI: 0.73 to 1.16) and 0.85 (95% CI: 0.66 to 1.11) among those with a pit toilet in the adjusted three-level models. These results are

Table 4. Associations between toilet access and probable major depression in age and sex-stratified analyses

	Unadjusted 3-level OR (95% CI)	Adjusted 3-level OR (95% CI)
Men (<i>n</i> = 29 834)		
No toilet	1.24 (1.00, 1.53)	0.92 (0.73, 1.16)
Pit toilet	1.00 (0.79, 1.27)	0.85 (0.66, 1.10)
Women (<i>n</i> = 34 248)		
No toilet	1.38 (1.08, 1.76)	0.99 (0.81, 1.22)
Pit toilet	1.15 (0.95, 1.39)	0.98 (0.82, 1.17)
45–54 (<i>n</i> = 23 800)		
No toilet	1.14 (0.86, 1.52)	0.90 (0.67, 1.21)
Pit toilet	0.94 (0.73, 1.19)	0.82 (0.64, 1.06)
55–64 (<i>n</i> = 19 790)		
No toilet	1.43 (1.09, 1.88)	1.03 (0.80, 1.34)
Pit toilet	1.10 (0.87, 1.41)	0.91 (0.71, 1.18)
65+ (<i>n</i> = 20 492)		
No toilet	1.48 (1.30, 1.68)	0.99 (0.84, 1.15)
Pit toilet	1.25 (1.00, 1.56)	1.04 (0.82, 1.33)

Notes: This table presents results from multilevel logistic regression models in which the three levels are individuals, SSU, and states/Union Territories. The adjusted models controlled for participant sex (male/female), age (continuous), education (never attended school, less than upper secondary, upper secondary and tertiary), household wealth quintile, and caste (Scheduled Caste, Scheduled Tribe and Other Backwards Caste). The reference group are those with a flush toilet.

presented in [Table 4](#). For adults between the ages of 45 and 54, the OR for major depression among those with no toilet was 0.90 (95% CI: 0.67 to 1.21) and 0.82 (95% CI: 0.64 to 1.06) for those with a pit toilet. For adults between 55 and 64, the OR for major depression among those with no toilet was 1.03 (95% CI: 0.80 to 1.34) and 0.91 (95% CI: 0.71 to 1.18) for those with a pit toilet. For adults above 65, the OR for major depression among those with no toilet was 0.99 (95% CI: 0.84 to 1.15) and 1.04 (95% CI: 0.82 to 1.33) for those with a pit toilet. These results are presented in [Table 4](#). Sensitivity analysis with age as a continuous variable is shown in [Supplementary Table 4](#).

State and Union Territory analysis

Results for each state and Union Territory differed in terms of magnitude and direction of association depending on the model. The adjusted association between no toilet access and depression (compared to flush toilet access) in the three-level random slopes model was 0.04 (95% CI: -0.12 to 0.21). In this model, the residual log odds for Bihar, for example, were 0.90 (95% CI: 0.53 to 1.28), indicating a positive association. However, in the state-stratified model, the association was negative (log odds -0.52, 95% CI: -0.95 to -0.08) for Bihar. Similarly, in Chhattisgarh, the residual log odds from the three-level random slopes model were 0.46 (95% CI: 0.03 to 0.90), again indicative of a positive association. In the state-stratified model, however, the association was negative (log odds -0.49, 95% CI: -1.11 to 0.13). These results are presented in [Table 5](#).

Table 5. Associations between toilet access and probable major depression by state/Union Territory

	Stratified Two-level model log odds (95% CI)		All-India random slopes three-level model Residual log odds (95% CI)	
	Pit toilet	No toilet	Pit toilet	No toilet
Andhra Pradesh (<i>n</i> = 2288)	0.22 (−0.38, 0.83)	−0.11 (−0.92, 0.70)	0.19 (−0.21 to 0.59)	−0.68 (−1.13 to −0.23)
Bihar (<i>n</i> = 3236)	−0.61 (−1.00, −0.22)	−0.52 (−0.95, −0.08)	−0.45 (−0.74 to −0.16)	0.90 (0.53 to 1.28)
Chhattisgarh (<i>n</i> = 1812)	−1.06 (−1.62, −0.50)	−0.49 (−1.11, 0.13)	−0.20 (−0.58 to 0.18)	0.46 (0.03 to 0.90)
Dadra & Nagar Haveli (<i>n</i> = 836)	0.12 (−0.77, 1.01)	0.39 (−0.77, 1.55)	−0.04 (−0.48 to 0.41)	0.24 (−0.34 to 0.83)
Daman & Diu (<i>n</i> = 782)	1.34 (0.38, 2.30)	−0.16 (−2.48, 2.17)	0.04 (−0.43 to 0.51)	−0.32 (−0.99 to 0.35)
Gujarat (<i>n</i> = 1974)	0.44 (−0.17, 1.05)	0.37 (−0.42, 1.16)	0.16 (−0.25 to 0.57)	−0.26 (−0.75 to 0.23)
Haryana (<i>n</i> = 1696)	0.50 (−0.01, 1.01)	0.76 (−0.04, 1.55)	0.07 (−0.34 to 0.49)	0.15 (−0.30 to 0.61)
Himachal Pradesh (<i>n</i> = 1188)	−0.71 (−1.35, −0.07)	−0.13 (−1.32, 1.07)	0.01 (−0.42 to 0.44)	0.15 (−0.35 to 0.65)
Jammu & Kashmir (<i>n</i> = 1458)	−0.14 (−0.78, 0.50)	0.01 (−0.97, 0.99)	−0.08 (−0.51 to 0.34)	0.09 (−0.38 to 0.55)
Jharkhand (<i>n</i> = 2175)	−0.17 (−0.65, 0.31)	−0.17 (−0.71, 0.36)	−0.08 (−0.44 to 0.28)	0.15 (−0.28 to 0.57)
Karnataka (<i>n</i> = 1986)	0.73 (0.28, 1.18)	0.09 (−0.38, 0.57)	−0.06 (−0.40 to 0.28)	0.39 (0.01 to 0.77)
Madhya Pradesh (<i>n</i> = 2654)	−0.39 (−0.73, −0.04)	−0.17 (−0.58, 0.24)	−0.22 (−0.52 to 0.08)	1.38 (1.01 to 1.76)
Maharashtra (<i>n</i> = 3514)	0.07 (−0.26, 0.40)	0.25 (−0.17, 0.67)	0.30 (−0.01 to 0.60)	0.41 (0.07 to 0.75)
Odisha (<i>n</i> = 2567)	0.85 (0.35, 1.35)	−0.33 (−0.88, 0.23)	−0.29 (−0.64 to 0.06)	−0.23 (−0.64 to 0.18)
Rajasthan (<i>n</i> = 2096)	−0.33 (−0.89, 0.24)	−0.29 (−0.89, 0.30)	−0.28 (−0.63 to 0.07)	0.32 (−0.08 to 0.71)
Tamil Nadu (<i>n</i> = 3149)	0.71 (0.16, 1.26)	−0.18 (−0.84, 0.47)	0.14 (−0.22 to 0.50)	−0.61 (−1.00 to −0.22)
Telangana (<i>n</i> = 2130)	0.13 (−0.36, 0.63)	0.60 (−0.04, 1.24)	0.13 (−0.25 to 0.50)	−0.22 (−0.64 to 0.21)
Uttar Pradesh (<i>n</i> = 4139)	−0.16 (−0.51, 0.19)	−0.09 (−0.49, 0.31)	−0.09 (−0.39 to 0.20)	0.99 (0.62 to 1.36)
Uttarakhand (<i>n</i> = 1248)	−1.03 (−1.59, −0.46)	0.30 (−0.56, 1.16)	0.10 (−0.32 to 0.51)	0.53 (0.08 to 0.99)
West Bengal (<i>n</i> = 3343)	−0.41 (−0.95, 0.12)	−0.12 (−0.65, 0.41)	−0.08 (−0.44 to 0.27)	0.30 (−0.04 to 0.63)

Notes: This table presents results from two separate analyses: 1) A two-level multilevel regression model was estimated for each state with a random effect specified at the community level. From this model, we interpreted the coefficient for pit toilet and no toilet with the reference being flush toilet access. 2) A three-level random slope model was estimated in a similar way to the all-India analysis. However, we specified random slopes for the toilet access association at the state level and interpreted the residual values for both in each state/Union Territory. In both cases, we interpret the log odds with a 95% CI. Both models were adjusted for participant sex (male/female), age (continuous), education (never attended school, less than upper secondary, upper secondary and tertiary), household wealth quintile, and caste (Scheduled Caste, Scheduled Tribe and Other Backwards Caste). In the three-level random slopes model, the adjusted log odds for the association between no toilet access and depression was 0.04 (95% CI: −0.12 to 0.21), and −0.001 (95% CI: −0.21 to 0.20) for the association between pit toilets and depression.

We also found differences in the magnitude and direction of the association between pit toilet use and depression, compared to flush toilet use. In the three-level random slopes model, the adjusted log odds for the association between pit toilet use and depression was −0.001 (95% CI: −0.21 to 0.20). In this model, the residual log odds for Karnataka, for example, were −0.06 (95% CI: −0.40 to 0.28), indicating a negative association. However, in the state-stratified model, the association was positive (log odds 0.73, 95% CI: 0.28 to 1.18) for Karnataka. Similarly, in Odisha, the residual log odds from the three-level random slopes model were −0.29 (95% CI: −0.64 to 0.06), again indicative of a negative association. In the state-stratified model, however, the association was positive (log odds 0.85, 95% CI: 0.35 to 1.35). These results are presented in Table 5.

Discussion

Our study had three salient findings. First, in a nationally representative cohort of older and ageing adults in India, we found no statistically significant association between the lack of a household toilet or pit toilet access and probable diagnosis of major depression when compared to flush toilet access. Second, we found no statistically significant associations between the lack of a household toilet or pit

toilet access and major depression when we stratified by sex and age category, compared to flush toilet access. Third, our state and Union Territory results varied by model thereby limiting our ability to draw inferences on the association between toilet access and depression.

Our results show that at the all-India level, there is no statistically significant association between the lack of a household flush toilet and major depression among adults above the age of 45. We show that the association present in the unadjusted models is attenuated when accounting for observed confounders and state and community random effects. Other factors, such as widowhood, marital status, and the presence of co-morbidities, also contribute to the risk of major depression [3] but do not confound the association between toilet type and major depression. Similarly, we found no consistent association between toilet access and major depression across India's states and Union Territories. These results are consistent with previous findings from a study conducted in Odisha, India, showing no association between inadequate access to sanitation and depression across life stages [6].

Despite our results, it is possible that stressors associated with inadequate access to toilets, such as feelings of shame from being seen by others, efforts to moderate food and water intake to avoid toilet use, fearing sexual violence when defecating in the open, and delay or avoidance of

toileting [8, 13, 32], are likely still present. The presence of these stressors could explain why inadequate access to sanitation is associated with adverse mental health outcomes in adolescents and younger adults [11] and is a determinant of depression among a cohort of women and men above the age of 50 in Ghana [33]. The presence of these stressors in the context of toilet access was not covered in the LASI survey. Collecting this information in the future could help elucidate how frequently older and ageing adults experience these stressors in different places across India and how these stressors are associated not only with depression but other mental health and well-being outcomes as well.

Additionally, we could not assess features of these toilets that may be especially relevant for older adults including if the toilet was a squat or seated toilet, distance to toileting location, and the presence of mobility aids in the toilet location [34, 35]. Doing so is important considering the physical challenges of managing sanitation needs in the absence of toilet access are associated with increased symptoms of depression and other adverse mental health outcomes [6]. Future research should collect more granular data regarding the toilet design and type and further examine the extent to which toilet type mediates the relationship between various forms of disability and major depression among older Indian adults.

There are several limitations to this study. Due to the cross-sectional and observational nature of the data, we cannot rule out the potential for uncontrolled confounding or reverse causation (something which could be better addressed when the next wave of LASI data are released and longitudinal data is available) to have biased our results. Though we controlled for multiple prevalent potential confounders, there may be other factors that are driving the observed association that are not accounted for here. For example, there may be residual confounding by household wealth that is not captured by the wealth index included in the wealth quintile. Furthermore, our analysis did not consider whether the flush toilet or pit latrine was being used as a facility being shared by multiple households, and if so, what the walking time/distance to that facility was. Distance from the toilet might be an important characteristic of toilet access, moderating the relationship between toilet access and depression. Additionally, our sub-national results are not representative of all of India's states and UTs as some regions either had a very low prevalence of individuals without a toilet or with major depression. Finally, the data used for this study are from 2017. Toilet coverage has increased considerably throughout India since then, and our study is unable to account for this change. Future research should leverage data from the second wave of LASI to better understand how increases in household toilet coverage are longitudinally associated with mental health outcomes among India's older and ageing adult population.

In conclusion, our results show no consistent association between no toilet and the risk of major depression when compared to flush toilet use among older and ageing adults in India. It is likely, however, that those without access to a

toilet are exposed to stressors that still might be associated with adverse well-being outcomes. Future research could better understand how these stressors shape mental health outcomes among older and ageing adults in India and how different types of toilets mediate the association between physical abilities and outcomes such as depression.

Supplementary Data: Supplementary data is available at *Age and Ageing* online.

Declaration of Conflicts of Interest: None declared.

Declaration of Sources of Funding: None declared.

Data Availability: The datasets used and/or analysed during the current study are available online at <https://g2aging.org/home>.

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Examining the association between toilet access and major depression among older adults in India: A cross-sectional analysis of the Longitudinal and Aging Study in India from 2017-2018

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This supplemental material has been provided by the authors to give readers additional information about their work.

Supplementary table 1: All-India and state/Union Territory prevalence of major depression and no household toilet. States/Union Territories in which the prevalence of either was below 4% were excluded from analysis.

	Mean prevalence of major depression	Mean prevalence of no toilet
All India	8.9%	27.0%
Andaman & Nicobar Islands	1%	9%
Andhra Pradesh	4%	15%
Arunachal Pradesh	3%	4%
Assam	7%	3%
Bihar	11%	54%
Chhattisgarh	6%	21%
Dadra & Nagar Haveli	6%	30%
Daman & Diu	4%	8%
Delhi	9%	3%
Gujarat	5%	20%
Haryana	7%	8%
Himachal Pradesh	6%	7%
Jammu & Kashmir	5%	12%
Jharkhand	7%	28%
Karnataka	8%	32%
Kerala	8%	0%
Madhya Pradesh	17%	36%
Maharashtra	10%	15%
Nagaland	3%	3%
Odisha	5%	44%
Punjab	9%	3%
Rajasthan	7%	31%
Tamil Nadu	5%	26%
Telangana	5%	20%
Tripura	5%	1%
Uttar Pradesh	15%	50%
Uttarakhand	7%	6%
West Bengal	8%	12%

Supplementary table 2: Differences in sample characteristics between individuals with and without missing data. Data are n (%) or mean (SD). Percentages for caste education electricity piped water and wealth quintile were calculated from a slightly smaller denominator due to missing values.

n		Not missing 64082	Missing 2522
Age		59.6 (10.5)	63.5 (12.8)
Household size		4.9 (2.6)	5.4 (2.7)
Age	45-54	23800 (37.1%)	735 (29.1%)
	55-64	19790 (30.9%)	645 (25.6%)
	65+	20492 (31.9%)	1142 (45.3%)
Caste ¹	Scheduled Tribe	11266 (17.6%)	271 (18.3%)
	Scheduled Caste	10776 (16.8%)	235 (15.8%)
	Other Backward Caste	24379 (38%)	528 (35.6)
	None of the above	17661 (27.6%)	450 (30.3%)
Gender	Male	29834 (46.6%)	1205 (47.8%)
	Female	34248 (53.4%)	1317 (52.2%)
Education	No schooling	30138 (47%)	1213 (48.1%)
	Primary school	15741 (24.6%)	617 (24.5%)
	Upper secondary	14899 (23.3%)	567 (22.5%)
	Tertiary	3304 (5.2%)	125 (4.9%)
Electricity	No	3807 (5.9%)	81 (6.6%)
	Yes	60275 (94.1%)	1155 (93.5%)
Piped water ²	No	19398 (30.3%)	359 (29.1%)
	Yes	44659 (69.7%)	877 (70.9%)
Urbanicity	Rural	41846 (65.3%)	1394 (55.3%)
	Urban	22236 (34.7%)	1128 (44.7%)
Wealth quintile ³	Lowest	11630 (18.2%)	284 (19.1%)
	Low	12846 (20.1%)	318 (21.4%)
	Middle	13131 (20.5%)	303 (20.4%)
	High	12921 (20.2%)	288 (19.4%)
	Highest	13554 (21.2%)	291 (19.6%)

Note: Smaller samples were used for the “missing” category due to missing data as follows

¹n=1484; ² n=1236; ³ n=1484

Supplementary table 3: Associations between toilet access and CIDI-SF score measured continuously

Variable	Mean difference (95% CI)
Toilet type (flush toilet is reference)	
Pit toilet	0.18 (-0.14, 0.5)
No toilet	-0.03 (-0.17, 0.11)
Age (continuous)	0.03 (0.02, 0.04)
Wealth quintile (lowest is reference)	
low	-0.54 (-0.7, -0.39)
middle	-0.96 (-1.19, -0.73)
high	-1.33 (-1.61, -1.04)
highest	-1.71 (-2.07, -1.35)
Education (no school is reference)	
Primary school	-0.19 (-0.28, -0.09)
Upper secondary school	-0.50 (-0.67, -0.33)
Tertiary (college)	-0.88 (-1.12, -0.64)
Caste (Scheduled Tribe is reference)	
Scheduled Caste (SC)	0.30 (0.03, 0.57)
Other backward class (OBC)	0.08 (-0.15, 0.32)
None of the above	0.04 (-0.16, 0.23)
Participant sex (male is reference)	
Female	0.46 (0.36, 0.56)
Place of residence (rural is reference)	
Urban	0.12 (-0.06, 0.29)

Note: This table presents results from a linear regression in which the three levels are individuals, secondary sampling units, and states/Union Territories. The adjusted model controlled for participant sex (male/female), age (continuous), education (never attended school, less than upper secondary, upper secondary, and tertiary), household wealth quintile, and caste (Scheduled Caste, Scheduled Tribe, and Other Backwards Caste).