State of the Science Review

The effect of hand-hygiene interventions on infectious disease-associated absenteeism in elementary schools: A systematic literature review

Zhangqi Wang MS a, Maria Lapinski PhD b, Elizabeth Quilliam PhD c, Lee-Ann Jaykus PhD d, Angela Fraser PhD a,∗

a Department of Food, Nutrition, and Packaging Sciences, Clemson University, Clemson, SC
b Department of Communication, Michigan State University, East Lansing, MI
c Department of Advertising and Public Relations, Michigan State University, East Lansing, MI
d Department of Food, Bioprocessing, and Nutrition Sciences, and Department of Microbiology, North Carolina State University, Raleigh, NC

Key Words:
Acute gastroenteritis
Respiratory illness
Health education
Hand washing
Children

Background: Hand-hygiene interventions are widely used in schools but their effect on reducing absenteeism is not well known.

Methods: The aim of our literature review was to determine whether implementation of a hand-hygiene intervention reduced infectious disease-associated absenteeism in elementary schools. The eligible studies (N = 19), published between 1996 and 2014, were summarized and the methodologic quality of each was assessed.

Results: Our review indicated evidence is available to show hand-hygiene interventions had an effect on reducing acute gastrointestinal illness-associated absenteeism but inadequate evidence is available to show an effect on respiratory illness-associated absenteeism.

Conclusions: The methodologic quality assessment of eligible studies revealed common design flaws, such as lack of randomization, blinding, and attrition, which must be addressed in future studies to strengthen the evidence base on the effect of hand-hygiene interventions on school absenteeism.

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Student absenteeism is a persistent public issue with serious consequences.1-3 Not only can individual academic performance suffer when a student misses class, but also the performance of an entire school can decrease as rates of absenteeism increase.4,5 Extra effort may then be required from teachers because they have to reteach missed content to absent students.6 Student absenteeism can also result in increased school administrative costs (ie, student tracking).7 For example, in the United States public school funding formulas are based on attendance records, hence increased absenteeism leads to less federal and state funding for individual schools.7,9 Lastly, absenteeism can directly affect families because parents or caregivers may have to miss work or hire a babysitter, which can be costly, when a child is too sick to attend school.2

A common cause of student absenteeism is illness, specifically infectious diseases such as acute gastrointestinal illness (AGI) and acute respiratory illness (ARI). Specifically, school absenteeism has been shown to increase due to illness during influenza season.10 In addition, between 1998 and 2008, 286 foodborne disease outbreaks (17,266 cases of illness), of which many were classified as AGI, were traced back to U.S. schools, possibly resulting in many more days of school missed because of illness.11

One way of reducing illness-related absenteeism is to promote good hand hygiene practices as proper hand hygiene is a well-known preventive measure for many infectious diseases.12 To date, 2 published reviews have analyzed the effect of hand-hygiene interventions but both focused on interventions delivered in the community and not in school settings.13,14 A third review only examined the effect of antimicrobial rinse-free hand sanitizer in elementary schools and not other types of interventions, such as those using soap and/or education only.15
The aim of our review was to summarize studies published between 1980 and 2015 that reported the effect of hand-hygiene interventions on absenteeism in elementary schools. Our 2 research questions were: What is the effect of a hand-hygiene intervention on infectious disease-associated absenteeism? and, What is the effect of different types of hand-hygiene interventions on infectious disease-associated absenteeism? Our findings can serve as a guide to design, deliver, and evaluate more efficacious hand-hygiene interventions.

METHODS

Search strategy

We used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses principles to create a transparent, systematic review of published studies to report the effect of hand-hygiene interventions on absenteeism in elementary schools (Fig 1). A comprehensive literature search was conducted to identify eligible studies written in English. We performed the search using the following databases: ScienceDirect (1980-2015), Academic Search Complete (1980-2015), Academic OneFile (1980-2015), AgEcon Search (1980-2015), and Web of Science (1980-2015). Academic Search Complete is managed by EBSCO, and allows for simultaneous searches through multiple databases, such as MEDLINE and the Cumulative Index to Nursing and Allied Health Literature. We conducted our search with 9 search terms divided into the following 3 categories: hygiene-related terms: hand hygiene OR handwashing, child-related terms: children OR student, and training-related terms: education OR campaign OR training OR information OR intervention. For ScienceDirect, only 2 search lines were available, so we chose 1 term at a time from each category to create each search phrase. For example, for the first search phrase we entered in Line 1: hand hygiene AND children, and in Line 2: education. Similarly, for AgEcon, only 2 search lines were available. When we entered in Line 1: hand hygiene OR handwashing and in Line 2: children OR student, no results were found. We also substituted in Line 2: education OR campaign OR training OR information OR intervention, and still no results were found. For all other databases, 3 lines were available and we were able to enter all terms from each category in a single line. For example, in Line 1 we entered hand hygiene OR handwashing; in Line 2: children OR student; and in Line 3: education OR campaign OR training OR information OR intervention. Depending on the capabilities of each database, we searched for our terms within keywords, titles, and abstracts of published studies. For databases in which these advanced search options were not available, we searched by topic or “anywhere in the record.” We also hand searched the reference lists of all review articles identified during initial screening to locate additional published studies.

Inclusion criteria and selection

First, we screened the title and abstract of each citation using our eligibility criteria (appropriate intervention, target population, and publication type) then sorted all articles by name to remove duplicates. Portable document format files of all potentially relevant citations were retrieved for review.

After the initial screening, studies were evaluated for inclusion based on 5 criteria: nature of intervention, target population, outcome, study design, and publication type. For criterion 1, interventions of interest included educational curricula, the use of hand sanitizer (alcohol-based or alcohol-free), and use of soap

Fig 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow chart describing the literature search procedures.
(antimicrobial or nonantimicrobial). To be classified as an educational intervention, the study was required to specify that an education curriculum or other educational activities were included in the intervention. For criterion 2, the population of interest was school-aged children between ages 4 and 15 years to accommodate studies conducted in elementary schools that included grades from prekindergarten through grade 8. To be included in our review, the study outcomes (criterion 3) had to measure absenteeism, but many also measured other outcomes (eg, attitude or behavior). Only empirical studies (criterion 4) published in peer-reviewed journals (criterion 5) were included.

Quality assessment

The Downs and Black Checklist was used to assess study quality because it was identified as a rigorous quality evaluation system. The checklist consists of 27 questions categorized into 5 sections: reporting (10 items), external validity (3 items), internal validity—bias (7 items), internal validity—confounding (selection bias) (6 items), and statistical power (1 item) (Table 1). It can be used to conduct systematic reviews for both randomized and nonrandomized trials and has been shown to adequately identify sources of potential bias. Two trained reviewers independently assessed the quality of all eligible studies using the checklist. Initially, across all studies, each item on the checklist was given a qualitative code (yes or no or unable to determine or yes or partial or no), which was converted to a numerical score (1 or 0 or 0 or 2 or 1 or 0) for analysis. The 2 reviewers discussed any disagreements in scoring and reached a consensus before mean quality scores were calculated.

Because of the large amount of heterogeneity across studies, we could not perform a meta-analysis, so we did not contact authors or use any tools to extract data from any included studies. As a result, we organized our results by first describing included studies then presenting summary findings to answer our 2 research questions: What is the effect of a hand-hygiene intervention on infectious disease-associated absenteeism? And, What is the effect of different types of hand-hygiene interventions on infectious disease-associated absenteeism?

RESULTS

Search strategy

Across all 5 electronic databases, 1,567 records were identified (Fig 1). A total of 79 potentially eligible studies were included for full-text review after duplicates were removed and titles and abstracts screened. Hand searching the reference list of the 10 review articles resulted in 13 additional articles, which were also reviewed for eligibility. After screening the full text, 73 studies were excluded because they did not meet the eligibility criteria, including type of intervention (n = 13), target population (n = 12), measured outcome (n = 19), study design (n = 4), and publication type (n = 14); additionally, review studies (n = 10) and articles for which the full text was inaccessible (n = 1) were excluded. Based on the inclusion criteria, 19 eligible studies were included in our review.

Study characteristics

Of the 19 eligible studies (all published between 1996 and 2014), 12 were conducted in the United States, and the remaining 7 were conducted in Denmark (n = 2), China (n = 1), Egypt (n = 1), New Zealand (n = 1), Spain (n = 1), or Thailand (n = 1). Ten studies...
were cluster-randomized controlled trials, \(^{19-21,26,32-37}\) 7 used a nonrandomized design, \(^{22,25,27-31}\) and 2 used a crossover design.\(^{23,24}\) The range of study sample sizes was wide—199–44,451 students and 1–87 elementary schools. The length of the interventions ranged from 1 day (a single education program) to an entire school year (with hand sanitizer used all year). In most studies \((n = 15)\) \(^{20,30,33-36}\) participants were between 4 and 12 years. One study included younger students \((ages 2–6 years)\)\(^{32}\) and 3 included older students \((ages 6 through 14 years and ages 5–15 years)\) \(^{19,31,32}\)

**Quality assessment**

Because Downs and Black\(^{17}\) do not report a method to classify good from poor studies, we used the method suggested by Gorber et al.\(^{38}\) These authors used the median of the quality scores generated using the Downs and Black checklist to classify studies as “higher” or “lower” quality. The median quality score of studies in our sample was 18 \((range, 10–20)\) of a possible high score of 28 \((Table 2).\) As expected, the 10 clustered-randomized-controlled studies had higher quality scores \((score, 17–25)\) \(^{19-21,26,32-37}\) than those that did not use randomization \((score, 10–18)\) \(^{22,25,27-31}\)

All studies had weaknesses in the reported study design, with 5 weaknesses common across most studies. In nearly all studies, subjects \((n = 18)\) and data collectors \((n = 17)\) were not blinded to the aim of the study, which was not surprising given that these were school-based studies and not clinical trials. Only 4 studies reported assessing compliance with the intervention protocol.\(^{20,22,23,35,37}\) Ten presented information about confounding variables, \(^{19-21,26,30,34,35}\) but only 7 reported making adjustments to their analysis protocol for these confounding variables.\(^{20,21,26,30,33-35}\) In addition, only 2 studies reported dates of recruitment, which is needed to assess whether subjects in different intervention groups were recruited over the same time period.\(^{22,35}\) Lastly, only 6 studies reported whether or not power calculations were performed to determine the sample size.\(^{20,32-36}\)

**Key findings**

Because 16 approaches were used to measure absenteeism, we could not perform a quantitative meta-analysis. Of the 19 studies, many \((n = 8)\) did not report the specific cause of illness-related absence, \(^{19,21,25,26,31-33}\) whereas 6 specifically measured AGI- and ARI-associated absenteeism, \(^{19,26,27,30,34,35}\) only measured ARI-associated absenteeism, \(^{20,30,33,35}\) or measured AGI- and ARI-associated absenteeism.\(^{20,30,33,35}\) One only measured AGI-associated absenteeism, \(^{20,30,33,35}\) and 1 did not specify the cause of absences, so the study investigators combined all absences \((illness or nonillness related\) in their analysis.\(^{31,32}\) In all studies in which illness-specific absenteeism was measured, symptoms used to classify the cause of illness were listed. Symptoms such as abdominal pain, diarrhea, and vomiting were used to identify students having AGI, whereas symptoms such as coughing, sneezing, fever, sinus trouble, bronchitis, fever, pinkeye, headache, and mononucleosis indicated an ARI, with 1 study including acute exacerbation of asthma as an additional symptom.\(^{31}\) Because operational definitions were not provided for each symptom, some absences might have been misclassified because some of the above-mentioned symptoms are also indicative of noninfectious diseases. Six of 7 studies that measured and reported AGI-associated absenteeism reported statistically significant reductions in absenteeism \((P < .05)\) in the intervention groups versus the comparison groups. The difference between groups in absenteeism reductions ranged from 29.5% \((57.1\%)\) \(^{21,26,27,30,34,36}\) to -90% \((P = .490)\).\(^{35}\) ARI-associated absenteeism was measured in 9 studies, \(^{20,21,26,27,29,30,34,35,37}\) with 6 also reporting AGI-associated absenteeism, as described above. Five of the 9 studies reported a significant reduction in ARI-associated absenteeism in the intervention group versus the comparison group, \(^{20,27,30,34,37}\) with the difference in absenteeism rates of reduction high for all 5 studies, ranging from 30.9% \(^{27}\) to 52.6%.\(^{30}\) Although Kimel\(^{10}\) observed decreased absenteeism in the intervention group 1 and 2 months postintervention compared with the comparison group, she reported no significant reduction at 3 months postintervention follow-up.

As previously mentioned, 8 studies reported combined illness-related absences and did not specify the cause of illness \((AGI or ARI)\) \(^{19,23-25,28,31-33}\) with 1 study not specifying the cause of absence, so absences could have been illness or nonillness-related.\(^{21}\) Of the 9 studies, 8 reported a significant difference in absenteeism between the intervention and comparison groups, with reductions ranging from 19.8%–50.6% \(^{19-22,24,25,28,31-33}\) with 1 showing no difference.\(^{23}\)

In addition to classifying studies by the type of infectious disease associated with absenteeism, we also examined the reported effect by type of hand-hygiene intervention. Three broad categories were identified: interventions in which hand sanitizer was emphasized, those in which soap was emphasized, and those providing only education. Each study was assigned to 1 mutually exclusive category to facilitate comparisons across intervention type \((Table 2).\) The 12 studies in which hand sanitizers were emphasized involved use of hand sanitizer alone \((alcohol-based or alcohol-free\) or the use of an alcohol-based handrub \((ABHR)\) coupled with education. Across all studies, hand sanitizer was offered at different times during the school day, making it difficult to compare study outcomes. Of the 3 studies that examined the effect of ABHR alone, 1 reported a 19.8% \((P < .05)\) reduction of combined illness-associated absenteeism in the intervention group versus the comparison group,\(^{1} \) and it reported a 34.6% \((P = .002)\) reduction in ARI-associated absenteeism within 1 of 2 intervention groups,\(^{37}\) and the third showed a 36.1% reduction \((P < .01)\) in AGI-associated absenteeism in the intervention group but no significant reduction in ARI-associated absenteeism.\(^{21}\) Five studies reported the effect of ABHR use coupled with education.\(^{20,24,25,31,36}\) Similar to the above results regarding ABHR use alone, 3 of 5 studies reported reductions in combined illness-related absenteeism in the intervention group versus the comparison group, ranging from 22.6%–50.6% \((P < .05)\).\(^{24,31}\) One reported a 29.5% reduction in AGI-associated absenteeism \((P < .001)\), whereas the remaining study\(^{31}\) did not detect a significant reduction in ARI-associated absenteeism between the intervention and comparison groups. It should be noted that Morton and Schulitz\(^{24}\) used a crossover design in which the intervention group during Phase 1 became the comparison group in Phase 2, at which point participants had already been exposed to the intervention. Therefore, we only included results from Phase 1 in our review, whereas the results from both phases were combined in the study authors’ analysis.\(^{24}\)

Two studies\(^ {19,27}\) tested the effect of using alcohol-free hand sanitizers alone \((education was provided to the intervention and comparison groups)\) and both reported statistically significant reductions in AGI-associated absenteeism \((37.5\%–38.6\%)\) and a reduction in ARI-associated absenteeism \((30.9\%–31.7\%)\) in the intervention groups.

Four studies evaluated interventions in which students washed their hands with soap.\(^ {20,32-34}\) In the study conducted by Bowen and colleagues,\(^{31}\) 2 different interventions were compared with a control group—a standard intervention, in which students only received handwashing education, and an expanded intervention, in which students received soap and were assigned a peer mentor to assist with handwashing techniques and to remind them of handwashing opportunities. These investigators found a significant reduction in combined illness-related absenteeism, 42% \((P < .05)\), but only in the expanded intervention group.\(^ {33}\) Nandrup-Bus\(^ {22}\) had similar findings, a significant reduction in combined illness-related absenteeism in the intervention group, 21.8% \((P < .01)\), when students were
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<td>Hammond et al (2000)</td>
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<td>X</td>
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<td>15 Days absent per student</td>
<td>19.8% Combined illness-related absenteeism significantly lower in the intervention group ((P &lt; .05))</td>
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<td>Pandejpong et al (2012)</td>
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<td>20 Absenteeism rate(^{1})</td>
<td>60 min: 34.6% ARI-associated absenteeism significantly lower in the intervention group ((P = .002)); but not significantly lower in the group using hand sanitizer every 120 min compared with control group ((P = .743))</td>
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<td>Hand sanitizer and education</td>
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<td>Azor-Martínez et al (2014)</td>
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<td>X</td>
<td>19 Percentage of absent days(^{2})</td>
<td>29.5% Percent AGI-associated absent days significantly lower in the intervention group ((P &lt; .001))</td>
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<td>Dyer et al (2000)</td>
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<td>X</td>
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<td>17 Days of absence due to communicable illness</td>
<td>AGI: 37.5% ARI: 30.9% AGI-associated ((P &lt; .001)) and ARI-associated ((P &lt; .02)) absences significantly lower in the intervention group</td>
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<td>Guinan et al (2002)</td>
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<td>X</td>
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<td>11 Absence episodes</td>
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<td>Morton and Schultz (2004)</td>
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<td>X</td>
<td></td>
<td>14 Number of children absent due to respiratory or gastrointestinal illness</td>
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<td>Nandrup-Bus (2011)</td>
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<td>X</td>
<td>X</td>
<td>16 Absence periods due to infectious illness(^{3})</td>
<td>22.6% Combined illness-related absenteeism significantly lower in the intervention group ((P = .018))</td>
</tr>
<tr>
<td>Priest et al (2014)</td>
<td>Cluster-RCT</td>
<td>X</td>
<td>X</td>
<td></td>
<td>25 Absence episodes per 100 child-days(^{4})</td>
<td>AGI: −7.1% ARI: −5.0% AGI-associated absence episodes not significantly lower in the intervention group ((P = .490)); ARI-associated absence episodes not significantly lower in the intervention group ((P = .439))</td>
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<td>Sandora et al (2008)</td>
<td>Cluster-RCT</td>
<td>X</td>
<td>X</td>
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<td>23 Absenteeism rate caused by respiratory or gastrointestinal illness(^{5})</td>
<td>AGI: 36.1% ARI: −7.9% AGI-associated absenteeism significantly lower in the intervention group ((P &lt; .01)); ARI-associated absenteeism not significantly lower in the intervention group ((P = .12))</td>
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<td>Stebbins et al (2011)</td>
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<td>–</td>
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<td>23 Absence episodes associated with influenza A or B(^{6})</td>
<td>6.3% Absence episodes due to lab-confirmed influenza (both A and B; ARI-associated absenteem) not significantly lower in the intervention group ((P = .33))</td>
</tr>
<tr>
<td>Vessey et al (2007)</td>
<td>Crossover</td>
<td>X</td>
<td>X</td>
<td></td>
<td>16 Absences due to communicable illness</td>
<td>0% Combined illness-related absences not significantly lower in the intervention group (no difference)</td>
</tr>
<tr>
<td>White et al (2001)</td>
<td>Cluster-RCT</td>
<td></td>
<td>X</td>
<td>X</td>
<td>17 Absence incidences(^{7})</td>
<td>AGI: 38.6% ARI: 31.7% AGI-associated ((P &lt; .01)) and ARI-associated ((P &lt; .01)) absence incidences significantly lower in the intervention group</td>
</tr>
</tbody>
</table>

\(^{1}\) Absenteeism rate refers to the proportion of students absent per day. \(^{2}\) Percentage of absent days refers to the proportion of total possible days absent. \(^{3}\) Absence periods due to infectious illness includes all types of infectious illnesses. \(^{4}\) Absence episodes per 100 child-days refers to the number of episodes per 100 child-days. \(^{5}\) Absenteeism rate caused by respiratory or gastrointestinal illness includes all types of respiratory and gastrointestinal illnesses. \(^{6}\) Absence episodes associated with influenza A or B includes all types of influenza A or B. \(^{7}\) Absence incidences refer to the number of absences per student.
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<td>Days of absence due to communicable illness</td>
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<td>AGI-associated days of absence significantly lower in the intervention group</td>
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<td>Master et al (1997)</td>
<td>Non-RCT</td>
<td>X X</td>
<td></td>
<td></td>
<td></td>
<td>(P = .0024); ARI-associated days of absence not significantly lower in the intervention group (P = .0756)</td>
</tr>
<tr>
<td>Nandrup-Bus (2009)</td>
<td>Cluster-RCT</td>
<td>X X</td>
<td>19</td>
<td>Absence periods due to infectious illness</td>
<td>21.8%</td>
<td>Combined illness-related absence periods significantly lower in the intervention group (P = .002)</td>
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<td>Talaat et al (2011)</td>
<td>Cluster-RCT</td>
<td>X X</td>
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<td>Absences due to illness per 100 student-weeks</td>
<td>AGI: 33% ARI: 40%</td>
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<td>Soap and education</td>
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<td>Bowen et al (2007)</td>
<td>Cluster-RCT</td>
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<td>19</td>
<td>Median absence episodes per 100 student-weeks</td>
<td>Expanded: 42% Standard: 44%</td>
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<td>Education alone</td>
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<td>Kimel (1996)</td>
<td>Non-RCT</td>
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<tr>
<td>Lau et al (2012)</td>
<td>Cluster-RCT</td>
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<td>18</td>
<td>Percent illness-related absent days during influenza season</td>
<td>26.8%</td>
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<td>Tousman et al (2007)</td>
<td>Non-RCT</td>
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<td>10</td>
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<td>34% (during second half of intervention)</td>
<td>Absenteeism rates (illness and/or nonillness-related) significantly lower in the intervention group (P = .027)</td>
</tr>
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</table>

AGI, acute gastrointestinal illness; ARI, acute respiratory illness; RCT, randomized controlled trial.

*When percent reduction was not presented in the article, we used the following formula to calculate: Reduction = \( \frac{\text{Control} - \text{Intervention}}{\text{Control}} \times 100\% \). All data used in our calculation were first normalized by sample size and/or possible days of attendance.

†Absenteeism rate = Number of sick days (caused by reported, physician-confirmed influenza-like illnesses) divided by the total number of school days.

‡Percentage of absent days = Absence days divided by all possible days of attendance and total possible days of attendance = total number of students multiplied by possible days of attendance.

¶Absenteeism rate = The number of days absent because of a single cause.

§One absence period = A series of one or more days of absence from school.

‖Absence rate = Number of school days missed during the study period specifically caused by reported respiratory or gastrointestinal illness, divided by the total number of school days eligible during the study period.

**Absence episode associated with an influenza-like illness that was subsequently laboratory confirmed as influenza A or B.

††Absence incidences = discrete illness periods per student.

†‡Infectious illness included respiratory infections, gastrointestinal infections, skin infections, and other infections.

‡‡Illnesses used in calculation for percent reduction were classified as either influenza-like illness or diarrhea.

§§Percent illness-related absent days = Illness-related absent days divided by all possible days of attendance; influenza season was October–December.
provided with handwashing education and were required to wash hands at additional times throughout the school day. Master and colleagues also evaluated an intervention in which students were required to wash their hands at additional times throughout the school day (although no additional education was provided) and reported a 57.1% reduction in AGI-associated absenteeism (P < .01), but only a 24.0% reduction in ARI-associated absenteeism (P = .0756) in the intervention group. Talaat et al presented a study where students in the intervention group were provided with soap and hand hygiene education and they reported significant reductions in both AGI-associated (33%) and ARI-associated (40%) absenteeism (P < .0001) in the intervention group.

The last type of intervention we examined were the 3 studies that included only education, comprised of a presentation, curricula, handouts, games, and/or posters. One detected a significant reduction, 52.6% (P = .001), in ARI-associated absenteeism in the intervention group, whereas another reported a 26.8% (P < .01) reduction in combined illness-associated absenteeism. The third reported a 34% reduction in absenteeism in the intervention group during weeks 3 and 4 of the 4-week intervention. The reduction was statistically significant (P < .05), but no data were collected on the cause of the absences, so both illness and nonillness-related absences might have been included.

DISCUSSION

Our results show that evidence is available to suggest that hand-hygiene interventions have an effect on AGI— but not ARI-associated absenteeism, which is consistent with the findings of 2 published reviews that examined the effect of hand-hygiene interventions in community settings. However, because we did not perform a quantitative meta-analyses, the strength of the evidence could not be determined.

Several reasons could explain our findings. First, the type of contamination events that prompt hand-hygiene attempts could influence whether one acts after the event. For example, washing hands after coughing or sneezing (possible symptoms of an ARI) may not be believed to be as necessary as it is after defecation (a symptom of AGI), yet washing hands after both events is essential for removal of pathogens from hands. Secondly, widely promoted coughing and sneezing etiquette includes among its recommendations that one can cough or sneeze into a tissue or into a flexed elbow. Because both minimize cough or sneeze secretions directly contacting one’s hands, one might believe they do not have to wash their hands or use a hand sanitizer after these events. Lastly, many respiratory diseases (eg, cold, influenza, and pneumonia) are commonly associated with bioaerosol exposure, whereas the only AGI agent known to be associated with bioaerosol exposure is human noroviruses. Therefore, we suggest coupling surface disinfection with hand hygiene immediately following an event to prevent ARIs, which might explain why hand-hygiene interventions showed no effect on ARI-associated absenteeism.

The use of hand sanitizers (ABHRs and alcohol-free) and soap was also associated with reducing nonspecific illness- and AGI-associated absenteeism but not absences attributed to ARI, presumably for the same reasons cited above. Meadows and Le Saux, who examined the effect of hand sanitizers on illness-related absenteeism, had similar conclusions to ours. These authors also reported that the available evidence extracted from the 6 studies reviewed was low quality, suggesting results regarding effect be interpreted with caution. Education-only interventions might have had an effect on reducing ARIs- or combined illness-associated absenteeism, but because of weaknesses in how methods were reported, as well as the lack of statistical tests, we could not determine its effect.

The findings from the studies included in our review could not be aggregated because absence measures and reporting procedures can vary widely across countries, states or provinces, and schools. Primary education is compulsory in all countries in which studies in our sample were performed—United States, China, Denmark, Egypt, New Zealand, Spain, and Thailand—so school attendance is tracked. However, different definitions of absenteeism, different methods to calculate absenteeism rates, and different methods to check attendance are believed to be used across countries and within countries. For example, a report prepared by Grewe that described student absenteeism in European countries concluded that the challenge of aggregating absenteeism findings was that methods used to define and track absences were not uniform similar to practices. Although information was not publicly available to prove this statement, we believe that this is a problem across countries and within countries.

Lastly, our results should be interpreted with caution because there were no well-designed trials, similar to the conclusions of Meadows and Le Saux, suggesting there is evidence but the strength of the evidence cannot be quantified. Some weaknesses are a result of the nature of the intervention so could not be avoided. For example, subjects or sites cannot always be randomly selected or assigned. Attirition, a common problem in our studies, can also be difficult to control. However, fidelity of implementation can and should be controlled to confirm that exposure to the intervention occurred as planned. No study authors reported that they measured fidelity. Lastly, inadequate blinding or insufficient identification and measurement of confounding variables are well-known causes of biased results and may actually attenuate study results, but were not commonly addressed in the studies in our sample.

Suggestions for future studies

To improve the evidence base about the effect of hand-hygiene interventions on school absenteeism, future studies must be more rigorously designed, specifically addressing randomization, blinding, fidelity of implementation, and attrition—all major sources of bias. In addition, statistical power should be estimated to determine the sample size necessary to detect effects. Furthermore, given that ABHRs and soap had an effect on AGI-associated absenteeism but the timing of application was not controlled, timing should be controlled in a future study. Lastly, participant handwashing compliance was rarely reported, and when reported, it was low, so the evaluation of future hand-hygiene interventions should investigate the frequency, duration, quality, and motivators of hand-hygiene practices.

Limitations

The presence of design flaws does not mean a treatment effect did not exist, because our review findings might have overestimated the lack of effect associated with hand-hygiene interventions on ARI-associated absenteeism as well as the effect of education on absenteeism. Secondly, there is a bias to publish significant results, so studies that were included might have overestimated the effects. Although the quality assessment tool used here was carefully chosen, the authors of the checklist note that the 5 dimensions of the checklist were assigned equal weight because there is insufficient evidence to prioritize 1 dimension over another despite the fact that the various quality dimensions are more or less critical for overall study quality. Lastly, only studies published in English were included. The inclusion of non-English language studies, as well as unpublished studies, might change the nature of the results reported here. However, it was deemed a necessary limitation given the scope of the current study.
CONCLUSIONS

Hand-hygiene interventions had an effect on reducing AGI-associated absenteeism in elementary schools, but the strength of that evidence was not determined. There is also inadequate evidence to show that hand-hygiene interventions are associated with the reduction of ARI-associated absenteeism. The use of hand sanitizers (ABHRs and alcohol-free) and soap was also associated with reducing nonspecific illness- and AGI-associated absenteeism, but not absences attributed to ARI. The effect of education-only interventions is inconclusive. Our findings can serve as a guide to design, deliver, and evaluate more efficacious hand-hygiene interventions.

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