Social Science & Medicine 217 (2018) 121–134

Contents lists available at ScienceDirect

Social Science & Medicine

journal homepage: www.elsevier.com/locate/socscimed

Review article

Exploring the relationship between sanitation and mental and social well-being: A systematic review and qualitative synthesis

G.D. Sclar[a,*], G. Penakalapati[a], B.A. Caruso[a], E.A. Rehfuess[b], J.V. Garn[a,c], K.T. Alexander[a,d], M.C. Freeman[a], S. Boisson[e], K. Medlicott[e], T. Clasen[a]

[a] Department of Environmental Health, Rollins School of Public Health, 1518 Clifton Road NE, Atlanta, GA, 30322, USA
[b] Institute for Medical Informatics, Biometry and Epidemiology, Pettenkofer School of Public Health, LMU Munich, Marchioninistr. 15, 81377, Munich, Germany
[c] School of Community Health Sciences, University of Nevada Reno, 1664 N Virginia St, Reno, NV, 89557, USA
[d] CARE, 151 Ellis St NE, Atlanta, GA, USA, 30303
[e] Department of Public Health, Environmental and Social Determinants of Health, World Health Organization, Avenue Appia 20, 1202, Genève, Switzerland

ARTICLE INFO

Keywords:
Sanitation
Open defecation
Mental well-being
Social well-being
Privacy
Safety
Qualitative synthesis
Conceptual model

ABSTRACT

The WHO defines health not as the absence of disease but as a "state of complete physical, mental, and social well-being." To date, public health research on sanitation has focused mainly on the impact of sanitation on infectious diseases and related sequelae, such as diarrhea and malnutrition. This review focuses on the mental and social well-being implications of sanitation. We systematically searched leading databases to identify eligible studies. Qualitative studies were assessed using a 17-point checklist adapted from existing tools, while quantitative studies were assessed using the Liverpool Quality Appraisal Tool. We followed a best-fit framework synthesis approach using six *a priori* well-being dimensions (privacy, shame, anxiety, fear, assault, and safety), which were examined using line-by-line coding. Two additional dimensions (dignity and embarrassment) inductively emerged during coding for a total of eight well-being outcomes. We then synthesized coded text for each dimension into descriptive themes using thematic analysis. For quantitative studies, we extracted any measures of association between sanitation and well-being. We identified 50 eligible studies covering a variety of populations and sanitation contexts but many studies were conducted in India (N = 14) and many examined the sanitation experience for women and girls (N = 19). Our synthesis results in a preliminary conceptual model in which privacy and safety, including assault, are root well-being dimensions. When people *perceive* or *experience* a lack of privacy or safety during open defecation or when using sanitation infrastructure, this can negatively influence their mental and social well-being. We found that perceptions and experiences of privacy and safety are influenced by contextual and individual factors, such as location of sanitation facilities and user's gender identity, respectively. Privacy and safety require thorough examination when developing sanitation interventions and policy to ensure a positive influence on the user's mental and social well-being.

1. Introduction

In 2010, the United Nations General Assembly adopted Resolution 64/292 'The human right to water and sanitation,' recognizing water and sanitation as "essential for the full enjoyment of life and all human rights" (UNGA, 2010). As of 2015, 2.3 billion people worldwide still lacked access to basic sanitation services, defined as a facility that hygienically separates the user from human excreta and is not shared among multiple households (JMP, 2017). Among these, 892 million practice open defecation (JMP, 2017). Public health research on sanitation has focused predominantly on the impact of sanitation on infectious diseases and related sequelae, such as diarrhea and malnutrition. Yet, the WHO defines health not as the absence of disease but as a "state of complete physical, mental and social well-being" (WHO, 1948). This holistic definition of health is critical to understanding how sanitation impacts *all* aspects of health.

Studies have increasingly documented how sanitation may influence health beyond disease, particularly for women and girls. Worldwide about 1 in 3 women have experienced gender-based violence (GBV), and studies indicate that inadequate sanitation may put women and girls at greater risk of experiencing violence (WHO, 2013). An ethnographic study in urban slums in Pune and Jaipur, India documented the harassment and violence that women regularly face when going for open defecation and accessing public toilets (Kulkarni

* Corresponding author.
E-mail address: gloria.sclar@emory.edu (G.D. Sclar).

https://doi.org/10.1016/j.socscimed.2018.09.016
Received 15 April 2018; Received in revised form 16 August 2018; Accepted 14 September 2018
Available online 19 September 2018

et al, 2017). Two secondary analyses of national datasets from Kenya and India found women who open defecate had significantly higher prevalence of experiencing non-partner sexual violence (NPSV) and/or physical violence compared to women who had access to sanitation (Jadhav et al., 2016; Winter and Barchi, 2016). The analysis by Jadhav et al. (2016) found the effect size for the association between open defecation and NPSV was about 75% larger than the effect size found for open defecation and child diarrhea. Moreover, a recent study by Caruso et al., (2018) found that despite having access to a latrine, women in rural Odisha, India may experience negative impacts to their mental well-being when urinating and defecating.

Studies also link sanitation to the attainment of primary and secondary education. The world has seen a dramatic decline in out-of-school rates for both girls and boys (UNESCO, 2017). However, adolescent girls in Sub-Saharan Africa and parts of Asia continue to have a higher out-of-school rate compared to their male classmates (UNESCO, 2017). A growing body of literature showcases how poor and inaccessible sanitation at school inhibits young girls from safely and comfortably managing their menstruation which may ultimately influence their social and educational engagement, concentration, and attendance (Caruso et al., 2013; Haver et al., 2013; Long et al., 2013; Sommer, 2010). In contrast, a recent study in Bangladesh found school absence was significantly less common among menstruating girls in schools with accessible (i.e. unlocked) girls' toilets (Alam et al., 2017).

Several literature reviews on the non-disease impacts of sanitation, such as GBV, psychosocial stress, and more, provide mounting evidence that the sanitation field should give greater consideration to mental and social health outcomes (Bisung and Elliott, 2016b; Pearson and McPhedran, 2008; Sommer et al., 2014). A recent commentary by Jain & Subramanian et al. (2018) calls for this broader examination of sanitation's "intrinsic and instrumental value" beyond physical health outcomes alone.

This review is the first of its kind to systematically synthesize the evidence on how different types of sanitation influence mental and social well-being. The "Capability Approach" by economist and philosopher Amartya Sen views well-being as a person's set of "real opportunities," or capabilities, *to be* and *to do* what is of value to them – such as a person's capability to be safe from harm and to achieve their full educational potential (Sen, 1985). White (2008) and McGregor (2007) expand upon the capability approach to develop a well-being framework that organizes Sen's 'beings' and 'doings' into three interactive dimensions: material well-being ("welfare and standards of living"), relational well-being ("personal and social relations"), and subjective well-being ("values, perceptions and experience"). In this review, the term "well-being" specifically refers to the subjective and relational dimensions in order to align with the WHO's mental and social components of health and to give the review a manageable scope.

2. Methods

2.1. Search strategy

We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Moher et al., 2009). We conducted our searches in English and utilized a generic search string where *sanitation* terms were combined with mental and social *well-being* terms using the Boolean operator "AND": (bathroom OR toilet OR "toilet facilities" OR latrine OR sanitation OR sanitary OR water closet OR ecosan OR feces OR faeces OR sewage or sewer OR sewerage OR "open defecation") AND (harassment OR "sexual harassment" OR privacy OR violence OR shame OR safety OR fear OR conflict OR anxiety OR stress OR "psychosocial stress" OR bullying OR "mental health"). This generic search string was adapted to the specific database searched. We considered all studies published in English, Spanish, Portuguese, French, German, or Italian with any publication status (published, unpublished, in press, grey literature, etc.) written between 1950 and November 2016.

We searched the following databases: British Library for Development Studies, Campbell Library, clinicaltrials.gov, Cochrane Library, EMBASE, EBSCO (CINHAL, PsychInfo), LILACS, POPLINE, ProQuest, PubMed, Research for Development, Sanitary Engineering and Environmental Sciences (REPIDISCA), Social Science Research Network (SSRN), Sustainability Science Abstracts (SAS), Web of Science, and 3ie International Initiative for Impact Evaluation. We also searched the following organizations' conference proceedings and websites: Carter Center, CDC Global WASH, International Water Association, Menstrual Hygiene Management in WASH in Schools Virtual Conference, Stockholm Environment Institute, Stockholm World Water Week Conference, UNC Water and Health Conference, UNICEF Water, Sanitation and Hygiene, UNICEF WASH in Schools, USAID EHP, WASHplus, World Bank WSP. We hand searched references of other review papers identified through the database and website searches.

2.2. Study eligibility

All countries, settings, and human populations were eligible. Due to the exploratory nature of the review's research question, all study designs were eligible. For qualitative study designs, the sanitation exposure of interest was the study population's *experience* with any type of sanitation or the practice of open defecation. In observational studies, the sanitation exposure of interest was access to or use of any type of sanitation facility or the practice of open defecation. Eligible studies had to explicitly document the connection between sanitation exposure or experience and a well-being outcome of interest– dignity, privacy, shame, embarrassment, anxiety, fear, assault, and safety (described further in *data synthesis*).

Two reviewers independently examined all titles and abstracts to determine if studies fell within the inclusion criteria for the review. When a title or abstract could not be included or rejected with certainty, the full text was obtained for further screening. Two reviewers then independently determined if the full-text articles met the inclusion criteria. If additional data was needed to determine eligibility, authors of the given study were contacted. For discrepancies between the two reviewers at any stage, a third reviewer was consulted. Two reviewers then split the eligible studies and extracted study characteristics using a standardized form that recorded study design, setting, methods, population, sanitation type, and well-being outcomes of interest.

2.3. Data synthesis

2.3.1. Qualitative data

We used 'best-fit framework synthesis,' a structured and mixed deductive and inductive approach, to synthesize our qualitative evidence (comprising both qualitative studies and the qualitative findings from mixed method studies) (Carroll et al., 2011). In this approach, themes are identified *a priori* based on previously proposed frameworks related to the research question of interest. The *a priori* themes are used to code the qualitative data and secondary thematic analysis can be used to build upon or revise the pre-existing framework (Carroll et al., 2011). Importantly, the initial framework can be modified inductively as new themes emerge from the data. For this review, we did not have a starting framework; instead, we conducted a scoping search of the literature and brainstormed among the authors to develop a set of *a priori* well-being dimensions, including privacy, shame, anxiety, fear, assault, and safety. These acted as a *skeletal framework* for the different aspects of well-being that different types of sanitation infrastructures may influence (i.e. private sanitation, shared sanitation, school sanitation, and open defecation). The types of sanitation were decided based on a cursory review of eligible papers to determine general but unique categories that could be applied to all papers.

Eligible papers were imported into MaxQDA version 12, a qualitative data analysis software. Two authors with qualitative research training (GDS and GP) conducted line-by-line coding. Extractable data

Table 1
Mental and social well-being dimensions and their corresponding definitions.

Mental and social well-being dimension	Definition
Dignity	A sense of pride in oneself; self-respect; self-worth.
Privacy	An individual's ability to feel free from observation or disturbance by others.
Shame	A social emotion caused by intense humiliation due to 'wrong' behavior.
Embarrassment	An emotion caused by the sense of self-consciousness or discomfort with oneself.
Anxiety	An emotion where one experiences relentless worry, nervousness, and/or unease.
Fear	An emotion caused by the sense that someone or something is dangerous or will lead to harm.
Assault	Aggressive and unwanted behavior that causes physical or mental harm towards an individual or group.
Safety	A state of being where one is protected from harm or danger, be it physical or social.

was always coded with both a well-being and sanitation type code and consisted of verbatim quotes by study participants reported in the paper or author-reported syntheses of their qualitative data.

Only the 'findings' or 'results' section of each paper was coded to avoid author interpretation of findings, such as in the 'discussion' section.

At the start of the coding process, two papers were coded by both authors and then compared to ensure codes were applied consistently between the authors. GDS and GP then split the remaining papers and coded independently. After this first round of coding, two additional inductive well-being codes were agreed upon, 'embarrassment' and 'dignity.' All papers were then *re-coded* in iterative fashion with this final set of codes. Definitions for the mental and social well-being codes were based on common dictionary definitions to allow for a broad and colloquial interpretation that would better capture the variety of ways in which eligible studies described and applied these terms, be it by the authors or quoted participants (Table 1).

Upon completion of the coding process, we used thematic analysis to construct descriptive themes (Guest et al., 2012). All coded text that had a co-occurrence of a given well-being code and sanitation type code (e.g. 'privacy' and 'open defecation') were examined to uncover emergent themes. The emergent themes were refined into *descriptive themes* that documented how experiences with a given type of sanitation related to a given dimension of well-being. The descriptive themes for each sanitation type were then mapped against the skeletal well-being framework and presented in a structured table format.

We then examined the well-being framework for each sanitation type to develop higher level *summary themes* that came out of the qualitative evidence synthesis. These summary themes were either singular descriptive themes that were supported by a number of studies or a combination of descriptive themes from multiple well-being dimensions that expressed a similar concept.

2.3.2. Quantitative data

We extracted any reported measures of association between sanitation and well-being from eligible papers presenting quantitative data (i.e. observational and mixed method study designs). In order to integrate these studies into the best-fit framework synthesis, the extracted quantitative findings were also considered when developing the higher level *summary themes*.

2.4. Quality appraisal for individual studies

Qualitative studies were assessed using a 17-point checklist for quality appraisal that the authors developed based on criteria outlined by Harden et al. (2009) and Walsh and Downe (2006) (Supplemental Table 1). Scores were recorded as very low quality (0–4 points), low quality (5–8 points), medium quality (9–12 points), or high quality (13–17 points). Quantitative studies were assessed using the Liverpool Quality Appraisal Tool (LQAT) (Pope et al. unpublished) with scores recorded as very serious risk of bias (0–3 points), serious risk of bias (4–6 points), or low risk of bias (7–9 points) (Supplemental Table 2). Mixed method studies were assessed using both tools and thus received two separate scores, one for each type of data. All studies were assessed solely based on the information presented in the paper; if details were not provided on a given assessment criterion, no points were given.

2.5. Confidence in evidence

We used the GRADE-CERQual ('Confidence in Evidence from Review of Qualitative research') approach to assess our confidence in each review finding (i.e. summary theme). As such, we examined four components to determine our level of confidence in each finding: (1) methodological limitations of the individual studies that support the finding, (2) coherence of the finding in regards to the data it represents, (3) adequacy of the data that supports the finding, and (4) relevance of the data to the scope of the review (e.g. target population) (Lewin et al., 2018a,b). Our assessment for each component was categorized as no or very minor concerns, minor concerns, moderate concerns, or serious concerns. We then considered the component assessments to determine an overall CERQual assessment of very low to high confidence in the summary theme.

3. Results

The search strategy yielded 6443 titles and abstracts. After an initial screening to remove irrelevant and duplicate studies, two authors examined the full-text of 738 studies. After the full-text review, 50 studies were determined eligible for inclusion – 35 qualitative studies, eight mixed method studies, and seven quantitative studies (Fig. 1). All seven quantitative studies were cross-sectional study designs. A summary description of each study can be found in Supplemental Table 3.

3.1. Quality appraisal of individual studies

Qualitative and mixed method studies received an average quality appraisal score of 11 points out of a possible 17, categorized as medium quality. Overall, 15 studies were of high quality, 19 medium quality, and 9 low quality. Most studies lost points for lack of information regarding qualitative data analysis methods, researcher reflexivity, and validity of data collection tools (e.g. piloting interview guides). The appraisal score of a study does not reflect the richness of its presented data. Instead, the score indicates that the paper did not provide sufficient information on the study design or study methods, highlighting the possibility that the data quality is poor.

Quantitative and mixed method study designs received an average LQAT score of 2 points out of a possible 9, indicating very serious risk of bias. Five quantitative studies had an LQAT score of 4 or 5, indicating serious risk of bias, while the remaining studies had a score of 0–2 indicating very serious risk of bias. Most studies lost points for not reporting participant response rate, evidence of bias in both exposure and outcome assessments due to self-report measures, bias in ascertainment (i.e. blinding), and lack of adjustment for confounding. Observational study designs are prone to introducing bias into quantitative effect estimates and were judged accordingly. In the context of the exploratory nature of this systematic review, they may nevertheless contribute

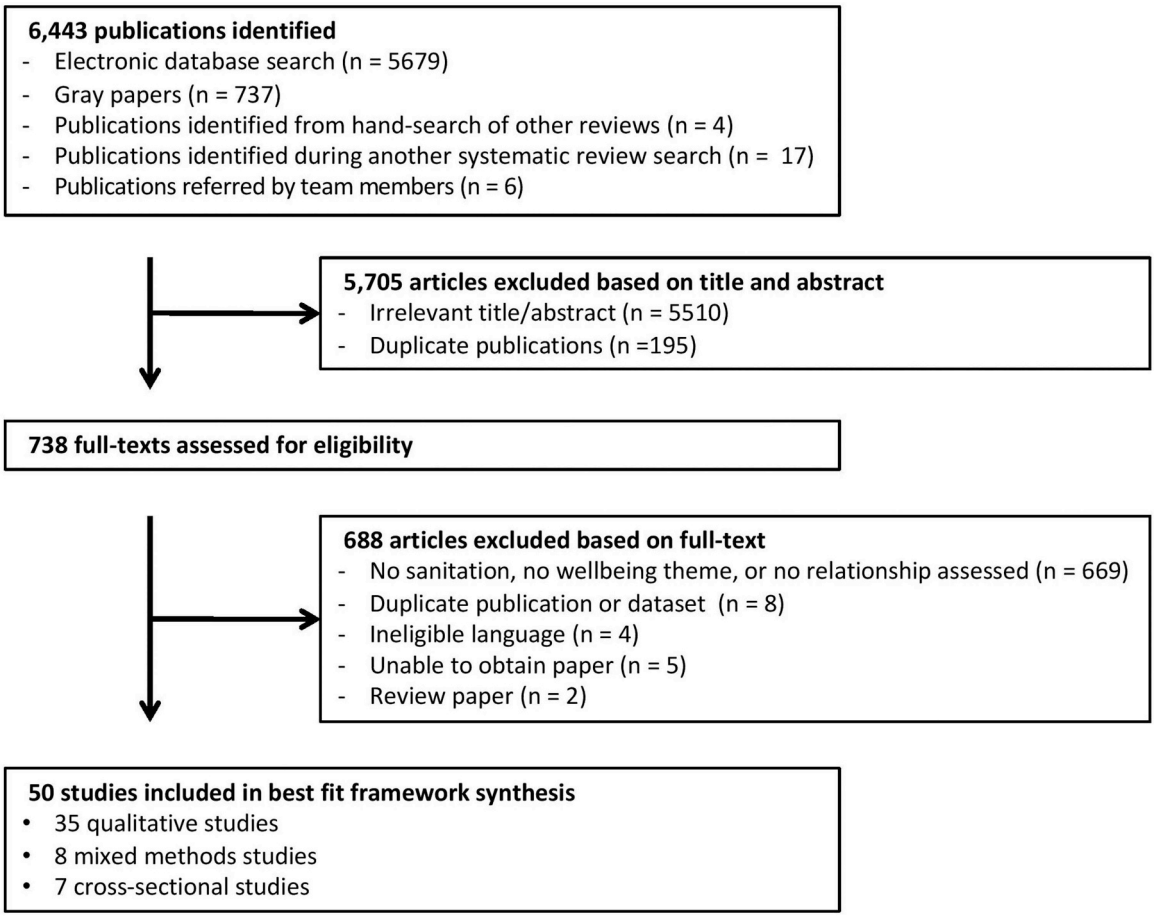

Fig. 1. PRISMA flow diagram of publications considered for the review.

relevant insights – in qualitative evidence synthesis we rely on identifying the subjective, unblinded, self-reported and thus biased experiences of sanitation users with different types of sanitation.

3.2. Settings and populations of included studies

Twelve studies were conducted in high-income countries: Sweden (3), United Kingdom (3), Australia (2), United States (2), Ireland (1), and Italy (1). The remaining 38 studies were conducted in low and middle-income countries (LMICs); six of these studies were set in more than one country. Study settings in Africa included Kenya (9), Ethiopia (2), Malawi (2), Burkina Faso (1), Egypt (1), Ghana (1), Niger (1), Rwanda (1), Sierra Leone (1), South Africa (1), Swaziland (1), Tanzania (1), Uganda (1), and Zambia (1). Studies set in Asia included India (14), the Philippines (3), Bangladesh (2), Cambodia (1), and Nepal (1). The only studies conducted in South America were set in Chile (1) and Bolivia (1). There were no studies conducted in Central America, Russia, or China.

Twelve studies took place in urban settings, with nine studies examining the sanitation experience in informal settlements. Seven studies were set in both urban and rural settings, nine studies in rural alone, and three studies examined national-level datasets. Nineteen studies took place in school settings, covering the sanitation experience from pre-school to university.

Nineteen studies focused on the sanitation experiences of women and girls exclusively while none of the studies focused solely on the sanitation experience of men and boys. Two studies explored the sanitation experience for people who are physically disabled, two studies examined the influence of sanitation on well-being for transgender and gender non-conforming college students, two studies focused on the homeless and urban poor, two studies addressed communities post natural disasters, one study explored sanitation for nursing home residents, and one study examined the relationship between sanitation and psychological distress for people living with HIV.

3.2.1. Influence of open defecation on mental and social well-being

Twenty studies examined open defecation practices: 16 qualitative, two mixed methods, and two cross-sectional studies. Studies were set in five different countries with 13 conducted in India. Eight of these Indian studies focused solely on the experience of women and/or girls. Fourteen qualitative and mixed method studies uncovered an influence of open defecation on privacy, 11 on safety, 10 on shame, nine on fear and assault, seven on dignity, and five on embarrassment and anxiety (Supplemental Figure 1). Two cross-sectional studies examined the association between open defecation and non-partner sexual and/or physical violence among women in Kenya (Winter and Barchi, 2016) and in India (Jadhav et al., 2016). Summary themes on open defecation are presented in Table 2, descriptive themes are reported in Supplemental Table 4, and extracted quantitative findings are reported in Supplemental Table 3.

Lack of access to sanitation seemed to have the greatest influence on the privacy and safety dimensions of well-being, which then influenced the anxiety, shame, and embarrassment dimensions, particularly among women and girls. Studies reported on the stress and anxiety that women and girls experience when going for open defecation due to the risk of exposing their bodies to men, a social rule that if broken even by accident can lead to embarrassment and shame (Rashid and Michaud, 2000; Hirve et al., 2015; Prabhakaran et al., 2016; Saha et al., 2015; Khanna and Das, 2016; Sahoo et al., 2015; Haver et al., 2013; Amnesty, 2010; Nallari, 2015; Kulkarni et al, 2017; Bisung and Elliott, 2016a).

Table 2
CERQual summary of findings.

Objective of Systematic Review: To synthesize evidence on the ways a lack of sanitation and different types of sanitation influence dimensions of mental and social well-being.
Perspective: Experiences, attitudes, and perceptions of people about open defecation (OD) and/or using a form of sanitation (shared sanitation, school sanitation, private sanitation) in any country.

Summary themes from review	Studies contributing to summary theme	CERQual assessment	Explanation of CERQual assessment
How can the act of open defecation influence a person's mental and social well-being?			
Bodily exposure and violation: Women and girls reported feeling a general lack of privacy and safety when going for OD, along with anxiety and fear, because of the risk of exposing their bodies to men and risk of men violating their privacy and/or bodies through verbal and sexual assault. Women and girls reported feeling shame and embarrassment during the act of OD because of bodily exposure, especially to men, and reported accounts of men verbally and sexually assaulting them (i.e. teasing, watching, rape).	N = 14 (Amnesty, 2010; Bapat and Agarwal, 2003; Bisung and Elliott, 2016a; Haver et al., 2013; Hirve et al., 2015; Khanna and Das, 2016; Krishnan et al., 2015; Kulkarni, O'Reilly, and Bhat, 2017; Nallari, 2015; Prabhakaran et al., 2016; Rashid and Michaud, 2000; Routray et al., 2015; Sahoo et al., 2015; Walters, 2014)	*High confidence* ***Finding largely representative of women in India.**	Moderate concerns about methodological limitations (mix of low, medium and high quality studies) and relevance (10 studies in India). No or very minor concerns about coherence and adequacy.
Loss of dignity from assault: Women sometimes experience a loss of dignity during OD because of accidental exposure of their bodies or from being verbally or sexually assaulted by men.	N = 6 (Amnesty, 2010; Hirve et al., 2015; Joshi et al., 2011; Khanna and Das, 2016; Rashid and Michaud, 2000; Saha et al., 2015)	*Very low confidence*	Serious concerns about methodological limitations (low and medium quality studies). Moderate concerns about adequacy (few studies) and relevance (only 3 country contexts)). Minor concerns about coherence but limited data.
Public shaming and assault: Women and men reported experiencing verbal or physical assault when going for OD, in attempts by others to socially shame them or stop them from open defecating on private land. Some women reported feeling anxiety, fear, and unsafe when going for OD because of this risk of being verbally or physically assaulted.	N = 7 (Caruso et al., 2014; Hirve et al., 2015; Khanna and Das, 2016; McMichael and Robinson, 2016; Prabhakaran et al., 2016; Sahoo et al., 2015; Walters, 2014)	*Moderate confidence* ***Finding largely representative of women in India.**	Moderate concerns about methodological limitations (mix of low, medium, high quality studies). No or very minor concerns about coherence. Minor concerns about adequacy (fear and anxiety finding from only 2 studies). Serious concerns about relevance (5 studies in India; 4 studies specific to women)
Safety and privacy issues with OD sites: OD sites were often perceived as unsafe spaces due to their location and environmental dangers which led to injury from accidents, animal attacks, and plants. As such, men and women feared being injured at OD sites. Population growth and seasonal effects influenced perceptions of privacy and safety at OD sites.	N = 9 (Hirve et al., 2015; Nallari, 2015; Routray et al., 2015; Sahoo et al., 2015; Kulkarni, O'Reilly, and Bhat, 2017; Bapat and Agarwal, 2003; Bisung and Elliott, 2016a; Khanna and Das, 2016; Rashid and Michaud, 2000)	*High confidence* ***Finding largely representative of women in India**.	Moderate concerns about methodological limitations (mix of low, medium, high quality studies). No or very minor concerns about coherence and adequacy. Serious concerns about relevance (7 studies in India, only 2 studies included men).
How can the use of public sanitation facilities influence a person's mental and social well-being?			
Exposure of bodily needs: Women and men reported experiencing a general lack of privacy when using public sanitation facilities because of the risk of exposing their bodies and bodily needs to others, which sometimes resulted in feelings of shame and embarrassment.	N = 5 studies (Kuria et al., 2005; Caruso et al., 2013; Moore and Breeze, 2012; Thys et al., 2015; White et al., 2016)	*Moderate confidence* ***Finding largely representative of African context.**	Serious concerns about methodological limitations (mix of low, medium, high quality studies). No or very minor concerns about coherence. Moderate concerns about adequacy (few studies, especially on shame and embarrassment) and relevance (4 studies in African countries; 4 studies in urban setting).
Verbal and sexual assault: Women and girls reported being fearful of and experiencing verbal and sexual assault by men and boys when accessing public sanitation facilities. Women and girls especially expressed their fear of being raped or actual accounts of rape.	N = 6 studies (Amnesty, 2010; Kuria et al., 2005; Moore and Breeze, 2012; Nallari, 2015; Corburn and Hildebrand, 2015; Kulkarni, O'Reilly, and Bhat, 2017)	*Moderate confidence* ***Finding representative of urban settings, especially slums and informal settlements in India and Kenya.**	Serious concerns about methodological limitations (low and medium quality studies) and relevance (all studies in urban setting, especially slums and informal settlements; only 3 country contexts – India, Kenya, and 1 study in UK). No or very minor concerns about coherence and minor concerns about adequacy.
Loss of dignity from defilement: Urban poor, especially women, and people with physical disabilities reported feeling a loss of dignity when inaccessible or dirty public sanitation facilities forced them to openly defecate or defile themselves, respectively.	N = 3 studies (Corburn and Hildebrand, 2015; Joshi et al., 2011; White et al., 2016)	*Very low confidence* ***Finding representative of urban settings.**	Serious concerns about methodological limitations (low quality studies contributed most to finding), adequacy (few studies), and relevance (only 3 country contexts; all studies in urban setting). No or very minor concerns about coherence but limited data.
Safety and privacy issues with public sanitation facilities: Public sanitation facilities were perceived as not being safe and/or private due to issues with design (e.g. lack of doors, no locks, poor lighting, uneven floors), maintenance (e.g. broken doors, slippery floors), and location (e.g. near liquor stores, in middle of community).	N = 7 studies (Corburn and Hildebrand, 2015; Kuria et al., 2005; Moore and Breeze, 2012; Nallari, 2015; Kulkarni, O'Reilly, and Bhat, 2017; Walters, 2014; White et al., 2016)	*High confidence* ***Finding representative of urban settings, especially slums and informal settlements in India and Kenya.**	Serious concerns about methodological limitations (primarily low and medium quality). No or very minor concerns about coherence and minor concerns about adequacy. Moderate concerns about relevance (4 country contexts with most studies in India; all studies in urban setting, especially urban slums and informal settlements).

(*continued on next page*)

Table 2 (*continued*)

Objective of Systematic Review: To synthesize evidence on the ways a lack of sanitation and different types of sanitation influence dimensions of mental and social well-being.
Perspective: Experiences, attitudes, and perceptions of people about open defecation (OD) and/or using a form of sanitation (shared sanitation, school sanitation, private sanitation) in any country.

Summary themes from review	Studies contributing to summary theme	CERQual assessment	Explanation of CERQual assessment
How can the use of school sanitation facilities influence a student's mental and social well-being?			
Exposure of bodily needs and violation of privacy: Students reported feeling a lack of privacy, anxiety, and fear when using school toilets because of the risk of exposing their bodies or bodily needs to their classmates (especially when teacher permission was required to access the toilet) and risk of other students violating their privacy through verbal and physical assault (i.e. teasing, bullying). Students sometimes reported feeling shame and embarrassment when their bodies and bodily needs were exposed.	N = 12 studies (Norling et al., 2016; Barnes and Maddocks, 2002; Lundbald et al., 2010; Tatlow-Golden et al., 2015; Caruso et al., 2014; Erhard et al., 2013; Haver et al., 2013; Moore, 1966; Seelman et al., 2012; Sommer et al., 2015; Njuguna et al., 2008; Senior, 2014)	*High confidence*	Minor concerns about methodological limitations (mostly high quality studies). No or very minor concerns about coherence and relevance (country contexts in Europe, North America, Africa, and Philippines; studies include rural and urban settings and students from primary to university). Minor concerns about adequacy.
Inadequate privacy and assault faced by schoolgirls: Schoolgirls reported experiencing a lack of privacy and embarrassment when school toilets were not gender-segregated or if they had to pass by the boys' toilet to access the girls' toilet. Similarly, schoolgirls reported being fearful of and experiencing verbal and sexual assault from boys when accessing school toilets.	N = 11 studies (Hirve et al., 2015; Norling et al., 2016; Caruso et al., 2013; Corburn and Hildebrand, 2015; Haver et al., 2013; Long et al., 2013; Millei and Gallagher, 2011; Sommer et al., 2015; Abrahams et al., 2006; Mitchell, 2009; Njuguna et al., 2008)	*High confidence*	Moderate concerns about methodological limitations (mix of low, medium, and high quality). No or very minor concerns about coherence, adequacy, and relevance (country contexts in Europe, Africa, Southeast Asia, and Bolivia).
Exposure of menstrual status: Schoolgirls reported experiencing a lack of privacy for managing their menstruation at school toilets because of the lack or proximity of gender-segregated toilets and having to share facilities with classmates. Schoolgirls sometimes reported feeling anxiety and fear around the risk of exposing their menstrual status and embarrassment from actual exposure (e.g. leaks, stains).	N = 9 studies (Sommer et al., 2015; Corburn and Hildebrand, 2015; Tegegne and Sisay, 2014; Haver et al., 2013; Keihas, 2013; Sommer, 2010; Caruso et al., 2013; Long et al., 2013; White et al., 2016)	*High confidence* ***Finding largely representative of African context.**	Minor concerns about methodological limitations, coherence, and adequacy. Moderate concerns about relevance (7 studies in African countries).
Safety and privacy issues with school sanitation facilities: School toilets were perceived by students as not being safe due to location and not being private due to issues with design and maintenance (e.g. broken doors, low walls, no locks, dirty).	N = 8 studies (Mitchell, 2009; Barnes and Maddocks, 2002; Moore, 1966; Njuguna et al., 2008; Norling et al., 2016; Caruso et al., 2014; Haver et al., 2013; Abrahams et al., 2006)	*High confidence*	Minor concerns about methodological limitations and adequacy. No or very minor concerns about coherence and relevance (country contexts in Europe, Africa, and Philippines; studies include rural and urban settings and students from primary to high school).
How can the use of private household sanitation influence a person's mental and social well-being?			
Dignity for women and girls: People perceived that private household latrines gave women and girls dignity because they could defecate in privacy and without risk to their safety (i.e. assault).	N = 3 studies (Khanna and Das, 2016; Routray et al., 2015; Thys et al., 2015)	*Low confidence*	Minor concerns about methodological limitations. No or very minor concerns about coherence but limited data available. Serious concerns about adequacy (few studies) and relevance (only 2 country contexts in rural setting).
Dignity from respect: People perceived that private household sanitation gave households dignity because of its association with modern status and respect.	N = 3 studies (Routray et al., 2015; Prabhakaran et al., 2016; Thys et al., 2015)	*Low confidence*	Minor concerns about methodological limitations. No or very minor concerns about coherence but limited data available. Serious concerns about adequacy (few studies) and relevance (only 2 country contexts in rural setting).
Bodily exposure to household members: People reported experiencing a lack of privacy when using their household's latrine because of exposure of their bodily needs to other household members which led to feelings of shame and embarrassment.	N = 3 studies (Routray et al., 2015; Thys et al., 2015; Hirve et al., 2015)	*Very low confidence*	Minor concerns about methodological limitations. Moderate concerns about coherence (some contradictory data). Serious concerns about adequacy (few studies) and relevance (only 2 country contexts in rural setting).
Safety and privacy issues with household sanitation facilities: Household latrines were perceived as not being safe and/or private due to issues with design (e.g. no roof, door, walls, locks, water), construction (e.g. unstable pit), and location (e.g. near high grasses where snakes live).	N = 4 studies (Khanna and Das, 2016; Routray et al., 2015; Thys et al., 2015; Kingery et al., 2016)	*Low confidence*	No or very minor concerns about methodological limitations and coherence but limited data available. Serious concerns about adequacy (few studies) and relevance (3 country contexts in rural setting).
How do people attempt to safeguard their well-being when they lack access to adequate sanitation?			
Well-being strategies for OD: Women and girls reported employing a variety of strategies to safeguard their well-being, especially their privacy and	N = 10 studies (Hirve et al., 2015; Prabhakaran et al., 2016; Routray et al., 2015; Kulkarni,	*Moderate confidence* ***Finding largely**	Serious concerns about methodological limitations (primarily medium and low quality studies) and relevance (all studies in

(*continued on next page*)

Table 2 (*continued*)

Objective of Systematic Review: To synthesize evidence on the ways a lack of sanitation and different types of sanitation influence dimensions of mental and social well-being.
Perspective: Experiences, attitudes, and perceptions of people about open defecation (OD) and/or using a form of sanitation (shared sanitation, school sanitation, private sanitation) in any country.

Summary themes from review	Studies contributing to summary theme	CERQual assessment	Explanation of CERQual assessment
safety, when going for OD. The most common strategies included - "stop and stand" when someone passes, defecate in early morning or late evening during times of darkness, go for OD in groups, suppress bowel movements, and withhold food and drink to prevent bowel movements.	O'Reilly, and Bhat, 2017; Bapat and Agarwal, 2003; Khanna and Das, 2016; Nallari, 2015; Rashid and Michaud, 2000; Sahoo et al., 2015; Walters, 2014)	**representative of Indian context.**	Southeast Asia – India and one study in Bangladesh). No or very minor concerns about coherence and adequacy.
Well-being strategies for school sanitation: Students reported suppressing their needs to urinate and defecate to avoid using the school toilets and subsequently avoid issues with privacy and feelings of anxiety, fear, and embarrassment.	N = 8 studies (Njuguna et al., 2008; Norling et al., 2016; Seelman et al., 2012; Haver et al., 2013; Moore, 1966; Millei and Gallagher, 2011; Barnes and Maddocks, 2002; Lundbald and Hellström, 2005)	*High confidence*	Moderate concerns about methodological limitations (mix of low, medium, and high quality studies). No or very minor concerns about coherence and minor concerns about adequacy and relevance (6 country contexts; studies in rural and urban settings with students from pre-school to university).

These negative influences on well-being for women and girls are amplified during menstruation as they also risk exposing their menstrual status (Khanna and Das, 2016; Nallari, 2015; Walters, 2014).

> *"When girls go outside, their entire attention is devoted towards worrying about whether someone has seen them or if they get a stain. They have to be careful that no one is coming as they are sitting between the bushes. They can't sit in the open field, or change pads there."*
>
> *-Young woman, India (rural)*
>
> Khanna and Das (2016).

Women and girls also fear violation of their privacy and personal security when going outside for defecation (Hirve et al., 2015; Khanna and Das, 2016; Nallari, 2015; Prabhakaran et al., 2016; Bapat and Agarwal, 2003; Krishnan et al., 2015; Routray et al., 2015; Sahoo et al., 2015; Kulkarni et al, 2017). Ten studies documented personal accounts and stories of women and young girls going for open defecation and being subjected to verbal, physical, and sexual assault by men, including teasing, watching, and rape (Bapat and Agarwal, 2003; Khanna and Das, 2016; Sahoo et al., 2015; Prabhakaran et al., 2016; Krishnan et al., 2015; Hirve et al., 2015; Nallari, 2015; Routray et al., 2015; Rashid and Michaud, 2000; Kulkarni et al, 2017). Some women noted that while they had not themselves experienced verbal or sexual assault during open defecation, they perceived this to be a serious risk.

> *"This place is very unsafe. It doesn't mean that nothing will happen in the future, just because it hasn't happened yet. Women always face a threat of being raped."*
>
> *-Woman, India (urban slums)*
>
> Kulkarni et al. (2017).

Three cross-sectional studies also connected open defecation to the privacy and safety dimensions. A survey of 306 women by Hirve et al. (2015) found women who openly defecate had greater odds of feeling stress due to lack of privacy (OR 25.31; 95% CI 9.06, 70.79) or due to lack of personal safety (OR 13.82; 95% CI 6.18, 30.87) compared to women who use latrines. A secondary analysis of Demographic Health Survey (DHS) data by Winter and Barchi (2016) found Kenyan women who reported primarily practicing open defecation had 1.39 greater odds of experiencing non-partner sexual and/or physical violence within the past year compared to women who did not report primarily practicing open defecation (95% CI 1.00, 1.92, $p < 0.05$). Similarly, Jadhav et al. (2016) conducted a secondary analysis on the 2005–2006 Indian National Family Health Survey-III dataset and found that Indian women who open defecated had 2.25 greater odds of experiencing NPSV within the past year compared to women who had access to a household toilet (95% CI 1.13, 4.50; p-value = 0.02).

Seven studies reported how women and girls ultimately lose their dignity if they experience accidental exposure of their body, violation of their privacy (i.e. men watching them), and/or sexual assault while openly defecating (Amnesty, 2010; Hirve et al., 2015; Rashid and Michaud, 2000; Saha et al., 2015; Joshi et al., 2011).

> *"There are instances when a boy forces himself on a girl, she screams, others gather around and he runs away. You might not have heard about it but that doesn't mean it doesn't happen, their bodies are not safe, their dignity is not safe."*
>
> *– Woman, India (rural)*
>
> Khanna and Das (2016).

Women and girls employ several strategies to ensure privacy and safety when going for open defecation: women walk long distances to find hidden spaces (Routray et al., 2015; Khanna and Das, 2016); they defecate early in the morning or late at night when it is dark (Bapat and Agarwal, 2003; Hirve et al., 2015; Khanna and Das, 2016; Nallari, 2015; Rashid and Michaud, 2000; Routray et al., 2015; Sahoo et al., 2015; Walters, 2014; Kulkarni et al, 2017); they go in groups or pairs to

safeguard each other's privacy (Nallari, 2015; Routray et al., 2015; Walters, 2014; Kulkarni et al, 2017); if someone is passing by they stop in the middle of defecating and stand to ensure their body is not exposed (Hirve et al., 2015; Prabhakaran et al., 2016; Routray et al., 2015; Kulkarni et al, 2017); they choose to defecate in a bag at home or in their backyard to ensure safety at night (Routray et al., 2015; Sahoo et al., 2015); and several studies found women and girls withhold food and drink and suppress their bodily needs, sometimes even taking anti-diarrheal medication, to avoid defecation altogether (Bapat and Agarwal, 2003; Khanna and Das, 2016; Rashid and Michaud, 2000; Kulkarni, O'Reilly, and Bhat, 2017). Kulkarni et al. (2017) found some women carry stones and spices with them so they can prevent or defend themselves against attacks. Such strategies highlight the severe restrictions women face around open defecating that are not present for men.

> *"Women do not go after six in the morning. They wait for the cover of darkness. We even eat less so that we do not need to relieve ourselves during the daytime because we do not have proper toilets."*
>
> *– Woman, India (urban slums)*
>
> Prabhakaran et al. (2016).

Men and women also fear and experience assault and shame when going for open defecation as some communities establish formal groups that shame open defecators, farmers verbally assault defecators on their land, and even fellow open defecators verbally assault each other because they don't want to be seen (Hirve et al., 2015; Prabhakaran et al., 2016; McMichael and Robinson, 2016; Caruso et al., 2014). One study documented the experience of a homeless family that endured harassment from security guards when they defecated on private land (Walters, 2014). Similarly, Hirve et al. (2015) describes how 'Good morning' committees instituted by the local government in rural India often target poor families for open defecating although they cannot afford to build a latrine.

> *"People go to the bank of the river for open defecation. This was controlled by the Good morning committee. People are scared of them and two of them died (accidental fall, drowning while being chased) because they used to go for open defecation."*
>
> *– Woman health worker, India (rural)*
>
> Hirve et al. (2015).

Privacy and safety issues can result not just from social expectations and ramifications, but from the dangerous environmental conditions of open defecation sites. When going for open defecation, particularly at night, people fear and experience injury from vegetation (thorns, stones, rice stalks) and animals (snakes, scorpions, leeches, crabs, insects, cattle) (Bapat and Agarwal, 2003; Hirve et al., 2015; Routray et al., 2015; Prabhakaran et al., 2016; Nallari, 2015; Sahoo et al., 2015; Bisung and Elliott, 2016a; Caruso et al., 2014; Kulkarni et al, 2017). Hirve et al. (2015) found 36% of women who identified as open defecators feared injury, snake bites, or animal attacks compared to only 5% of women who used latrines ($p < 0.000$). In addition, open defecation sites that are perceived as private can lose that sense of privacy due to environmental changes such as a shift in seasons, natural disasters, and population growth (Hirve et al., 2015; Nallari, 2015; Rashid and Michaud, 2000; Bisung and Elliott, 2016a; Kulkarni et al, 2017). Compared to rural open defecators, urban defecators are forced to defecate in more public and dangerous areas such as along railway tracks, highways, and canals, with reports of injury and even death (Bapat and Agarwal, 2003; Khanna and Das, 2016; Kulkarni, O'Reilly, and Bhat, 2017).

While most studies found open defecation to negatively influence dimensions of well-being, one study documented a positive influence. Routray et al. (2015) found some rural Indian women and girls felt open defecation offered many benefits as it gave them a break from household chores, a chance to socialize, and an outlet for de-stressing and venting about family matters.

3.2.2. Influence of shared sanitation on mental and social well-being

Thirteen qualitative and mixed method studies addressed shared sanitation. Eight of these studies reported an influence of shared sanitation on privacy, seven on safety, six on dignity and assault, five on fear, four on anxiety, three on embarrassment, and two on shame (Supplemental Figure 1). In regards to the *type* of shared sanitation, ten of the studies explored *public sanitation facilities* in urban settings with seven of those studies examining informal settlements in Kenya and/or India. The remaining three studies examined community latrines in rural Zambia, shared sanitation for nursing home residents in Italy, and the experience of using shared facilities among several families for people living with physical disabilities in Malawi. Summary themes on shared sanitation are presented in Table 2, descriptive themes reported in Supplemental Table 5, and extracted quantitative findings reported in Supplemental Table 3.

People experience a lack of privacy with shared sanitation due to the inherent greater risk of exposure to others (Caruso et al., 2013; Kuria et al., 2005; Thys et al., 2015). Women and girls are embarrassed even when others see them accessing public sanitation facilities (Kuria et al., 2005; Caruso et al., 2013). Women also fear sharing public sanitation facilities with men due to the risk and experience of verbal and sexual assault, including rape (Amnesty, 2010; Kuria et al., 2005; Moore and Breeze, 2012; Nallari, 2015; Corburn and Hildebrand, 2015; Kulkarni et al, 2017). Public sanitation facilities also do not allow women and girls to privately manage their menstruation because they are harassed by other users for taking too long and fear leaving behind blood or other evidence of their menstruation (Amnesty, 2010; Walters, 2014).

> *"There is the issue of privacy when you have your menstrual periods and your male neighbors and relations are there waiting as you have to use the bathroom or toilet to change and clean-up. Because it is usually a single room latrine/toilet or bathroom, you have to queue often and people are always knocking on the door rushing you."*
>
> *– Woman, Kenya (urban slums)*
>
> Amnesty (2010).

Among men, one study by Moore and Breeze (2012) documented the anxiety men in the UK experience when using public urinals. Men risk having their privacy violated or accidentally violating the privacy of other men by breaking the 'no looking' rule at urinals. This can result in shame and physical or sexual assault and in turn, affect dignity.

> *"At my football club they've renovated the toilets and places where people congregate so that they wouldn't fight each other. Like, [mimics tough voice] 'What are you doing? Why are you looking at my dick mate?!' and then punching each other in the face …."*
>
> *– Man, UK (urban)*
>
> Moore and Breeze (2012).

Another anxiety for public sanitation users is the fear of not being able to access the toilet in time when there are long queues and the person is suffering from diarrhea (Bapat and Agarwal, 2003; Thys et al., 2015).

Public sanitation facilities can also be unsafe and lack privacy due to their design, maintenance, and location. Public sanitation facilities that lack doors or have broken doors, no locks, low walls, and/or poor lighting can impact the user's sense of safety and privacy (Corburn and Hildebrand, 2015; Kuria et al., 2005; Moore and Breeze, 2012; Nallari, 2015; Walters, 2014; Kulkarni et al, 2017). Public sanitation facilities located in the middle of a community do not offer privacy and facilities that are far away or in dangerous locations, such as near liquor stores, are unsafe (Corburn and Hildebrand, 2015; Kuria et al., 2005; Moore, 1966; Thys et al., 2015; Moore and Breeze, 2012; Kulkarni et al, 2017). White et al. (2016) explored the experience of using shared sanitation

for people living with disabilities and found people with visual impairments felt unsafe because they risked falling into the hole while people with physical disabilities risked getting hurt if floors were uneven or slippery. Public sanitation facilities are seen as unsafe for children due to similar maintenance issues (e.g. slippery floors, open wastewater trenches nearby) (Bapat and Agarwal, 2003; Kuria et al., 2005). Children also fear they might fall into the hole when using a pit latrine, be it shared or private, and as a result prefer going for open defecation (Routray et al., 2015; Thys et al., 2015).

Inaccessible and inadequate public sanitation facilities can lead to a loss of dignity as people feel forced to defecate in a way that damages one's self-respect. Walters (2014) and Kulkarni et al. (2017) documented how urban homeless women and slum residents in India, respectively, rely heavily on public sanitation but are forced to open defecate at night or in the early morning when facilities are closed. Amnesty (2010) and Joshi et al. (2011) uncovered that the urban poor feel forced to use dirty community latrines that have feces and urine on the floor to avoid open defecation. Similarly, White et al. (2016) reported people with physical disabilities are forced to touch other's feces and urine when using poorly maintained shared latrines. Lastly, Corburn and Hildebrand (2015) documented how women feel forced to defecate in a bucket or bag at home when shared facilities are far away and lack lighting, making it too risky to access at night.

> *"We are forced to use a bucket…a bucket in one room in front of your children, fathers and brothers. Can you imagine? Sometimes we use the 'flying toilets' at night but your neighbors don't like this. Without any garbage collection, I wake up at dawn and sneak away to empty the bucket or dispose the bag. There is no dignity in our toilet situation."*
>
> *– Woman, Kenya (urban slums)*
>
> Corburn and Karanja (2016).

Conversely, Joshi et al. (2011) found access to appropriate, well maintained public sanitation facilities can provide a greater sense of social status and pride to the urban poor and subsequently a sense of dignity.

> *"We are proud to invite friends and family now."*
>
> *– Resident, Kenya (urban slum)*
>
> Joshi et al. (2011).

3.2.3. Influence of school sanitation on student mental and social well-being

Twenty-five studies examined school sanitation: 17 qualitative, five mixed methods, and three cross-sectional studies. The studies examined sanitation experiences for students from primary school to university, in urban and rural areas, and across 21 different countries. One study focused on the experience of school sanitation for students with physical disabilities. Twenty qualitative and mixed method studies uncovered an influence of school sanitation on privacy, eight on anxiety and fear, five on embarrassment and assault, four on safety, three on shame, and one on dignity (Supplemental Figure 1). Two cross-sectional studies examined students' perceptions and experiences with school toilets and how this impacted their toilet use (Barnes and Maddocks, 2002; Lundbald and Hellström, 2005). Another cross-sectional study examined the association between denial of access to college bathrooms and lifetime suicide attempts for transgender and gender non-conforming individuals (Seelman, 2016). Summary themes on school sanitation are presented in Table 2, descriptive themes reported in Supplemental Table 6, and extracted quantitative findings reported in Supplemental Table 3.

Much like adult sanitation users, students from preschool age to junior high are mostly concerned about the safety and lack of privacy at school toilets and the risk of exposing themselves to their classmates, either due to inadequate infrastructure or the behavior of other students. Examples of inadequate sanitation infrastructure include school toilets with low, damaged, or missing doors or walls; doors without locks; and/or windows with holes (Caruso et al., 2014; Haver et al., 2013; Mitchell, 2009; Moore, 1966; Norling et al., 2016; Njuguna et al., 2008). Barnes and Maddocks (2002) surveyed 87 students ages 4–15 years old and found 52% reported they were only sometimes or never able to close and lock the toilet door. Lack of cleanliness can also cause students to feel anxious and fear exposure to other's germs (Caruso et al., 2014; Norling et al., 2016; Njuguna et al., 2008).

Students expressed feelings of embarrassment, anxiety, and shame from the lack of privacy at school toilets due to the exposure of one's bodily needs to others through sight (being seen accessing the school toilet), sound (being heard using the toilet), and/or smell (leaving an odor after use) (Norling et al., 2016; Lundbald et al., 2010; Tatlow-Golden et al., 2015; Caruso et al., 2014; Haver et al., 2013). Students also endure fear and embarrassment when they must ask permission from the teacher to use the toilet, as this exposes their bodily needs to their classmates (Moore, 1966; Haver et al., 2013; Lundbald et al., 2010).

> *"Everyone gets to know that I need to pee. It's really embarrassing. I should be able to go without everyone's eyes on me."*
>
> *– Student, Sweden (urban schools)*
>
> Lundbald et al. (2010).

In other cases, when a student uses the school toilet their privacy is purposefully violated by their classmates who look over or under the walls/doors, peep through cracks, or unlock doors (Senior, 2014; Haver et al., 2013; Norling et al., 2016; Sommer et al., 2015). Moreover, students are teased and bullied when using the school toilets, especially when there is evidence that they defecated (i.e. odor), causing anxiety and shame (Njuguna et al., 2008; Norling et al., 2016). Senior (2014) surveyed 232 primary school students and found 71% of girls and 65% of boys reported a fear of other students' behavior at the school toilets. Lastly, students with disabilities face being bullied by their classmates when accessing school toilets (Erhard et al., 2013).

Schoolgirls fear and experience verbal and sexual assault from their male classmates when accessing school toilets (Mitchell, 2009; Njuguna et al., 2008; Seelman et al., 2012; Abrahams et al., 2006; Hirve et al., 2015). One study by Mitchell (2009) in Rwanda and Swaziland found schoolgirls fear being raped at their school toilets. Consequently, schoolgirls do not feel there is adequate privacy if the toilets are not gender-segregated or if they must pass by the boys' toilet in order to access their own toilet (Hirve et al., 2015; Norling et al., 2016; Caruso et al., 2013; Corburn and Hildebrand, 2015; Haver et al., 2013; Long et al., 2013; Millei and Gallagher, 2011; Sommer et al., 2015). Schoolgirls also experience anxiety and fear over the risk of menstrual leaks, stains, and odors because of the many barriers they face with managing their menstruation at school due to inadequate toilets (Sommer et al., 2015; Corburn and Hildebrand, 2015; Tegegne and Sisay, 2014; Haver et al., 2013; Keihas, 2013; Sommer, 2010; Erhard et al., 2013). Haver et al. (2013) documented the embarrassment girls feel when their menstrual status is exposed to their classmates and the teasing that results. In contrast, Caruso et al., 2014 documented how schoolgirls in rural Kenya liked their school's toilets because they provided sufficient privacy for menstrual management.

> *"You can do whatever you want inside there without someone knowing. You can even change your pads without someone knowing that you were on periods."*
>
> *-Schoolgirl, Kenya (rural schools)*
>
> Caruso et al., 2014.

Students employ a variety of strategies to address these privacy issues around school toilets, many of which are reminiscent of the strategies used by women and girls for open defecation. Schoolgirls go to the toilet in pairs to ensure each other's privacy and/or run water at the sinks so no one can hear them defecate (Norling et al., 2016; Abrahams et al., 2006; Haver et al., 2013; Long et al., 2013).

> *"We do not go alone and take a friend with – they must keep the door closed or stand in the door as a guard."*

– *Schoolgirl, South Africa (urban and semi-rural schools)* Abrahams et al. (2006).

Norling et al. (2016) found students go to the toilet during class when other students aren't around or use the toilets designated for school staff, which are often in more private locations. Eight qualitative studies documented how students avoid the school toilets altogether and suppress their needs to urinate and defecate until they get home (Moore, 1966; Millei and Gallagher, 2011; Norling et al., 2016; Haver et al., 2013; Njuguna et al., 2008; Seelman et al., 2012; Barnes and Maddocks, 2002; Lundbald and Hellström, 2005). In addition, Lundbald and Hellström (2005) surveyed 385 students ages 6–16 years old and found 67% reported always or sometimes avoiding the school toilet with anxiety being a statistically significant reported reason.

Lastly, Seelman et al. (2012) explored the sanitation needs of transgender and gender non-conforming college students and found the students experience fear and anxiety over using gender-segregated toilets because they are often questioned, harassed, and assaulted for their gender expression. To feel safe, transgender and gender non-conforming students prefer gender neutral, single-stall, lockable toilets.

"Somebody went in and just found all the bathrooms on campus and wrote it down and described what kind of bathrooms they were. Mainly we were trying to find, I guess, single-stall lockable restrooms that are often the handicap bathroom. But if you're trans and you don't want to get harassed and you're worried about it, you can just use one of those and not worry about assholes treating you badly."

– *Transgender student, USA (colleges and universities)* Seelman et al. (2012).

In addition, Seelman (2016) conducted a secondary analysis of the National Transgender Discrimination Survey (NTDS) data and found respondents who were denied access to a bathroom during college due to being transgender or gender non-conforming had 1.32 greater odds of attempting suicide at some point in time compared to respondents who had not been denied access to a bathroom during college (95% CI 1.00, 1.74, $p < 0.05$).

3.2.4. Influence of private sanitation on mental and social well-being

Fourteen studies addressed private sanitation: nine qualitative, two mixed methods, and three cross-sectional. The studies were conducted across six different countries, with ten studies in India. Most of the studies focused on the experiences of private sanitation for women, especially women living in rural India. Six qualitative and mixed method studies uncovered an influence of private sanitation on safety, five on privacy, four on dignity, two on shame, embarrassment, fear, and assault, and one on anxiety (Supplemental Figure 1). One cross-sectional study by Bangdiwala et al. (2004) assessed the association between access to private sanitation and both physical and psychological intimate partner violence (IPV). Another cross-sectional study by Kang et al. (2016) examined the relationship between poverty indicators, such as access to private sanitation, and psychological distress for people living with HIV. Summary themes on private sanitation are presented in Table 2, descriptive themes reported in Supplemental Table 7, and extracted quantitative findings reported in Supplemental Table 3.

In some contexts, private sanitation can give a family dignity by improving their social standing since household latrines are sometimes associated with a more modern status and can also act as a sign of respect for guests and visitors (Routray et al., 2015; Prabhakaran et al., 2016; Thys et al., 2015).

"There is dignity especially for visitors. When a visitor comes at home and asks to use a latrine, you easily point it out. That person may be happy not to go in the bush. There is respect at a home if there is a latrine."

– *Man, Zambia (rural)* Thys et al. (2015).

In contrast, Bisung and Elliott (2016a) documented the shame and embarrassment people feel when they are unable to offer private sanitation to guests and visitors and instead must *"show them to the bush."* Subsequently, people reported feeling anxiety over their inability to afford constructing a private household latrine (Bisung and Elliott, 2016a).

Access to a household latrine can also give women and girls dignity through their ability to defecate in a private and safe setting (Khanna and Das, 2016; Routray et al., 2015; Pfadenhauer and Rehfuess, 2015; Krishnan et al., 2015; Thys et al., 2015; Kulkarni et al, 2017). Women in India who had access to private and safe sanitation expressed relief from the fear, shame, and risk of assault they experienced when practicing open defecation (Khanna and Das, 2016; Prabhakaran et al., 2016).

However, private sanitation facilities can also lack privacy and safety, causing the same feelings of embarrassment and shame that women experience with open defecation. Household latrines that are in unsafe locations and/or lack a door, lock, roof, walls, high enough walls, or other structural features do not offer adequate privacy or ensure safety (Sahoo et al., 2015; Thys et al., 2015; Routray et al., 2015; Khanna and Das, 2016; Kingery et al., 2016). The location of the household latrine is another privacy issue. Men and women alike do not want to be seen walking to the latrine by other household members or to accidentally meet at the latrine (Hirve et al., 2015; Thys et al., 2015; Routray et al., 2015). This loss of privacy was described by one man as *"like you have been undressed"* (Thys et al., 2015). As a result, men and women sometimes prefer openly defecating instead of using their household's latrine.

3.3. Confidence in evidence

Our CERQual Summary of Findings is presented in Table 2 and our assessment met the minimum criteria for fidelity to the GRADE-CERQual approach (Lewin et al., 2018a,b). For open defecation, we have moderate to high confidence in the evidence for three of the four summary themes: 'bodily exposure and violation,' 'public shaming and assault,' and 'safety and privacy issues with OD sites.' The themes had moderate concerns about methodological limitations but no or minor concerns about coherence and adequacy. The themes had moderate to serious concerns about relevance since a majority of contributing studies specifically examined the experience of open defecation for women in India. We did not, however, lower our confidence in the evidence in regards to relevance when a theme had a large number of supporting studies. Instead, we note that the theme is largely representative of a certain context and population.

For shared sanitation, we again have moderate to high confidence in the evidence for three of the four summary themes: 'exposure of bodily needs,' 'verbal and sexual assault,' and 'safety and privacy issues with public sanitation facilities.' The themes had serious concerns about methodological limitations but no or very minor concerns about coherence and minor or moderate concerns about adequacy. Similar to open defecation themes, shared sanitation themes had moderate to serious concerns about relevance as the evidence was largely representative of urban settings, especially informal settlements in India and Kenya. We have high confidence in the evidence for all four school sanitation summary themes: 'exposure of bodily needs and violation of privacy,' 'inadequate privacy and assault faced by schoolgirls,' 'exposure of menstrual status,' and 'safety and privacy issues with school sanitation facilities.' The findings had minor to moderate concerns about methodological limitations, no or minor concerns about coherence and adequacy, and even no or very minor concerns about relevance - except for 'exposure of menstrual status' which was largely representative of the African context. We have very low to low confidence in the evidence for all four summary themes on private

sanitation due to the very limited number of studies contributing to the evidence. Likewise, we have very low to low confidence in the summary themes across sanitation types that addressed the dignity dimension due to lack of studies (open defecation = 'loss of dignity from assault'/ shared sanitation = 'loss of dignity from defilement'/private sanitation = 'dignity for women and girls' and 'dignity from respect'). Lastly, we have moderate to high confidence in the evidence on the 'well-being strategies' summary themes for open defecation and school sanitation.

3.4. Preliminary conceptual model

We found several overarching patterns emerge across the summary themes for the different sanitation types. All sanitation types had a summary theme around bodily exposure or exposure of bodily needs and a theme on privacy and safety issues with sanitation facilities or open defecation sites. All but private sanitation had a theme on assault and all but school sanitation had a theme around the loss or preservation of dignity. Based on this examination, we developed a *preliminary* conceptual model for how inadequate sanitation can negatively influence mental and social well-being and how the different well-being dimensions relate to each other (Fig. 2). The model shows how privacy and safety, including the dimension of assault which acts as a form of violating personal safety, appear to be root well-being dimensions. We found that when people *perceive a risk* to their privacy or safety, this can lead to feelings of anxiety and fear as they *anticipate* an act of violation, while when people *experience* a violation of their privacy or personal safety (i.e. assault), this can lead to feelings of shame and embarrassment and sometimes loss of dignity because of that violation. As described above, for many of these summary themes we have moderate to high confidence in the evidence. However, it is important to note that several summary themes are only representative of specific contexts and populations and we have very low to low confidence in themes around dignity due to the limited number of studies contributing to the evidence. As such, in the model, the lines connecting to dignity are dashed to indicate this limited evidence. Finally, an examination of the descriptive themes uncovered several contextual and individual factors that appear to mediate the perceptions and experiences a person has around privacy and safety when accessing sanitation.

4. Discussion

To date, systematic reviews on the impact of sanitation on health have primarily focused on infectious disease and related sequelae, such as diarrhea and malnutrition (Freeman et al., 2017; Dangour et al., 2013; Grimes et al., 2014; Stocks et al., 2014; Strunz et al., 2014; Wolf et al., 2014). In this review, we synthesize the evidence for how sanitation influences dimensions of mental and social well-being, specifically dignity, privacy, shame, embarrassment, anxiety, fear, assault, and safety.

Based on the summary themes uncovered in this review, we constructed a preliminary conceptual model on how inadequate sanitation negatively influences mental and social well-being (Fig. 2). The model showcases how privacy and personal safety, including assault, appear to be root well-being dimensions. When people *perceive* or *experience* a lack of privacy or safety when going for open defecation or using a form of sanitation this can lead to negative influences on other dimensions of well-being (i.e. anxiety, fear, embarrassment, shame, dignity). An underlying pattern across the summary themes revolved around the risk or experience of exposing one's body to others and the risk or experience of violation of privacy, often from verbal, physical, or sexual assault. This pattern arose across the sanitation types from women and girls reporting bodily exposure and violation during open defecation to people reporting unwanted bodily exposure to family members when accessing their private household latrine. People, primarily women, reported feeling fear and anxiety when they *perceived risks* to their privacy and safety and feeling shame, embarrassment, and sometimes a loss of dignity, when they *experienced* violation of their privacy and safety. We also found that women and students employ similar strategies to safeguard their well-being when they do not have access to private and safe sanitation, such as suppressing bowel movements and withholding food and drink. Moreover, individual factors, such as gender identity, physical ability, life stage, residency status, and socioeconomic status, can influence the perceptions and experiences a person has around privacy and safety when accessing sanitation.

We found that the privacy and safety issues expressed in the summary themes could be attributed to three types of contextual factors - structural, environmental, and social. *Structural* privacy and safety

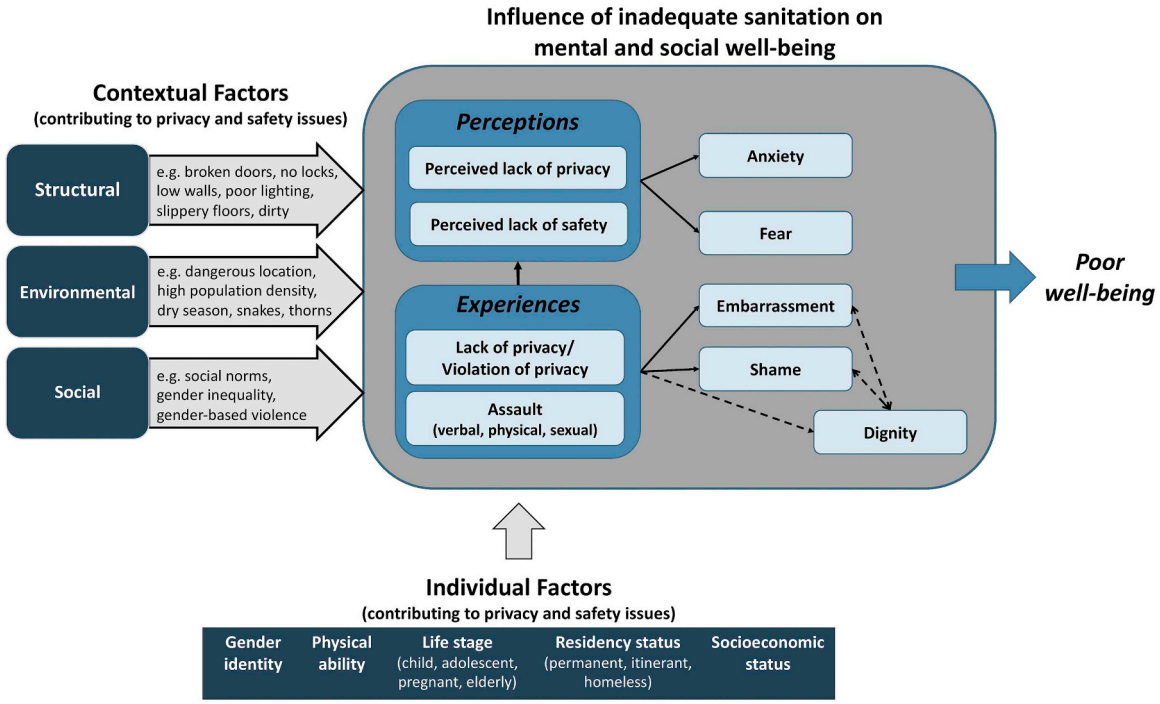

Fig. 2. Preliminary conceptual model of the influence of inadequate sanitation on mental and social well-being.

issues involved facility design and maintenance (e.g. low walls, no roof or doors, lack of locks, poor lighting, slippery floors, etc.), which were experienced across the different types of sanitation. *Environmental* issues highlighted how physical location of a sanitation facility (e.g. center of community) or open defecation site (e.g. along railway tracks) and the surrounding natural environment (e.g. snakes, thorns, low bushes) led to experiences of inadequate privacy and hazardous situations. *Social* privacy and safety issues revolved around social norms and expectations of privacy, gender inequalities, and gender-based violence. For example, women and girls often face stricter privacy requirements compared to men. As one woman from rural India noted *"What problems do men face? They can go for defecation at any time and at any place"* (Khanna and Das, 2016; Prabhakaran et al., 2016). Recent studies by O'Reilly (2016) and Caruso et al., 2017a call on the sanitation field to move beyond toilet construction alone and instead also confront these more deeply rooted social issues related to sanitation that influence mental and social health, such as gender inequality.

These findings suggest that to ensure a positive impact on a user's mental and social well-being, practitioners, researchers, government officials, and other stakeholders need to thoroughly examine issues of privacy and safety when developing policies or when designing and implementing sanitation interventions. Specifically, sanitation stakeholders should consider the structural, environmental, and social factors that could lead to privacy and safety issues for the user and explore ways to mitigate these factors. Our findings suggest that whether a sanitation facility provides a user adequate privacy and safety is largely based on the user's *perceptions* and as a result, sanitation users should be closely involved in the design and decision-making process for sanitation policy and interventions.

Similarly, this review elucidates the need for more comprehensive evaluations of sanitation that consider impacts on mental and social well-being. Currently, the sanitation sector primarily relies on the 'sanitation service ladder' to evaluate and compare sanitation across countries (JMP, 2017). The rungs of the ladder start at the bottom with open defecation and move up to unimproved (pit latrines without slab or platform, hanging latrines, or bucket latrines), to limited (shared sanitation), to basic (improved facilities that are not shared and hygienically separate excreta from human contact), to safely managed (excreta from improved facilities is safely disposed). However, these top rungs focus mainly on structural factors (e.g. facility design) with little emphasis on environmental and social factors that also impact the mental and social well-being dimensions illustrated in this review. While private sanitation (i.e. basic service level) may ameliorate aspects of those factors, certain user groups such as students and the urban poor must rely on limited services (i.e. shared sanitation). Evaluations of sanitation interventions should use more comprehensive measures that give appropriate emphasis to environmental and social factors, such as latrine location and user perceptions of safety.

To comprehensively evaluate sanitation, future research should also examine ways to *measure* mental and social well-being. Research by Caruso et al., 2017b offers initial insights into how to measure these more psychosocial impacts on health from sanitation. The authors developed a novel 'sanitation insecurity' measure that assesses "the range and frequency of women's sanitation-related concerns and negative experiences." The measure includes 50 survey items that evaluate the physical environment, social environment, and individual-level constraints around a person's sanitation experience that could negatively impact their mental well-being. In addition, the definitions applied to the well-being dimensions explored in this review are broad and not theoretically grounded (Table 1). Further research is needed to more rigorously *define* mental and social well-being indicators in this context and create appropriate measures for assessment.

We invite sanitation researchers to examine, build upon, and revise the preliminary conceptual model presented in this review (Fig. 2). While this review highlights privacy and safety, including assault, as root well-being dimensions, there could be other critical dimensions such as feelings of cleanliness. 'Cleanliness' inductively arose during our coding process but was not systematically analyzed. Studies documented how the experience of using a clean sanitation facility led to feelings of comfort, happiness, and pride while unclean facilities led to feelings of disgust and forced defilement (Erhard et al., 2013; Joshi et al., 2011; White et al., 2016). Likewise, the summary themes on dignity were assessed with low confidence due to the lack of studies, indicating dignity is underexplored. Dignity should be more thoroughly examined as it is often part of the sanitation discourse in the development field but with limited evidence to date.

4.1. Limitations

This review has several limitations. First, the selected well-being dimensions limited the scope of the review and the best-fit framework approach did not allow for a more inductive exploration. As a result, it is possible other themes on sanitation and mental and social well-being were not captured. In addition, while we are able to report that some dimensions, privacy and safety specifically, emerged more commonly than others, it is not possible to know if this is because they are truly more important or they were simply investigated more intentionally than the other six dimensions. Similarly, aspects of material well-being were not addressed in this review and should be explored in future research. Second, this review is limited in its generalizability due to the skewed geographical distribution of studies and predominant focus on the experience of women and girls. Summary themes on open defecation were largely representative of women in India and shared sanitation themes were largely representative of urban settings in India and Kenya. None of the studies explicitly focused on the sanitation experience of men and boys. Consequently, the presented findings largely represent how sanitation influences the mental and social well-being of women and girls. Though women and girls bear a significant burden of sanitation challenges, more research is needed on the experience of men and boys, as well as vulnerable groups like people experiencing homelessness, people with physical disabilities, and trans-gender populations. Third, all of the quantitative study designs had serious or very serious risk of bias and the majority of the qualitative study designs were of medium quality. Furthermore, instead of applying two separate appraisal tools depending on the type of data, a single appraisal tool specific to a mixed method study review could have been applied (Pace et al., 2012; Pluye et al., 2009). However, this appraisal tool is still being refined (Hong et al., 2018). Finally, the eligible studies predominantly examined people's negative experiences with sanitation, or lack of sanitation, which in turn made the focus of this review on how sanitation *negatively* influences mental and social well-being. There is a need for future research on how and when sanitation *positively* influences well-being.

Acknowledgements

We are grateful to Hannah Rogers, Librarian at the Woodruff Health Science Library at Emory University, for her guidance and support with the electronic database searches. We are also grateful to Darcy Anderson, Henrietta Lewis, Amrita Mahtani, Divya Narayanan, and Rachel Stelmach for their work on the title, abstract, and full-text review. Funding for this review was provided by the WHO (HQPHE1611466 - 64083). WHO funding was made possible through contributions from the UK Department for International Development and the Bill & Melinda Gates Foundation. Authors JVG and MCF have received funding as consultants for the WHO as part of separate assessments of sanitation on health. Authors SB and KM are employees of WHO. The authors alone are responsible for the views expressed in this article and do not necessarily represent the views, decisions, or policies of the institutions with which they are affiliated. The authors declare no other competing interests exist.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2018.09.016.

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