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The determinants of handwashing behaviour in domestic settings: An integrative systematic review

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ABSTRACT

Background: Hygiene promotion interventions are likely to be more effective if they target the determinants of handwashing behaviour. Synthesis of the evidence on the determinants of handwashing behaviour is needed to enable practitioners to use evidence in hygiene promotion programming.
Purpose: To identify, define and categorise the determinants of handwashing behaviour in domestic settings and to appraise the quality of this evidence.
Methods: We conducted an integrative review, searching three databases for terms related to handwashing and behaviour change determinants. Studies were summarised and their quality assessed against a pre-defined set of criteria for qualitative, quantitative and mixed-method studies. Data on determinants were extracted and classified according to a predefined theoretical taxonomy. The effect of each association between a determinant and handwashing behaviour was summarised and weighted based on the quality of evidence provided. Determinants that were reported more than three times were combined into a meta-association and included in the main analysis. Sub-analyses were done for studies conducted during outbreaks or humanitarian crises.
Results: Seventy-eight studies met the criteria. Of these, 18% were graded as 'good quality' and 497 associations between determinants and handwashing behaviour were extracted. We found that 21% of these associations did not clearly define the determinant and 70% did not use a valid or reliable method for assessing determinants and/or behaviour. Fifty meta-associations were included in the main analysis. The determinants of handwashing that were most commonly reported were knowledge, risk, psychological trade-offs or discounts, characteristic traits (like gender, wealth and education), and infrastructure. There was insufficient data to draw conclusions about the determinants of behaviour in outbreaks or crises.
Conclusions: This review demonstrates that our understanding of behavioural determinants remains sub-optimal. We found that there are limitations in the way behavioural determinants are conceptualised and measured and that research is biased towards exploring a narrow range of behavioural determinants. Hygiene promotion programmes are likely to be most successful if they use multi-modal approaches, combining infrastructural improvement with 'soft' hygiene promotion which addresses a range of determinants rather than just education about disease transmission.

1. Introduction

Handwashing with soap (HWWS) is an effective means of preventing infectious disease. Meta-analyses suggest that HWWS can reduce the risk of diarrhoeal disease by 23%–48% (Cairncross et al., 2010; Freeman et al., 2014; Wolf et al., 2018) and reduce risk of respiratory infections by 21%–23% (Rabie and Curtis, 2006; Aiello et al., 2008). However, we still do not know how best to go about promoting handwashing in the communities that could most benefit. Systematic reviews of the effectiveness of hygiene promotion interventions to change handwashing behaviour have reported mixed results and identified many challenges (Naikoba and Hayward, 2001; Wilson et al., 2011; Luangasanatip, Hongsuwan et al. 2014, 2015; De Buck, Van Remoortel et al., 2017; Mbakaya et al., 2017; Watson et al., 2017; Martin et al., 2018), including the need to identify factors which can be modified to prompt changes in handwashing behaviour. We refer to these potential factors as 'behavioural determinants'. For a behaviour change intervention to be effective, behaviour change theorists argue that it must address some of the determinants that influence a behavioural outcome (Coombes and Devine, 2010; Mosler, 2012; Aunger

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Table 1
Handwashing determinant definitions adapted from on the BCD checklist of determinants (Aunger and Curtis, 2019).

Behavioural determinants defined by the BCD framework		Definitions of each determinant adapted to handwashing
Brain	Executive Brain	The extent to which knowledge of handwashing behaviour and its benefits affects handwashing intentions and plans, and eventually performance of the behaviour.
	Motivated Brain	The goal-related drivers of behaviour. Motives for handwashing can include (but is not limited to) disgust (the desire to avoid cues to sources of infection), affiliation (the desire to fit in with others) and nurture (the desire to care for your child).
	Reactive Brain	The extent to which handwashing can be automatically triggered based on past experience and repetition.
	Discounts	The perceived time, effort and costs of washing hands with soap as compared to other courses of action.
Body	Characteristics	Socio-demographic characteristics that may affect handwashing, including gender, wealth, age, education and employment.
	Senses	The sensory perceptions that may cue handwashing behaviour or be experienced during or after handwashing.
	Capabilities	Whether an individual has the skills required to wash their hands with soap. Whether an individual perceives themselves to be able and willing to actually wash their hands at the times required.
Behaviour settings	Stage	The design and set up of the specific physical spaces where handwashing behaviour takes place.
	Infrastructure	Durable infrastructure associated with handwashing such as water supply systems, sanitation, kitchen facilities and handwashing facilities.
	Props	The value, characteristics, usability, ownership and accessibility of soap and other objects used for handwashing.
	Roles	The ways in which an individual's role, identity or responsibilities influence their handwashing practices.
	Routine	The sequence of behaviours regularly performed in association with handwashing.
	Norms	The extent to which an individual's handwashing practice is influenced by their perception of normative setting-specific rules. This includes an individual's perception of whether handwashing is commonly practiced in their community (descriptive norm); whether handwashing is part of their role and their normal behaviour (personal norm); whether handwashing is socially approved of (injunctive norm); and whether handwashing is practiced by their 'valued others' (subjective norm).
Environment	Physical environment	Factors in the physical or built environment including climate and geography.
	Biological Environment	Factors associated with an individual's interaction within their biological environment.
	Social Environment	The structure of an individual's social environment, including how they interact with it and perceive themselves within it.
External context	Political and historical context	The historical and cultural events that have shaped current perceptions and practices of handwashing. The extent to which handwashing-related policies or local and national leadership on handwashing issues, shape handwashing perceptions and practices at the individual level.

and Curtis, 2016; Dreibelbis et al., 2016).

Within the WASH sector there are multiple behavioural frameworks, each with different ways of defining and categorising the determinants of behaviour. IBM-WASH (the Integrated Behaviour Model for WASH) (Dreibelbis et al., 2013) is an example of an ecological framework and stratifies determinants according to their level of behavioural influence (e.g. those which influence people at individual, local, community and social/cultural levels). RANAS (Mosler, 2012) is another widely applied method which is grounded in health psychology and focuses on domains of cognitive reasoning such as risk, attitudes, norms, abilities and self-regulation. FOAM (Coombes and Devine, 2010) is an approach specifically focused on handwashing behaviour which has roots in social cognition theory. FOAM postulates three categories of determinants: opportunity (covering determinants like social norms and access to products), ability (covering determinants like knowledge and social support) and motivation (covering determinants such as beliefs, intentions and emotional drivers). Additionally WASH practitioners and academics have commonly used a set of more generic behavioural frameworks including Designing for Behaviour Change (CORE Group and Behavioural Change Working Group, 2008), COM-B (Michie et al., 2011), Theory of Planned Behaviour (Ajzen, 1991), the Health Belief Model (Becker MH. 1974) and Behaviour Centred Design (Aunger and Curtis, 2016). Across these behavioural frameworks there is a high level of overlap in the determinants mentioned. Yet each model conceptualises determinants and their relationship to one another differently.

Whilst research on handwashing in communities has expanded in recent decades (Global Handwashing Partnership 2017, 2019) there have, as yet, been no systematic reviews focusing on its determinants.

This current review has two objectives: 1) to identify, define and categorise the determinants of handwashing behaviour in domestic settings globally and, 2) to appraise the quality of this evidence, with the broader aim of assisting practitioners to better focus their handwashing promotion efforts.

2. Methods

We completed an integrative systematic review. This style of review allows for the inclusion of diverse methodologies and are particularly useful for informing and developing theory, appraising the quality of evidence provided by different types of studies in relation to a topic, and identifying gaps in current research (Russell, 2005; Whittemore and Knafl, 2005). We followed the five step process outlined by Whittemore and Knafl, (2005) and Russell, (2005). Step 1 is formulation of the problem, step 2 is defining the search criteria, step 3 is the evaluation of the data, step 4 is the analysis of data and step 5 is the presentation of data. Each of these steps are described below.

2.1. Step 1: problem formulation

Integrative reviews require a well-defined philosophical or theoretical framework for analysis (Kirkevold, 1997). We therefore sought a practical and flexible framework for systematically classifying the determinants of behaviour. We further specified a definition of our outcome, 'handwashing behaviour', and selected appropriate populations of interest and study types for the review.

2.1.1. Definition of determinants

In identifying a framework of determinants for this review we sought to use an approach that had been widely used in water, sanitation and hygiene (WASH) research; which had a clearly defined set of determinants; and which reflected the diverse ways determinants are conceptualised across academic disciplines. The approach of Behaviour Centred Design (BCD) (Aunger and Curtis, 2019) was selected because its theory is generic, and draws from a range of disciplines such as evolutionary and cognitive psychology, social ecology, and social marketing practice. BCD presents a more comprehensive set of behavioural determinants than any of the other models we considered and defines each of these clearly(Aunger and Curtis, 2019). Types of determinant include factors in the brain (including knowledge, risk,

motives, reactions, and psychological trade-offs), factors in the body (characteristic traits and sensations) factors related to the settings where the behaviour takes place (infrastructure, props, roles, routine and norms) and factors in the broader environment (the biological, physical and social environment and the wider context). BCD proved broad enough to classify all of the determinants described in other frameworks. It has also been widely used for handwashing and other behaviour change studies (Biran et al., 2014; Greenland et al., 2016; White et al., 2016; Gautam et al., 2017; Tidwell et al., 2019). Table 1 provides definitions of each BCD determinant adapted for handwashing behaviour.

2.1.2. Behaviour of interest

We then specified the outcome, handwashing with soap, by defining and categorising measures of behaviour. Handwashing with chlorine mixtures, ash or alcohol gel were not included because they are less widely used and their determinants may be different. In cases where authors used more ambiguous terminology (e.g. 'hand hygiene practices' or 'handwashing'), we emailed authors to clarify whether handwashing was carried out with soap. HWWS in the 'domestic environment' was defined as handwashing after contact with faeces or prior to cooking and eating food at home. Handwashing behaviour is known to be difficult to measure. All study methods, such as self-report and structured observation suffer from limitations, especially measurement bias (Ram, 2010; Loughnan et al., 2015). We followed the general consensus on behavioural measurement within the hygiene sector (World Health Organization, 2009; WHO and UNICEF, 2015). We classified evidence gathered through direct observation or monitors (devices inserted into soap bars or soap dispensers) as 'good', evidence from proxy measures (such as the presence of water and soap near a toilet), handwashing 'sticker diaries' (Schmidt et al., 2019) or demonstrations of handwashing behaviour as 'moderate', and self-reported behaviour as 'weak' evidence.

2.1.3. Population of interest

We excluded studies conducted in schools, universities, day-care centres, aged-care homes, prisons, health facilities or workplaces. Studies in any country were eligible for inclusion. A sub-analysis was performed on studies conducted during disease outbreaks and during humanitarian crises (this included studies conducted during disasters, conflict or displacements of populations). This was because the determinants of handwashing behaviour may differ when there are major disruptions to social, physical and biological environments.

2.1.4. Study types

We included all types of qualitative and quantitative peer-reviewed publications concerning interventional or observational studies. Commentaries, editorials, review articles or theoretical articles that did not present new data or provide an analysis of secondary data were excluded.

2.2. Step 2: search criteria

We conducted our searches via the Embase, Medline, and psycINFO databases on the June 22, 2018. Searches combined handwashing and hygiene mesh terms with either broad terms relating to behaviour change and behaviour determinants, or to specific terms describing each determinant in the BCD checklist (see ESM 1). We only included studies published in English. Studies published before the year 2000 were excluded. This cut-off date was decided based on adoption of the Millennium Development Goals. After this point there appears to have been a recognition that handwashing and hygiene were as important as water and sanitation (Curtis and Cairncross, 2003) followed by a corresponding increase in WASH-related research.

2.2.1. Data management and screening

We imported citations into Endnote and duplicates were removed. We screened citations for eligibility first on titles and abstracts and then on a full text review. Eligibility was determined based on whether the manuscript reported any relationship between a behavioural determinant and handwashing behaviour in the results section of the paper (hereafter we describe this as 'an association'). Associations could be qualitatively or quantitatively described. No weighting was given based on the type of data or reported size of effect. We excluded papers that only speculated or expressed opinions on potential determinants of handwashing behaviour without actual data. We screened the references of all included papers so to identify further relevant texts, however, no additional studies were identified.

2.3. Step 3: evaluation of data

Studies were tabulated according to: publication date; country of focus (disaggregated according to World Bank classifications (World Bank, 2018)); population sampled (whether the study population was rural or urban, and whether the population were in a stable setting or were experiencing an outbreak or were crisis-affected); the study design and study methodology (classed as observational or interventional, and as qualitative, quantitative or mixed methods); the methods used for assessing behavioural determinants; the means of measuring the behavioural outcome; and whether the study referenced or used a behavioural theory.

2.4. Step 4: data analysis

Each reported determinant was categorised against the definitions in the BCD checklist. This process was double coded by authors SW and VC. For each association we also categorised whether the determinant was reported to have a positive effect on HWWS, no effect, or a negative effect. We also assessed each association in terms of whether the determinant was well defined and whether a valid and reliable method was used to assess the determinant and the resulting HWWS behaviour. The first author (SW) summarised the effect and assessed the definition and measurement of determinants. The second author (AHT) cross-checked a random 25% of all the classifications to validate the process. Inter-rater agreement between the two authors was assessed using Fleiss' Kappa (Fleiss and Cohen, 1973). Almost perfect agreement was found (Kappa score = 0.88) (Landis and Koch, 1977) so no further double-coding was undertaken. Where initial disagreement was identified, the authors discussed the rationale for their coding decision and were able to resolve all difference of opinion.

We calculated a composite quality score (range: 0 to 4) for each association. This was comprised of the sum of three specific quality measures: overall study quality (0–2 points), if determinant was well defined (0 or 1 point), and if valid and reliable methods were used to measure both handwashing behaviour and determinant (0 or 1 point). This composite means of assessing quality was necessary because study quality alone was an insufficient measure of the quality of determinant reporting and measurement within the study. Table 2 provides a detailed description of how the quality measures were defined and calculated.

If more than three studies described the same association between a determinant and HWWS (irrespective of how HWWS was measured), then the associations were summarised and included in the main analysis. For each of these 'meta-associations' we enumerated the number of individual associations in each effect category (positive effect on HWWS, no effect on HWWS, or negative effect on HWWS). The quality scores from each individual association were summed across each of the meta-association categories. This process allowed us to appraise both the number of studies reporting a certain type of effect and the quality of the evidence associated with each effect.

All authors were then invited to review this data and independently

Table 2
Description of the methods used to calculate the composite quality score for each association between a behavioural determinant and HWWS behaviour.

Quality Score Components	Possible Scores	Definition
Overall Study Quality	• 0 points for poor quality • 1 point for moderate quality • 2 points for good quality	We assessed the quality of each study using the methods adapted from Hill et al. (Hill, D'Mello-Guyett et al., 2014) We graded quantitative studies against 10 criteria, qualitative studies against 8 criteria and mixed method studies against 10 criteria. Studies were considered to be of good quality if they scored nine or ten on the quantitative or mixed method criteria and seven or eight on the qualitative criteria. Studies were considered to be of moderate quality if they scored between six and eight on the qualitative and mixed methods criteria and between four and six on the qualitative criteria. Studies scoring less than this were considered to be of poor quality. A full summary of the quality grading of all papers is provided in the supplementary materials (ESM2).
Determinant definition	• 0 points for a poor definition • 1 point for a clear definition	A 'clear definition' required that the determinant and the means of measuring it be explained in the text.
Valid and reliable measurement of the determinant and of HWWS behviour	• 0 points if the modes of measurement were not valid and reliable • 1 point if the modes of measurement were valid and reliable	A 'valid and reliable' measurement required two things: • That the method of measuring the determinant had either been tried elsewhere, or, if being tried for the first time, the validity and reliability of the method had to have been discussed. • That the method for measuring HWWS behaviour did not rely only on self-report.

draw their own conclusions about the overall effect of each meta-association and the quality of evidence in each meta-association category. Authors were asked to grade the meta-association effect as: a) a positive effect, b) inconsistent results indicating a positive effect, c) no effect, d) inconsistent results indicating no effect, e) negative effect, f) inconsistent results indicating a negative effect or g) inconsistent findings. Authors also graded the quality of evidence in each meta-association category as weak, moderate or good. Inter-rater agreement between the four authors was assessed using Fleiss' Kappa (Fleiss and Cohen, 1973). According to Landis and Koch's definitions (Landis and Koch, 1977) we reached almost perfect agreement in relation to the effect direction (Kappa score = 0.93) and substantial agreement on the quality of evidence (Kappa Score = 0.8). Where disagreement was identified the opinion of the majority of authors was reported.

We conducted a sub-group analysis of studies conducted during outbreaks and humanitarian crises by summarising the types of determinants reported in these settings and comparing them with the overall dataset.

Our review adheres to the PRISMA reporting guidelines (Moher et al., 2009).

3. Results

3.1. Characteristics of the studies included in this review

Fig. 1 presents a flow diagram of the search process used in this review and Fig. 2 presents a flow diagram of the analysis process. We identified 78 studies that met inclusion criteria. These studies took place in 44 countries, the majority of which were middle income (60%). Studies were equally divided between urban and rural contexts and 69% took place in stable settings. Sixteen took place during disease outbreaks while nine took place in humanitarian crises. Together the studies included over a million participants, although not all studies stated their sample size clearly. Only seven behaviour change theories were mentioned across all the studies and 45 studies did not cite any behaviour change theory. The theories mentioned were: IBM-WASH (Dreibelbis et al., 2013), Behaviour Centred Design (previously known as Evo-Eco) (Aunger and Curtis 2013, 2016), Theory of Planned Behaviour (Ajzen, 1991), RANAS (Mosler, 2012), the Health Belief Model (Becker MH. 1974), FOAM (Devine, 2009; Coombes and Devine, 2010), and Protection Motivation Theory (Rogers, 1983). Among the included studies the most common study design was cross-sectional quantitative studies that used self-reported measures of handwashing behaviour. However, the second most common measure of HWWS behaviour was direct observation, which was used in 30 studies. Table 3 summarises the characteristics of the studies in greater detail.

3.2. Quality of the studies included in this review

Table 4 summarises the quality of the studies. Only 13 studies were graded as high quality, with mixed-methods studies proportionally more likely to be graded as high quality when compared with qualitative or quantitative studies. A quarter of the papers did not provide a description of the context where the research was undertaken. Many papers (22%) provided ambiguous descriptions of their methods for assessing determinants and the majority provided no rationale for how methods were selected. Furthermore, 70% of papers did not discuss the limitations or biases of their methods.

3.3. Quality of assessment of associations between determinants and behaviour

We identified a total of 496 associations between a reported behavioural determinant and the HWWS outcome in the 78 included studies. Of the 496 associations identified, the determinant was not clearly described in 108 (22%) cases. Even in cases where determinants were well defined, there was little consistency in definitions across the literature. For example, nine manuscripts (Sakisaka et al., 2002; Scott et al., 2007; Lohiniva et al., 2008; Biran et al., 2009; Luby et al., 2009; Schmidt et al., 2009; Hulland et al., 2013; Oswald et al., 2014; Friedrich et al., 2017) discussed the importance of having either piped water or a water source close to the household, yet there was no agreement on what 'close' meant. Similarly, six papers reported that living in certain geographic regions made participants more likely to wash their hands (Schmidt et al., 2009; Miao and Huang, 2012; Al-Khatib et al., 2015; Hirai et al., 2016; To et al., 2016; Kumar et al., 2017) but did not describe the characteristics of these locations.

A further 344 of the reported associations did not use a valid and/or reliable method to measure either the determinant or the HWWS outcome, most often because the outcome measure was self-reported.

3.4. Reported associations between determinants and handwashing behaviour

Fig. 2 shows the total number of associations in each of the determinant categories of the BCD checklist. The association between socio-demographic characteristics and HWWS was the most widely reported determinant (n = 122, 25%). Several determinants were under-represented (mentioned fewer than 10 times across the literature), such as the biological environment, contextual factors, routines,

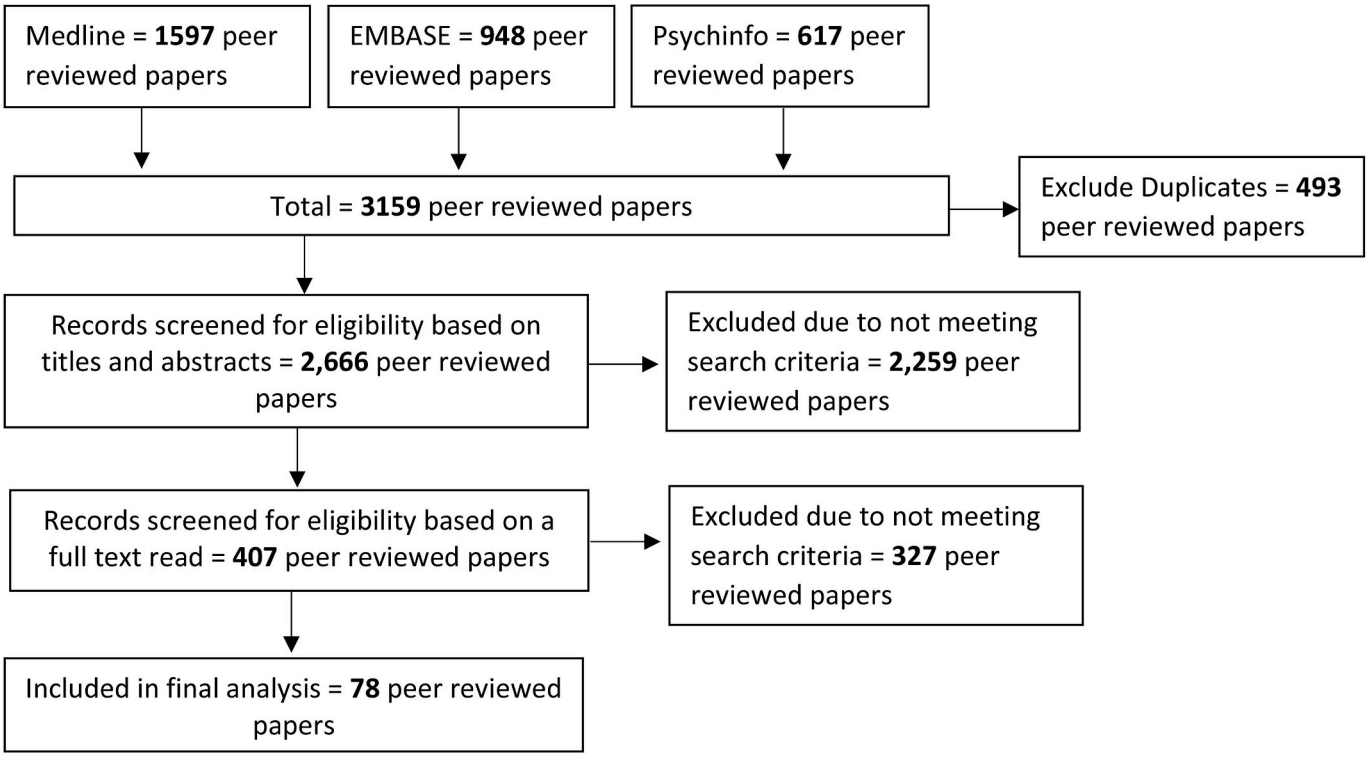

Fig. 1. Flow chart of the literature search process.

roles, capabilities, intention and motivations other than disgust, comfort, fear and nurture.

Fifty 'meta-associations' – i.e. determinants that were mentioned three or more times – were identified and included in the main analysis. The meta-associations are summarised in Table 5 and a full description of the analysis is provided in the supplementary material (ESM3). These meta-associations were drawn from 338 individual determinant references. The remaining 111 associations were mentioned only once or twice and are included in a table as part of the supplementary material (ESM4). Among the 338 associations included in the main analysis, a third were graded as 'good quality' (85 graded at 3 points and 26 graded at 4 points). We identified greater consensus (more meta-associations identified) about handwashing determinants in the categories of executive brain (particularly risk and discounts), characteristics, motivations, and behavioural settings (particularly infrastructure). There were lower levels of consensus around capabilities, roles, certain

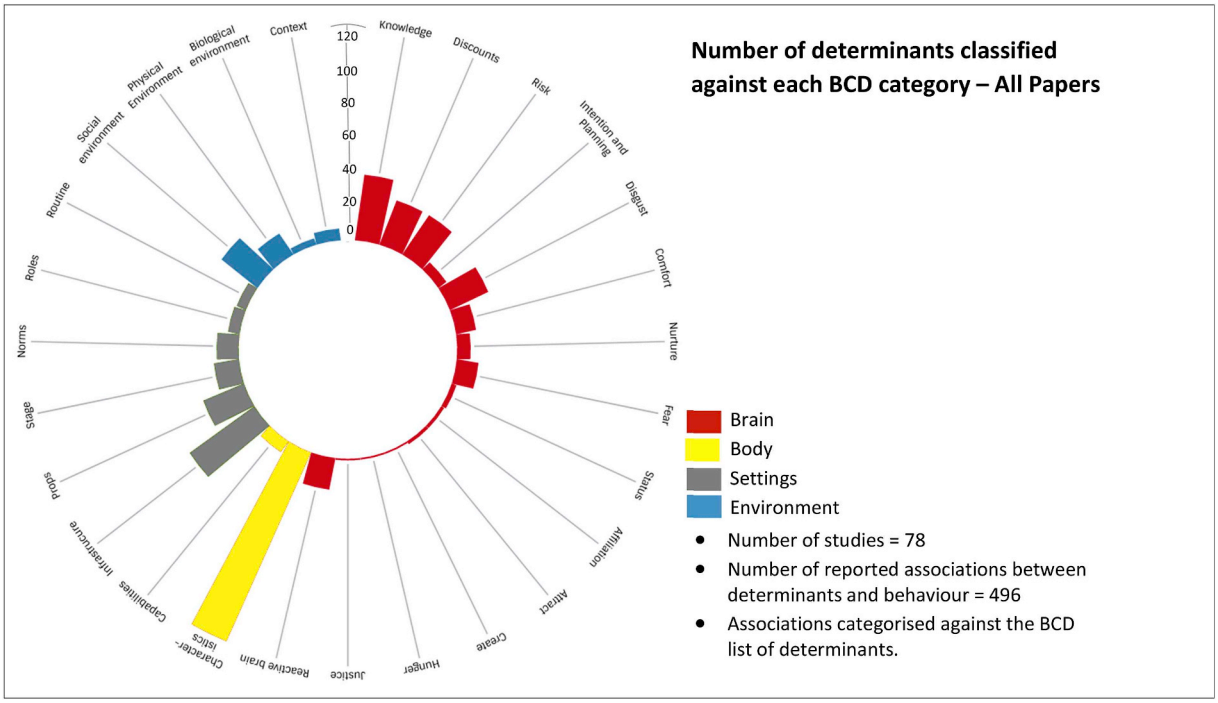

Fig. 2. Reported determinants of handwashing behaviour according to the Behaviour Centred Design determinant categories – All papers.

Table 3
Characteristics of the included studies.

Descriptive characteristics of studies	N (78)	%
Number of countries represented by the review	44[a]	
High income	17	22%
Upper-middle income	8	10%
Lower-middle income	38	50%
Low income	11	14%
Multi-country	4	5%
Total number of research participants	1,014,293	
Number of studies in rural areas	30	38%
Number of studies in urban areas	30	38%
Number of mixed location studies	18	23%
Number of studies in stable settings	54	69%
Number of studies in outbreaks settings[b]	16[a]	21%
Number of studies in crisis settings (conflict, displacement, earthquake, drought, famine)[b]	9[a]	12%
Types of studies		
Interventional	28	36%
Observational	50	64%
Qualitative	11	14%
Quantitative	51	65%
Mixed-methods	16	20%
Methods used for assessing behavioural determinants		
Questionnaire	52	67%
Observation	30	38%
In-depth interview	20	26%
Focus Group Discussion	18	23%
Behaviour Trails or Trials of Improved Behaviour[c]	2	3%
Ranking or voting	2	3%
Transect walk	1	1%
Methods for assessing handwashing behaviour		
Observation (good quality)	27	35%
Monitors (good quality)	2	3%
Proxy measures (moderate quality)	10	13%
Sticker diaries (moderate quality)	0	0%
Handwashing demonstrations (moderate quality)	2	3%
Self-report (poor quality)	51	65%
Number of studies that made any reference to theory	33	42%

[a] Taiwan, Hong Kong and the Palestinian territories are treated as countries in the World Bank income classification and in this study.

[b] Studies had to explicitly make reference to a crisis or outbreak to meet this classification.

[c] Behaviour Trials (also known as Trials of Improved Behaviour) involve asking the target population to follow the ideal behaviour for a certain period of time or sometimes populations are asked to use a new product or handwashing facility to wash their hands for a certain period of time. (Aunger et al., 2017).

Table 4
Summary of the quality of studies in this review.

	Good quality	Moderate quality	Poor quality
Qualitative (n = 11)	0	9	2
Quantitative (n = 52)	8	29	14
Mixed methods (N = 16)	5	7	4
Total	13 (17%)	45 (58%)	20 (26%)

motives (e.g. hunger and affiliation), the biological environment and the political, cultural and historical context.

3.5. Effect of determinants on handwashing behaviour

The authors unanimously agreed on the effect direction and quality of evidence for 35 of the 50 meta-associations. Twenty-five of the meta-associations were found to have a positive effect on HWWS and a further 13 were found to have inconsistent results but indicating that there may be a positive effect. Of these 38 positive-leaning meta-association categories, nine were deemed to be supported by good evidence. These included six meta-associations related to handwashing infrastructure, stage and props (specifically having a handwashing facility with soap and water present, having a handwashing facility located close to the kitchen and/or toilet, having handwashing facilities that are desirable and user friendly and having piped water close to the household, using soapy water and the presence of an improved latrine). Other positive-leaning meta-association categories, which were considered to have good evidence, were feeling that your handwashing was being observed due to the presence of others in the bathroom, living in certain geographic environments and having a young child in the family.

Four meta-association categories were classed as having a positive effect but having weak evidence to support them. These related to risk (specifically believing that handwashing with soap is efficacious in reducing outbreaks and disease transmission), motives such as disgust (specifically a desire to avoid germs and contamination) and nurture (specifically parents who have a strong desire to care for their children and are attentive to their needs) and habit formation in the reactive brain (specifically being taught handwashing behaviour from a young age). Many of the meta-associations in the characteristics category were found to have a positive effect on HWWS. For example, women and girls were found to be more likely than men to wash their hands with soap. Wealthier and more highly educated people were also more likely to HWWS. Despite many studies reporting these associations, the quality of evidence for these characteristic-related determinants was graded as weak or moderate because the majority of the studies reporting them relied on self-reported measures of HWWS.

Nine of the meta-associations were classified as having a negative effect on HWWS. While four of these were classified as having moderate evidence to support this effect, none of these negative meta-associations were classed as having good evidence. Five of these negative meta-associations related to discounts including being too busy, distracted, tired or lazy to focus on handwashing, perceiving soap to be expensive, believing that handwashing uses lots of water, or thinking that handwashing was not an important activity.

We classified three meta-associations as having inconsistent evidence which indicated that there may be no effect. There was moderate evidence to support two of these categories, while the other was classified as weak. These included biomedical knowledge of disease transmission, the real or perceived availability of water, and the likelihood of practicing handwashing if your friends and family practice handwashing.

Only one meta-association was found to have such inconsistent findings that no effect direction could be concluded. This related to the effect of believing that other people in your community wash their hands and therefore practice handwashing to adhere to this norm.

3.6. Determinants of handwashing behaviour during disease outbreaks

There were 17 studies that were undertaken during a disease outbreak. The majority of these were H1N1 influenza outbreaks (n = 9) but the sub-analysis also included H5N1 (n = 2), cholera (n = 2), typhoid (n = 2) and salmonella (n = 1). Of these, 12 were in high income or upper middle income countries. In comparison to the overall dataset these studies were more likely to use cross-sectional surveys as their only data collection method (71% compared to 30% overall). In total 103 associations were extracted from the 17 studies. None of these were mentioned frequently enough across the papers to be included in the main analysis. Part 1 of Fig. 3 shows the number of associations categorised against each BCD determinant for the outbreak sub-analysis. It highlights that there are gaps in the evidence related to some motivations, aspects of behavioural settings and the physical environment. It also reveals that studies undertaken during outbreaks predominantly focus on determinants like fear, risk perception and demographic characteristics.

3.7. Determinants of handwashing behaviour during other types of humanitarian crises

There were nine studies where authors described the context as

Table 5
Descriptive and weighted analysis of handwashing determinants reported by three or more studies (summarised version).

BCD categories		Hypothesised relationship between determinants and HWWS	Number of associations reported	Assessment of overall Association	Assessment of quality of evidence
Executive Brain	Knowledge	Biomedical knowledge about health and disease	10	Mixed results indicating no association*	Moderate
		Knowledge about the critical times to wash hands	10	Mixed evidence indicating a positive association	Moderate
	Risk	Believing that HWWS is efficacious in reducing outbreaks and disease transmission.	11	Positive association	Weak
		Believing that there are no preventative or curative treatments for an outbreak related disease.	3	Positive association	Moderate
		Perceiving yourself to be vulnerable to disease	9	Mixed evidence indicating a positive association	Moderate*
		Perceiving the consequences of getting diarrhoea or an outbreak related disease to be serious.	8	Mixed evidence indicating a Positive association	Moderate
	Intention and planning	Intending to wash hands with soap.	5	Mixed evidence indicating a positive association	Moderate
	Discounts	Being busy or getting distracted by other tasks	9	Negative association	Moderate*
		Perceiving soap to be expensive	6	Negative association	Weak
		Thinking that HWWS is not an important activity.	4	Negative association	Moderate
		Believing that HWWS requires a lot of water.	4	Negative association	Weak
		Feeling tired or lazy	3	Negative association	Moderate
Motivated Brain	Disgust	Perceiving unwashed hands to be disgusting	6	Positive association	Moderate*
		Hands being contaminated with something that is dirty, foul or smelly.	16	Positive association	Moderate
		A strong desire to avoid germs and contamination.	3	Positive association	Weak
	Comfort	Believing that HWWS will leave hands smelling nice.	5	Positive association	Moderate
		Believing that HWWS will make hands feel nice and help them to feel refreshed, confident and comfortable.	5	Mixed results indicating a positive association	Moderate

(*continued on next page*)

Table 5 (*continued*)

BCD categories		Hypothesised relationship between determinants and HWWS	Number of associations reported	Assessment of overall Association	Assessment of quality of evidence
	Nurture	Parents who have a strong desire to care for their children and are attentive to their needs.	9	Positive association	Weak
	Fear	Experiencing worry or anxiety in relation to a disease or outbreak.	9	Mixed results indicating a positive association	Moderate
	Status	Believing that HWWS is linked to being respected in society.	3	Positive association	Moderate*
Reactive Brain		Being cued to wash hands by the presence of a handwashing facility.	6	Positive association	Moderate
		Believing that your HWWS behaviour is habitual.	3	Positive association	Moderate
		Visual reminders (e.g. posters about handwashing or images of eyes to make people feel like they are being watched).	4	Mixed results indicating a positive association*	Moderate*
		Being taught HWWS behaviour from a young age.	3	Positive association	Weak
Characteristics		Having higher levels of education	25	Mixed results indicating a positive association	Moderate
		Being female	14	Mixed results indicating a positive association	Moderate
		Being wealthy	22	Positive association	Moderate
		Having a young child in the family	3	Mixed results indicating a positive association*	Good*
		Belonging to certain ethnic groups	4	Mixed results indicating a positive association*	Moderate
		Having a professional or office-based job.	3	Positive association	Moderate
		Being older.	10	Inconsistent results*	Weak*
Stage		Having an improved latrine.	3	Mixed results indicating a positive association	Good*
		Having access to a private toilet.	3	Positive association	Moderate*
		Working away from home	3	Negative association	Moderate
Infrastructure		Having a handwashing facility with soap and water present.	9	Positive association	Good
		Having handwashing facilities that are conveniently located close to the kitchen and toilet.	3	Positive association	Good
		Having handwashing facilities that are desirable and user friendly (a mirror, a soap holder, a basin, nicely coloured).	5	Positive association	Good
		Having piped water or a water source close to the household.	9	Positive association	Good
		Having water available at the handwashing facility.	9	Positive association	Moderate*

(*continued on next page*)

Table 5 (*continued*)

BCD categories	Hypothesised relationship between determinants and HWWS	Number of associations reported	Assessment of overall Association	Assessment of quality of evidence
	A real or perceived lack of water.	4	Mixed results indicating no association	Moderate*
Props	Having soapy water.	3	Positive association	Good
	An actual or perceived limited availability of soap	5	Negative association	Weak
	Soap being conveniently located and near to the place where hands are washed.	8	Positive association	Moderate
Routine	Doing other household tasks involving water within a close time proximity to a critical handwashing occasion.	5	Negative association	Weak
Norms	Believing that other people in your community wash their hands you are more likely to wash your hands.	5	Inconsistent results	Moderate
	Believing that HWWS is practiced by your friends, family, and others who are important to you.	4	Mixed evidence indicating no association*	Weak*
Physical Environment	Living in an urban area	9	Positive association	Moderate
	Living in certain geographic regions.	6	Positive association	Good
Social Environment	Having role models or people with some authority (e.g. teachers, health workers, parents) encourage and support HWWS.	6	Positive association	Weak
	More than one person present in a public bathroom.	3	Positive association	Good

Colour coding for direction of the association: Grey indicates inconsistent results or no association. Red indicates a negative association. Blue indicates a positive association.
Colour coding for quality of evidence: The dark blue indicates good evidence, the medium blue indicates moderate evidence and the pale blue indicates weak evidence.
*unanimous agreement was not found between all authors.

being a humanitarian crisis. This included studies done in conflict settings (n = 2), in refugee or displacement camps (n = 3), and during climatic events (droughts n = 2) and disasters (earthquakes n = 2). None of the papers described research done in the acute phase of an emergency. In two of these studies there were concurrent disease outbreaks. These papers were included in both of the sub-analyses. In total 39 associations were extracted from the nine studies. None of these were mentioned frequently enough across the papers to be included in the main analysis. Part 2 of Fig. 3 shows the number of associations categorised against each BCD determinant for humanitarian crisis sub-analysis. This highlights the overall paucity of evidence in this area as well as key gaps in the determinants literature in relation to some motives, some aspects of behavioural settings, the biological environment and contextual factors.

4. Discussion

Despite there being a growing body of work on handwashing, there are major gaps in the literature on the determinants of HWWS. Our review indicates that the overall quality of the evidence on this topic remains poor and that the literature is skewed towards reporting certain types of determinants (e.g. characteristic traits, infrastructure and executive brain functions such as knowledge, risk and discounts) at the expense of a more complete understanding of what drives HWWS. More evidence is needed about how HWWS is influenced by routines, norms, context, the physical and biological environments, and motives. Further, there are no standard ways of defining or measuring determinants across this literature, which impedes the accretion of scientific evidence. Even with these limitations, we were able to identify some consensus within the literature as to the effect of certain determinants of HWWS behaviour.

4.1. Implications for designing programmes to change handwashing behaviour

This review identified 50 associations that were reported more than three times in the literature, indicating some level of agreement about the determinants influencing HWWS behaviour. While the evidence around many of these remains sub-optimal, there are some implications for those seeking to promote HWWS.

Historically practitioners have primarily tried to improve HWWS by educating populations about disease transmission. This review found that knowledge about disease and disease transmission may have limited or no impact on HWWS. Many studies in our review documented already high levels of knowledge about disease transmission (Curtis et al., 2009; Aunger et al., 2010; Hirai et al., 2016) yet handwashing remained rare. Knowledge may not be necessary or sufficient to influence handwashing behaviour in the face of competing priorities or unconducive behavioural settings (Biran et al., 2005; Curtis et al., 2009; Rheinlander et al., 2015). In contrast this review indicates that the

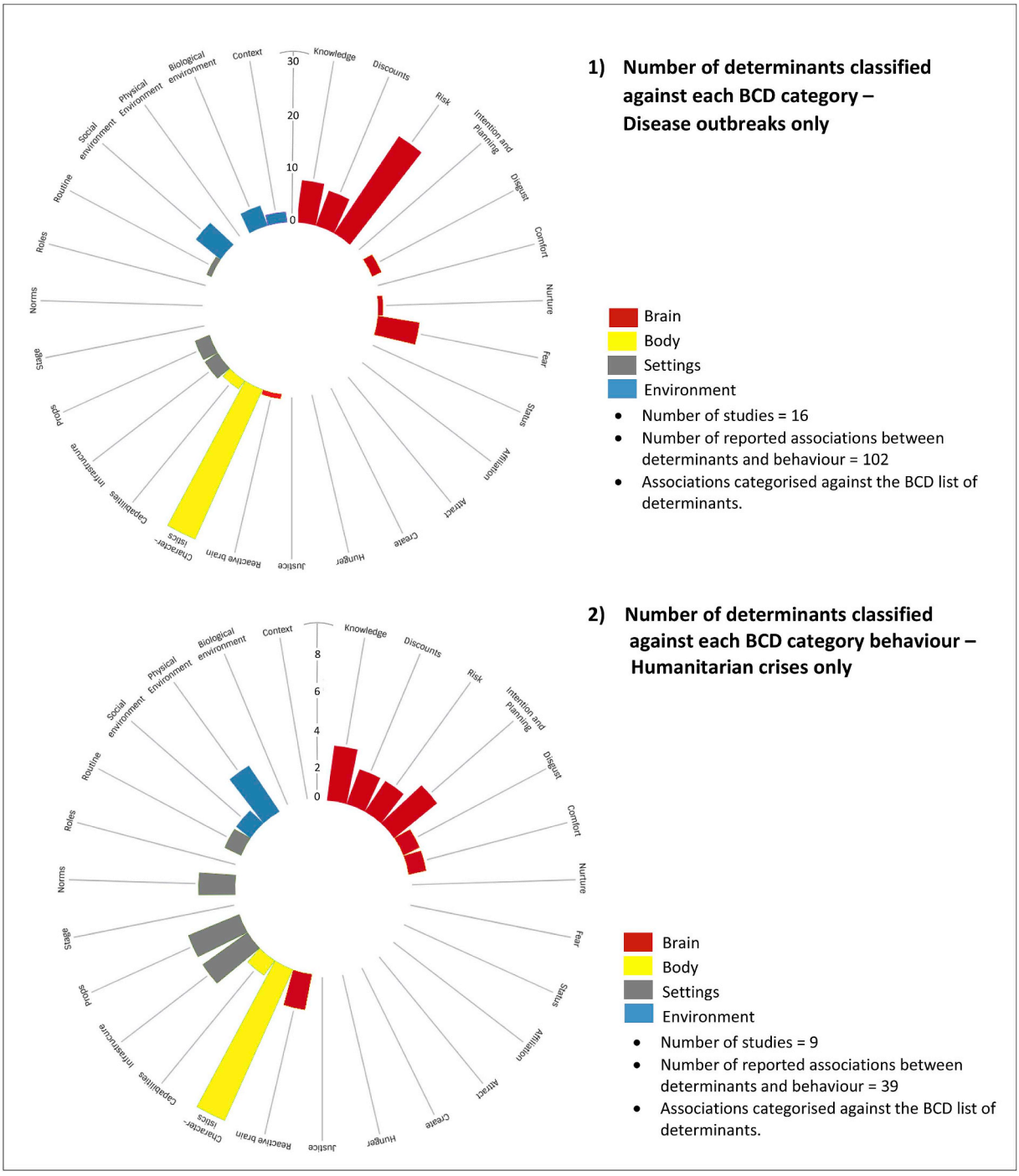

Fig. 3. Reported determinants of handwashing behaviour 1) in disease outbreaks and 2) in other humanitarian crises.

greatest opportunity to improve HWWS may be to ensure access to a desirable and conveniently-located handwashing facility, with soap and water present. This body of literature indicates that this is likely to be effective because handwashing infrastructure acts a cue or reminder for HWWS and works to overcome some of the psychological trade-offs that may prevent handwashing (such as perceived effort, and feeling busy or tired). Positioning facilities in 'observable' settings, where people can easily notice whether or not hands are being washed is also likely to have an increase behaviour by enhancing positive social pressure.

Socio-economic factors such as wealth and education do seem to be associated with a higher likelihood of HWWS. It is hard to specify what the causal route is here, given the likely interactions and confounds with other determinants. We do know that WASH access and quality typically improves with the economic growth of nations (Cha et al., 2017) but that even high income settings where HWWS is easier it is not ubiquitous (Garbutt et al., 2007; Judah et al., 2010; Freeman et al., 2014). It is not the role of hygiene programmes to address broader wealth or educational challenges within a nation, but without broader societal and economic change it is possible that handwashing promotion programmes may only achieve moderate impacts.

4.2. Differences in handwashing determinants during outbreaks and humanitarian crises

We were unable to draw conclusions about whether the determinants of HWWS differ between stable settings, outbreaks and

humanitarian crises. In the literature relating to outbreaks this was because of the poor quality of studies and the tendency for researchers to focus only on a narrow subset of determinants like knowledge, fear and risk. No conclusions could be drawn in relation to the determinants of behaviour in humanitarian crises because of lack of evidence. Other reviews have also highlighted the lack of hygiene behaviour change research in these settings (Ramesh et al., 2015; De Buck, Van Remoortel et al., 2017). Despite this, it remains plausible that a major disruption to a person's social life, psychological state, physical or biological environment, such as that experienced during crises or outbreaks could lead to changes in the determinants of HWWS. Future research in this area could consider a broad range of behavioural determinants in contexts that reflect the diversity of both outbreaks and humanitarian crises (the literature we reviewed was biased towards outbreaks in middle and high-income settings and protracted crises).

4.3. Refining what is meant by 'handwashing determinants'

Our ability to identify the determinants of handwashing behaviour was hampered by the lack of scientific consensus on how behaviour operates in general. We neither have commonly agreed definitions of what constitutes behaviour (Levitis et al., 2009), nor do we have commonly agreed categories of factors that determine behaviour (Morgenstern et al., 2013). Whilst humans are inclined to rationalise why they do, or do not, practice a behaviour like HWWS, individuals cannot objectively identify the determinants of their own behaviour. Though the BCD checklist of behavioural determinants moves us forwards, complete, valid, and agreed upon methods for objectively measuring the determinants of behaviour are still beyond our grasp.

The determinants that are reported in the literature are thus likely to reflect a bias towards factors that are easy to measure. For example, it is easier to assess knowledge, characteristic traits, and the influence of infrastructure, because there are simple ways of reporting these, or they are observable. It is much harder to assess determinants which operate at a partially or fully sub-conscious level such as motives, roles, social influence, and factors in the physical and biological environments. Many studies rely on methods which require participants to report their perceptions regarding their own behaviour. Study findings may also be subject to confirmation bias, with researchers typically only generating findings related to a choice of determinants generated ad hoc at the beginning of the research. Lists of determinants have become more comprehensive over time, and are no longer so biased towards knowledge and cognition. However, there are some indications that confirmation bias may be replicated across research studies. For example, the earliest reference to motives such as disgust in this literature was 2005 (Biran et al., 2005). Other motives began to be reported on in 2009 (Curtis et al., 2009; Judah et al., 2009) and since then 21 manuscripts have reported on motives. To mitigate this tendency, we recommend that future studies aiming to explore behavioural determinants should, as a minimum, utilise a comprehensive determinant checklist (such as that offered by BCD) but ideally incorporate a range of methods that allow them to identify determinants *a posteriori* such that the existing determinant categories can be extended or modified.

4.4. Designing 'fit for purpose' studies on determinants of handwashing behaviour

There were three main types of studies included in this review: exploratory or formative research (typically using qualitative or mixed method approaches); cross-sectional (primarily using surveys); and intervention (including experimental studies of simple interventions, trials of complex interventions, and process evaluations). The exploratory and formative research studies allowed a range of determinants to be explored, including those not identified *a priori*. However, their findings were less generalizable; they were less likely to report on determinants which had no impact on behaviour; and these studies typically did not identify which determinants had the strongest influence on behaviour. Cross-sectional studies, on the other hand, are better positioned to explore the relative importance of different determinants. However, these studies had multiple limitations. Measurement bias was an issue in these studies because of the absence of standardised, thoroughly tested survey tools and many used self-reported measures of HWWS, which made them subject to social desirability and recall bias. As with all cross-sectional studies, we cannot be sure of the direction of causation, for example, does hand washing routine determine handwashing behaviour or handwashing behaviour determine the routine? Finally, the cross-sectional studies included in this review were only able to generate data on the determinants that they identified *a priori*. This may be one reason why socio-demographic determinants are the most commonly reported. Intervention studies ought to be well positioned to provide high quality evidence on determinants. However, many HWWS interventions comprised multiple components which targeted different determinants. This made it challenging for authors to attribute change to one particular determinant. Other reviews of WASH-related behaviour change (Martin et al., 2018), hospital-based hygiene (Huis et al., 2012), protective behaviour during pandemics (Bish and Michie, 2010) and obesity-related behaviour (Buchan et al., 2012) have documented similar challenges in measuring both determinants and behavioural outcomes.

Many frequently cited handwashing intervention studies were excluded from this review because they only hypothesised about determinants in their discussion, but did not measure determinants directly (Huda et al., 2012; Biran et al., 2014, Greenland et al., 2016, Gautam et al., 2017; Ram et al., 2017). Furthermore, many of the studies which were included had multiple objectives, and exploring the determinants of HWWS was just one of these. This may be a factor limiting detailed descriptions of the methods used to understand behavioural determinants.

This review highlights a number of ways in which the quality of research on handwashing determinants could be improved. Firstly, as we suggested above, studies investigating behavioural determinants should employ a comprehensive set of theoretically derived potential determinants and utilised a mixed method or iterative research design approach. Secondly, there are opportunities to improve the way we assess HWWS outcomes with relatively little cost. For example, only ten studies in this review used proxy measures like the global handwashing indicator ('the availability of a handwashing facility within the [household] premises with soap and water'(WHO and UNICEF, 2015)). While this measure is imperfect, it is more reliable than self-reporting and is feasible to conduct at scale. Thirdly, research on determinants of HWWS must adequately describe the characteristics of the context in which it is set. This would allow evidence-users to understand the relevance and transferability of the findings to their own contexts. As a minimum Polit and Beck suggest that "readers should know when data were collected, what type of community was involved, and who the participants were, in terms of their age, gender, race or ethnicity, and any clinical or social characteristics" (Polit and Beck, 2010). Fourthly, research in this area needs to provide greater detail about how methods were developed, the rationale for using them, and the biases and limitations of these methods. Lastly, the studies that provided the highest quality of evidence in this review were experimental studies that tested one potential determinant at a time and showed the impact of this on observed behaviour (Johnson et al., 2003; Judah et al., 2009; Contzen et al., 2015; Pfattheicher et al., 2018). Further research of this nature should be encouraged, particularly since small-scale pilots can be done relatively quickly and cost-effectively.

4.5. Methodological limitations

This review aimed to identify direct associations between single determinants and HWWS. It was not designed to explore the interactions between determinants. Quality limitations within the dataset also

prevented us from doing deeper analyses of the size of the effect of any particular determinant. These are areas that could be addressed as the state of evidence progresses.

This review screened peer-reviewed publications only. However, in the process of reviewing the references of the included texts it was clear that many authors drew on grey literature, particularly unpublished formative research studies. Researchers should be encouraged to publish formative research and other studies on behavioural determinants.

The findings of this review are not disaggregated by handwashing occasion (e.g. HWWS prior to eating compared with HWWS post-defecation). This was because this differentiation was not consistently applied in the literature. However, HWWS practices and determinants may vary by occasion (Biran et al., 2005; Biran et al., 2009; Schmidt et al., 2009; Aunger et al., 2010; Halder et al., 2010;Schmidt et al., 2012; Greenland et al., 2013; Contzen et al., 2015).

This review did not perform a sub-analysis on whether handwashing determinants differ according country-level income categories. This decision was made because of the quality limitations of the data at this stage.

This review used the BCD framework to analyse and structure the findings. The determinant definitions that this framework provided were generally able to account for the diversity of determinants reported in this body of literature. Through the process of classifying determinants against the BCD determinant list we realised that some of the determinant categories are broad and could benefit from further sub-categorisation, while others are narrow and overlapping. For example, 'executive brain' is a broad category covering knowledge, beliefs, planning/intention, perceptions of risk and discounts. Consequently, these were displayed as sub-categories in our main analysis. In contrast, our original classification included 'senses' as a determinant category. However, it was not possible to differentiate between the motive of disgust and the category of senses. Papers did not specify whether it was just the sensation of feeling dirty that caused people to wash their hands or whether it was the combination of feeling dirty and perceiving that dirt to be disgusting that led to people wash their hands. As such the category of senses was dropped from the analysis.

We did not register the protocol for this study in the standard repository as PROSPERO currently does not include integrative reviews.

5. Conclusion

This is the first review to attempt to identify, define and categorise the determinants of HWWS in domestic settings and appraise the quality this evidence. We found some consensus across this diverse body of literature and these insights provide opportunities for practitioners to improve the design of handwashing behaviour change programmes. Specifically, this review highlights the need for hygiene programme designers to use multi-modal approaches, combining infrastructural improvement with 'soft' hygiene promotion which addresses a range of determinants rather than just education about disease transmission.

This review also demonstrated that our understanding of behavioural determinants remains sub-optimal. Much more can be done to strengthen the methods we use to measure both the determinants and the practice of HWWS.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijheh.2020.113512.

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