



## Effectiveness of behaviour change techniques used in hand hygiene interventions targeting older children – A systematic review

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### ABSTRACT

**Background:** Promoting good hand hygiene in older children is an important measure to reduce the burden of common diseases such as diarrhoea and acute respiratory infections. The evidence around what works to change this behaviour, however, is unclear.

**Objectives:** To aid future intervention design and effective use of resources, this review aims to identify the individual components used in hand hygiene interventions and assesses their contribution to intended behavioural change.

**Methods:** We systematically searched seven databases for experimental studies evaluating hand hygiene interventions targeting children (age 5–12) and quantitatively reporting hand hygiene behaviour. Interventions in each study were categorised as ‘promising’, or ‘non-promising’ according to whether they led to a positive change in the targeted behaviour. Behaviour change techniques (BCTs) were identified across interventions using a standard taxonomy and a novel promise ratio calculated for each (the ratio of promising to non-promising interventions featuring the BCT). ‘Promising’ BCTs were those with a promise ratio of  $\geq 2$ . BCTs were ranked from most to least promising.

**Results:** Our final analysis included 19 studies reporting 22 interventions across which 32 unique BCTs were identified. The most frequently used were ‘demonstration of the behaviour’, ‘instruction on how to perform the behaviour’ and ‘adding objects to the environment’. Eight BCTs had a promise ratio of  $\geq 2$  and the five most promising were ‘demonstration of the behaviour’, ‘information about social and environmental consequences’, ‘salience of consequences’, ‘adding objects to the environment’, and ‘instruction on how to perform the behaviour’.

**Conclusions:** Our findings suggest that hand hygiene interventions targeting older children should employ a combination of promising BCTs that ensure children understand the behaviour and the consequences of their hand hygiene habits, appropriate hardware is available, and social support is provided. Researchers are encouraged to consistently and transparently describe evaluated interventions to allow promising components to be identified and replicated.

### 1. Introduction

Hand hygiene is a critical measure for the prevention of communicable disease. Handwashing with soap alone can reduce both diarrhoea and acute respiratory infections (ARIs) by over 20% (Aiello et al., 2008; Cairncross et al., 2010; Freeman et al., 2014; Wolf et al., 2018) and has been linked to the reduction of certain neglected tropical diseases such as trachoma (Stocks et al., 2014) and some soil-transmitted helminth

infections (Strunzet al., 2014).

Older children - children age 5–14 as often defined in Global Burden of Disease studies (Kyuet al., 2018) - are an important target group for hand hygiene interventions. Although the greatest burden of diarrhoea and ARIs is borne by children under-five, these diseases are also some of the leading causes of mortality among older children; they account for over 19% of all deaths in this age group globally (World Health Organization, 2020).

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Evidence suggests that improving hand hygiene among older children may also reduce school absenteeism (Nandrup-Bus, 2009; Talaat et al., 2011; Willmott et al., 2015). By the age of five, children have typically begun attending school; then, they are expected to practice hand hygiene independently and can subsequently act as agents of change, passing on hygiene messages they receive to their family and peers (Adair et al., 2013; Bresee et al., 2016; Onyango-Ouma et al., 2005). Furthermore, many habits established during childhood years can persist through to adulthood (Kelder et al., 1994; Movassagh et al., 2017; Pressman et al., 2014). For these reasons, effective interventions targeting older children which aim to improve their hand hygiene behaviour are likely to achieve significant public health impacts.

The rationale for targeting hand hygiene interventions at children is strong but the evidence around which intervention approaches work best is unclear (Mbakaya et al., 2017; Watson et al., 2017). Hand hygiene is influenced by different social, environmental, and behavioral determinants, which may vary from context to context, and different approaches are needed to address these determinants and change behaviour (Curtis et al., 2009; White et al., 2020). Published studies, however, often do not report which components of their interventions were successful, making it difficult to assess what works and how to best allocate resources. To aid future design and implementation of hand hygiene interventions, and to ensure the most efficient use of resources, it is important to identify the individual components of interventions that positively contribute to targeted changes in behaviour. In the behaviour change literature, these individual components are often labelled *behaviour change techniques* (BCTs) – the smallest observable and replicable components of behaviour change interventions that on their own have the potential to change behaviour; they can be used individually or in combination (Michie and Johnston, 2012).

Michie and colleagues have validated a 93-item hierarchically structured BCT Taxonomy (BCTTv1) of consensually agreed (by expert opinion), clear and distinct BCTs for specifying components of behaviour change interventions, for example, goal setting, social comparison, and habit formation (Michie et al., 2013). This taxonomy has been used to specify intervention techniques across a wide range of public health behavioural domains such as physical activity and healthy eating (Cradock et al., 2017; Samdal et al., 2017), sedentary behaviour (Gardner et al., 2016), gestational weight management (Soltaniet al., 2016), smoking (Brown et al., 2019a), cardiac rehabilitation (Heron et al., 2016), and HIV and STI prevention (De Vasconcelos et al., 2018). Although the taxonomy has been used recently to specify techniques in hand hygiene and environmental-disinfection interventions in settings likely to include children (Staniford and Schmidtke, 2020), to our knowledge the BCTTv1 has not yet been used to assess the effectiveness of specific BCTs across hand hygiene interventions specifically targeted at older children.

In this systematic review, we aim to use the BCTTv1 to identify and classify the individual techniques used across hand hygiene interventions targeted at older children, assess their contribution to intended intervention outcomes, and determine their relative effectiveness. To navigate the problems consistently faced by past systematic reviews of hygiene interventions (Mbakaya et al., 2017; Watson et al., 2017) – namely finding too much heterogeneity across studies to perform meta-analyses or make conclusive recommendations – we have included interventions in low-, middle-, and high-income countries as well as experimental study designs both with and without a control group. We then employed a novel approach to determining effectiveness – the promise ratio – first developed by Gardner et al. (2016). The promise ratio allows synthesis of heterogeneous data by categorising interventions according to whether they are promising or not – i.e., whether they achieved a significant change in the intended outcome – and using these categories to assess the contribution of individual BCTs to ‘intervention promise’.

## 2. Methods

The current systematic review is reported in accordance with the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) statement (Moher et al., 2009) and a complete PRISMA checklist is available in Appendix S1.

### 2.1. Search strategy

Electronic searches were performed on 26 April 2020, by one reviewer (JW), using seven bibliographic databases: Medline (OvidSP interface), Embase (OvidSP interface), Global Health (OvidSP interface), IBSS, Africa-Wide Information (Ebsco Interface), CINAHL (Ebsco Interface), and Web of Science Core Collection (Web of Science interface).

The search strategy incorporated terms related to three concepts: (1) hand hygiene behaviour; (2) promotion; and (3) children. Medical Subject Headings (MeSH) terms and keywords were originally developed for the Medline database and subsequently adapted for use in the other databases using database-specific controlled vocabulary terms and search filters. A full description of the search strategy and search terms for the Medline database is included (Appendix S2). In addition to the search strategy described above, the reference lists of included articles were also hand searched for any relevant articles.

### 2.2. Inclusion criteria

Studies were eligible for inclusion if they met the following criteria:

**Publication and language:** Studies published in peer-reviewed journals on any date up to 26 April 2020 and available in English.

**Types of study design:** Randomised controlled trials (RCTs), non-randomised controlled trials (NRCTs), controlled before-after studies (CBAs), and before-after studies without a control group (BAs). For controlled studies, if there were multiple intervention arms and/or the control arm received an active comparator intervention, each study arm was reclassified as an individual BA study for analysis purposes.

**Control group:** RCTs, NRCTs, and CBAs were included if the control group received no intervention or basic standard care, or if the control group received another active comparator intervention and baseline and endline data were available to reclassify each study arm as an individual BA study. If these data were not available these studies were excluded.

**Types of participants:** Interventions targeting children aged 5–12 years. Note that although the term ‘older children’ typically refers to children age 5–14 we restricted our inclusion criteria to children age 5–12 as this range is the typical primary school age and intervention techniques adopted in primary and secondary school settings are likely highly heterogeneous.

**Types of settings:** Studies in household, community, or school settings, in any country.

**Types of interventions:** Interventions aiming to change hand hygiene (defined as hand washing with soap or disinfecting hands with sanitiser).

**Types of outcomes:** Studies reporting a quantitative frequency measure for hand hygiene practice. Both observed and self-reported measurements were eligible for inclusion. Measures of hand hygiene technique were not an outcome of interest.

Observational studies, conference abstracts, editorials, commentaries, perspectives, short reports, case series, dissertations, and qualitative studies were not eligible for inclusion in this review. Studies with any number of children outside of the 5–12 age range were excluded. Studies specifically targeting children with an illness or disability (e.g., those with hearing impairments or learning difficulties) and studies in healthcare facilities or in any other non-school institution were also excluded to increase the generalisability of our findings. Studies in which the intervention was not well described, and where this information could not be obtained by contacting the author, were also excluded.



### 2.3. Data collection and analysis

#### 2.3.1. Selection of studies

According to PRISMA guidelines, study screening and data extraction were initially conducted by one reviewer (JW) and a second reviewer (AC) cross-checked a sample of records and the extracted data for all studies. All studies retrieved from the database searches were imported into Endnote X8 (Thomson Reuters, New York, USA) and duplicates removed. Studies were screened for relevance by title and abstract, with non-eligible studies excluded. The full texts of the remaining eligible studies were subsequently assessed for inclusion and, in the case of any discrepancies, consensus was reached by discussion between the two reviewers (JW and AC). Where consensus could not be reached, a third reviewer (RD) arbitrated.

#### 2.3.2. Data extraction and management

Data were extracted from each study in a pre-specified table recording the following information: (i) Author/s and Publication Date; (ii) Study Title; (iii) Study Design; (iv) Setting/Country; (v) Intervention Description; (vi) Study Population and Sample Size; (vii) Intervention Intensity (i.e. how much it was repeated); (viii) Length of Follow-up; (ix) Outcome Measure and method of assessment (reported or observed); and (x) Results (note: only data on our outcomes of interest were extracted).

#### 2.3.3. Risk of bias assessment

To accommodate the multiple study designs included in the review, the risk of bias of each individual included study was assessed using an adapted combination of the tools developed by the National Heart, Lung and Blood Institute for controlled intervention studies and before-after studies with no control group (Nhlbi, 2018). Our adapted risk of bias assessment tool includes 14 items (detailed in Appendix S3). For each study, each of these 14 items were scored as 1 = 'yes', 0.5 = 'partially' (where applicable), and 0 = 'no' or 'not applicable'. The overall risk of bias in each study was subsequently calculated by summing up individual item scores, producing a risk of bias index of 0–14, with a score of

(RD), also experienced in BCT coding, mediated the decision.

#### 2.3.5. Analysis of behaviour change techniques

The analysis of BCTs took place in four consecutive steps.

**Step 1:** The intervention/s in each study was given an 'intervention promise rating' according to potential to improve the specified outcome. Interventions were rated as: (i) 'Promising' (= 1) if, in studies with a control group, there was a statistically significant (at  $p < 0.05$ ) increase in the targeted handwashing behavioral outcome in the intervention group compared to the control group at endline, or, if, in studies without a control group (including studies with only comparator intervention groups, which we redefined as before-after studies) there was a statistically significant ( $p < 0.05$ ) increase in the handwashing behavioral outcome at the endline relative to baseline; (ii) 'Non-promising' (= 0) if there was no statistically significant change at  $p < 0.05$ , or a negative change in the handwashing behavioral outcome. This scale is adapted from that used by Gardner et al. (2016). Unlike traditional meta-analyses which require the same outcome to be measured in the same way across studies, it enables comparison of different outcome measures across studies. Instead of using Gardner's 3-point scale ('very promising', 'quite promising' and 'non-promising'), however, we only categorised interventions as 'promising' or 'non-promising' since our additional step of weighting promise ratio by the individual study's risk of bias (see below) naturally accounts for a lack of control group. Note that if more than one measure of the behavioral outcome was reported, only the most objective outcome was used in the rating (i.e., we selected observed measures over self-reported measures).

**Step 2:** Following the approach by Gardner et al. (2016), after coding, a 'promise ratio' was calculated for each BCT identified across the interventions of the included studies by dividing the number of 'promising' interventions featuring a specific BCT by the number of 'non-promising' interventions featuring that BCT:

$$\text{BCT Promise Ratio} = \frac{\text{Number of 'promising' interventions featuring specific BCT}}{\text{Number of 'non - promising' interventions featuring specific BCT}}$$

0 indicating the highest possible risk of bias and a score of 14 the lowest possible risk of bias. This scoring system restricted BA study designs to a maximum score of 10, as only ten items (items 1–10) were applicable. For BCT coding (see below), the overall risk of bias score for each study was converted to a percentage of the maximum possible score and expressed as a decimal.

#### 2.3.4. Coding of behaviour change techniques

We used Michie's BCTTv1 framework (Michie et al., 2013) (Appendix S4), to identify and code the BCTs used in intervention and control arms of the studies. Two reviewers (JW and AC), both who had successfully completed online training for use of the BCTTv1 ([www.bct-taxonomy.com](http://www.bct-taxonomy.com)), independently coded the technical content of intervention and control groups and rated each of the 93 BCTs as either present or absent. The frequency at which individual BCTs were delivered within an intervention was not coded. The target of BCTs identified with the BCTTv1 was hand hygiene, as defined above. Where interventions targeted other behaviours, only the BCTs related to the relevant target behaviour were coded. Cohen's  $\kappa$  was calculated to measure inter-coder agreement (McHugh, 2012). Any disagreement over BCT coding between the researchers (JW and AC) was resolved by researcher consensus and where consensus could not be reached, a third researcher

Note that, for any given controlled study, we considered only those BCTs that featured exclusively in the intervention group (i.e., they did not also feature in the control group), because intervention 'promise' could not be confidently associated with a BCT if it featured in both intervention and control group.

BCTs must have been present in at least three interventions to be included in the promise ratio analysis. This was decided because, for a BCT to be considered 'promising', it must have been used in at least twice as many promising as non-promising interventions (i.e., promise ratio  $\geq 2$ ), and when weighting BCT promise ratios by risk of bias (see next step), it would be impossible for BCTs used at a low-frequency (in  $\leq 2$  interventions) to be rated as 'promising' unless both studies had a perfect risk of bias rating. Where BCTs were used in only promising interventions (three or more), the number of interventions in which they were used was reported as the promise ratio.

**Step 3:** To account for the different study designs and the reporting and analysis of studies, BCT promise ratios were weighted according to the risk of bias across the individual studies in which they were present. Each BCT promise ratio was multiplied by the mean risk of



bias score (on a scale of 0–1) across all interventions in which that BCT was present to give the weighted BCT promise ratio.

**Step 4:** BCTs were then ranked from the most promising to least promising according to their weighted BCT promise ratio.

#### 2.4. Additional analyses

The association between an intervention's promise rating and the number of BCTs used in that intervention was assessed using Firth's penalized maximum likelihood logistic regression (firthlogit) to account for the small number of interventions and the skewedness in the intervention promise ratings. The firthlogit technique uses Firth's method to impose a bias term on the standard likelihood function that is sensitive to a small number of events, ultimately reducing the estimates towards zero (Devikaet al., 2016; Firth, 1993; Gim and Ko, 2017; Heinze and Schemper, 2002; Rojas, 2018). A Welch's two-sample *t*-test was performed to determine if there was a statistically significant difference ( $p < 0.05$ ) between the number of BCTs used in non-promising interventions compared to promising interventions.

Co-occurrence patterns of promising BCTs were described using network plots. The number of times each pair of promising BCTs occurred within the same intervention was counted. These co-occurrences were then visualised in a network plot, in which each BCT was represented by a node. The width of each edge (line joining nodes) was proportional to the total number of co-occurrences of BCTs. The size of each node was proportional to the 'promise ratio'.

#### 2.5. Sensitivity analysis

We excluded studies without a control group (i.e., BA studies) in a sensitivity analysis to check if this affected our results.

### 3. Results

#### 3.1. Search results

Database searches identified a total of 5207 articles from Medline (751), Embase (1,412), Global Health (738), IBSS (76), AWI (456), CINHAL (719), and Web of Science (1,055). No further articles were identified through reference list screening. After de-duplication, a total of 3360 articles were screened by title and abstract and 94 articles were selected for full-text screening. Applying the pre-defined inclusion criteria, 19 articles were included in the final analysis, detailing 22 interventions. The flow diagram in Fig. 1 outlines the results of the database searches and the screening process, according to PRIMSA guidelines (Moheret al., 2015). Reasons for excluding the remaining 75 articles on full-text screening are given in Appendix S5.

#### 3.1.1. General characteristics of included studies and interventions

The Appendix summarises study characteristics; full details of the characteristics of included studies can be found in online supplemental Appendix S6.

#### 3.2. Settings

Fifteen (79%) of the included studies were conducted in low- and middle-income countries (LMICs) and the remaining 4 studies (21%) were conducted in high-income countries (HICs), classified as such by the World Bank (World Bank, 2019). Eighteen (95%) of the 19 included studies were implemented in schools and the one remaining study was a household-level intervention in an internally displaced camp in Northern Iraq. Eleven (58%) studies were conducted in rural settings, 7 (37%) in urban settings, and 1 (5%) study in a mix of urban and rural settings. The skewedness towards rural settings was more pronounced when looking at studies in LMICs only (11 studies in rural settings vs 3 studies in urban settings) whereas all 4 studies in HICs were conducted in urban

settings.

#### 3.3. Study design

Of the 19 included studies, 9 were RCTs (6 with a cluster design), 1 was a NRCT with a cluster design, 4 were CBAs, and 5 were BAs. For BCT coding and analysis, Grover et al., 2018 (Grover et al., 2018a), a cluster RCT, was redefined as two separate BA studies due to an active comparator group. Two of the studies: Pickering et al. (2013) and Snow et al. (2008) were multi-arm trials in which all intervention arms targeted hand hygiene behaviour, as defined in this review. The intervention arms in each of these studies were analysed individually and the effect of each intervention (compared to the control group) noted for each intervention arm.

#### 3.4. Intervention

Intervention intensity varied from a single hygiene promotion session or initial infrastructure improvements only, to repeated sessions every two weeks over a six-month period. Length of follow-up ranged from one day to one year.

#### 3.5. Outcomes

Observation was considered the most rigorous measure of hand hygiene behaviour and was used in 14 (74%) of the included studies. In the remaining 5 studies (26%), hand hygiene behaviour was measured via self-reporting. Of the 22 interventions tested across the 19 included studies, 19 (86%) of these were classified as promising interventions (i.e., reported an increased frequency of hand hygiene behaviour). The remaining 3 (14%) interventions did not have a positive effect on hand hygiene behaviour and were classed as non-promising interventions.

#### 3.6. Risk of bias assessment

Only one study (Lewis et al., 2018) was awarded the highest possible overall risk of bias rating of 14 (i.e., was at the lowest risk of bias). The other 18 studies had overall risk of bias ratings ranging from 4 to 11, with a mean of 7.84. Fig. 2 shows the proportion of studies at low, unclear, or high risk of bias (i.e., 'yes', 'partially', or 'no/not applicable',

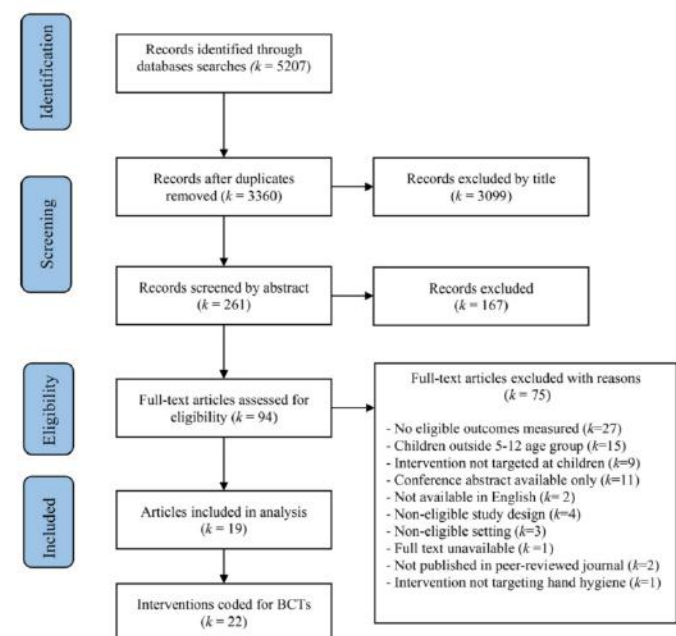


Fig. 1. Flow of studies into the systematic review.





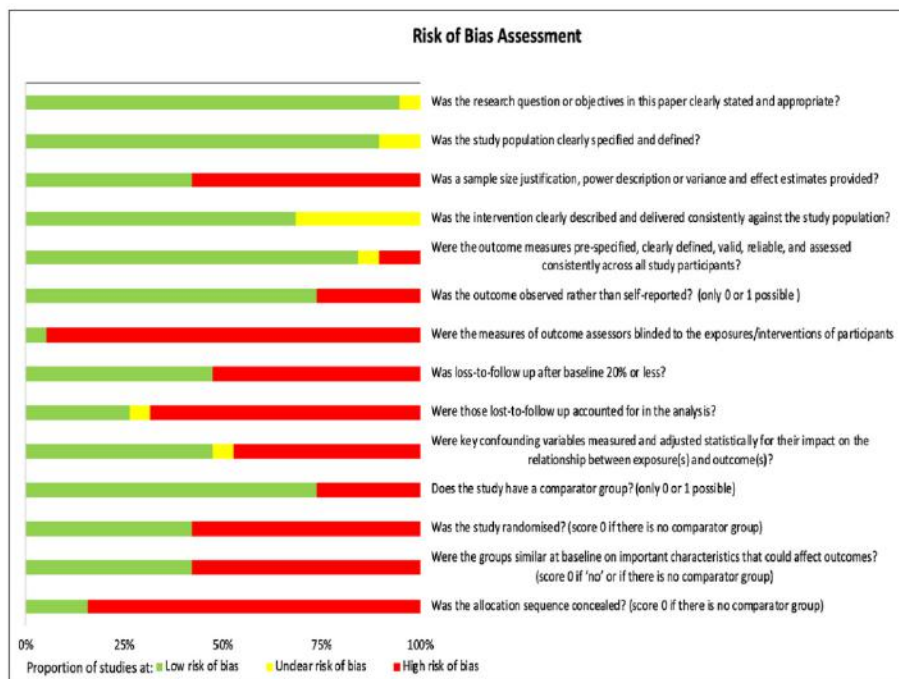


Fig. 2. Risk of bias assessment.

respectively, were the answers to the risk of bias items) for each of the 14 risk of bias items. The full assessment can be found in [Appendix S7](#). Lack of blinding of assessors to the exposures/interventions of participants, no sample size justification, high loss-to-follow-up rates and not accounting for loss-to-follow-up in the analysis were common sources of potential bias across the studies. For controlled studies, a lack of randomisation, baseline imbalance between groups and allocation concealment were also common sources of bias.

### 3.7. Behaviour change techniques

We identified 32 unique BCTs from the 22 interventions included in this review, belonging to 13 of the 16 hierarchical clusters of the BCTTv1. Inter-coder agreement was almost perfect ( $\kappa = 0.87$ ). Details of the BCTs coded in each intervention can be found in [Appendix S8](#). The most frequently employed BCTs (coded in  $\geq 25\%$  of interventions ([Brown et al., 2019](#))) were ‘instruction on how to perform the behaviour’ (14 interventions; 64%), ‘adding objects to the environment’ (13 interventions; 59%), ‘demonstration of the behaviour’ (12 interventions; 55%), ‘information about social and environmental consequences’ (8 interventions; 36%), ‘prompts/cues’ (8 interventions; 36%), ‘salience of consequences’ (7 interventions; 32%), ‘behavioural practice/rehearsal’ (7 interventions; 32%), ‘restructuring the social environment’ (7 interventions; 32%), and ‘information about health consequences’ (6 interventions; 27%).

The number of BCTs identified in a single intervention ranged from 2 to 16 with a mean of 6.4 (CI 6.2–6.6) BCTs per intervention. Firth’s penalized maximum likelihood logistic regression analysis showed that the number of BCTs used in an intervention was negatively associated with the intervention promise rating (i.e., intervention effectiveness) (OR 0.92  $p < 0.01$ ), however this association was no longer statistically significant when adjusted for risk of bias in studies (OR = 0.98,  $p = 0.33$ ). There was also a significant difference between the mean number of BCTs used in non-promising interventions (7.7 CI 7.0–8.3) and in promising interventions (6.2 CI 6.0–6.4) (Welch’s 2-sample t-test (df = 321.6) = 4.3,  $p < 0.01$ ).

It was possible to report promise ratios for 17 of the BCTs identified. The remaining 15 BCTs were excluded from the promise ratio analysis as

they were used at too low a frequency across interventions (i.e., used in only one or two interventions). After adjusting for study quality, a total of 8 individual BCTs had a promise ratio of  $\geq 2$  and were therefore considered as ‘promising’, or most likely to enhance effectiveness of interventions to improve hand hygiene among children. The BCTs with the highest promise ratios (i.e., the most promising BCTs) were: ‘demonstration of the behaviour’ (adjusted promise ratio (aPR) 6.12); ‘information about social and environmental consequences’ (aPR = 4.31); ‘salience of consequences’ (aPR = 3.73); ‘adding objects to the environment’ (aPR = 3.22); and ‘instruction on how to perform the behaviour’ (aPR = 3.22).

The 8 BCTs we found to be promising belonged to 6 of the hierarchical clusters of the BCTTv1. ‘Natural Consequences’ was the cluster with the highest number of promising BCTs ( $k = 3$ ). The remaining 5 clusters had 1 promising BCT each. [Table 1](#) shows the frequency of occurrence of each BCT identified across the interventions and their promise ratios.

### 3.8. Sensitivity analysis

Omitting studies without a control group ( $k = 5$ ) in our sensitivity analysis revealed a few disparities between the promise ratio analyses across all studies compared to controlled studies only, but the highest ranked BCTs were similar indicating that including studies without a control group did not substantially change our results ([Fig. 3](#)).

### 3.9. Co-occurrence patterns of promising BCTs

Visual inspection of the co-occurrence network plot of promising BCTs suggests that three of the most promising BCTs, ‘demonstration of the behaviour’, ‘instruction on how to perform the behaviour’ and ‘adding objects to the environment’ all co-occur frequently with one another ([Fig. 4](#)). ‘Information about social and environmental consequences’ also appears to co-occur frequently with the BCTs ‘demonstration of the behaviour’ and ‘instruction on how to perform the behaviour’. No other clear co-occurrence relationships were observable from visual inspection.



**Table 1**  
Behaviour change technique analysis.

Behaviour Change Technique	BCT FAMILY	Total frequency across interventions	Frequency across promising interventions	Frequency across non-promising interventions	Promise ratio*	Mean Quality score	Adjusted Promise ratio**
6.1 Demonstration of the behaviour	Comparison of behaviour	12	11	1	11.00	0.556	6.12
5.3 Information about social and environmental consequences	Natural Consequences	8	7	1	7.00	0.616	4.31
5.2 Salience of consequences	Natural Consequences	7	6	1	6.00	0.622	3.73
12.5 Adding objects to the environment	Antecedents	13	11	2	5.50	0.585	3.22
4.1 Instruction on how to perform the behaviour	Shaping Knowledge	14	12	2	6.00	0.536	3.22
5.1 Information about health consequences	Natural Consequences	6	5	1	5.00	0.583	2.92
3.2 Social support (practical)	Social support	5	5	0	5.00	0.543	2.72
11.3 Conserving mental resources	Regulation	5	4	1	4.00	0.671	2.68
3.1 Social support (unspecified)	Social support	4	3	1	3.00	0.660	1.98
13.2 Framing/reframing	Identity	4	4	0	4.00	0.464	1.86
10.2 Material reward (behaviour)	Reward and threat	3	3	0	3.00	0.595	1.79
1.9 Commitment	Goals and Planning	3	2	1	2.00	0.785	1.57
12.1 Restructuring the physical environment	Antecedents	4	3	1	3.00	0.518	1.55
8.1 Behavioural practice/rehearsal	Repetition & Substitution	7	5	2	2.50	0.612	1.53
12.2 Restructuring the social environment	Antecedents	7	5	2	2.50	0.576	1.44
7.1 Prompts/cues	Associations	8	5	3	1.67	0.607	1.01
8.3 Habit formation	Repetition & Substitution	4	2	2	1.00	0.660	0.66
1.2 Problem Solving	Goals and Planning	1	1	0	L/F	0.643	L/F
1.5 Review behaviour goal(s)	Goals and Planning	1	1	0	L/F	0.643	L/F
13.1 Identification of self as a role model	Identity	1	1	0	L/F	0.428	L/F
15.3 Focus on past success	Self-belief	1	1	0	L/F	0.714	L/F
2.5 Monitoring of outcome(s) of behaviour	Feedback and monitoring	1	1	0	L/F	0.428	L/F
2.7 Feedback on outcome(s) of behaviour	Feedback and monitoring	1	1	0	L/F	0.286	L/F
5.6 Information about emotional consequences	Natural Consequences	1	1	0	L/F	0.714	L/F
6.3 Information about others approval	Comparison of behaviour	1	1	0	L/F	0.714	L/F
9.1 Credible source	Comparison of outcomes	1	1	0	L/F	0.71	L/F
10.1 Material incentive (behaviour)	Reward and threat	2	2	0	L/F	0.68	L/F
1.4 Action planning	Goals and Planning	2	2	0	L/F	0.54	L/F
1.1 Goal Setting (behaviour)	Goals and Planning	2	2	0	L/F	0.46	L/F
2.2 Feedback on behaviour	Feedback and monitoring	2	2	0	L/F	0.43	L/F
2.3 Self-monitoring of behaviour	Feedback and monitoring	2	1	1	L/F	0.64	L/F
2.1 Monitoring of behaviour by others without feedback	Feedback and monitoring	1	0	1	L/F	1.00	L/F

\* Promise ratio denotes the number of promising interventions in which a BCT is featured, divided by the number of non-promising interventions in which it is featured.

\*\* Adjusted promise ratio denotes the promise ratio weighted by risk of bias score. An adjusted promise ratio of 2 or above means the BCT can be classed as promising. Rows in green represent the most promising BCTs (promise ratio >3), rows in yellow represent BCTs with a promise ratio between 2-3, and rows in red represent non-promising BCTs.  
L/F = low frequency, excluded from the promise ratio analysis.



