Mandatory handwashing in elementary schools reduces absenteeism due to infectious illness among pupils: A pilot intervention study

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Background: The objective of this study was to determine the effect of mandatory, scheduled handwashing on actual absenteeism due to infectious illness in elementary school pupils in Denmark.

Methods: A 3-month pilot intervention study, randomized between 2 schools, was performed on 652 pupils age 5 to 15 years. The pupils at the intervention school (IS; n = 290) were required to wash their hands before the first lesson, before lunch, and before going home. Those at the control school (CS; n = 362) continued their usual handwashing practices. All absences due to illness were recorded, and data were analyzed statistically.

Results: Multivariate analysis demonstrated a significantly reduced rate of absenteeism for the IS compared with the CS (P = .002). For girls, the rate was 1.05 periods (95% confidence interval [CI] = 0.90 to 1.22) for the IS versus 1.35 (95% CI = 1.26 to 1.44) for the CS. For boys, these rates were 0.87 (95% CI = 0.72 to 1.05) and 1.12 (95% CI = 0.92 to 1.36). An alternative approach demonstrated that the odds ratio for absence was 0.69 (95% CI = 0.52 to 0.92) for the IS compared with the CS.

Conclusion: This study suggests that handwashing could be an effective tool to reduce absences due to infectious illness in elementary school pupils. A school policy regarding hand hygiene and teaching of hand hygiene is warranted.

Key Words: Hand washing; mandatory; pupils; infectious illness absenteeism; intervention; elementary school.

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Attendance is a leading predictive factor of academic success for elementary school pupils. According to the Centers for Disease Control and Prevention, in 2007 more than two-thirds of US pupils age 5 to 17 years missed school in the preceding 12 months due to illness or injury. Similar data are not available for Denmark, but a 2006 study found that 793 pupils had an average of 527 illness-related absence periods per month. Handwashing is a well-known primary infection control measure. Furthermore, handwashing with soap and water has been cited by the World Health Organization as “the most important hygiene measure in preventing the spread of infection.” Schools, like hospitals, have close, crowded environments that increase the risk of microbial cross-contamination and transmission. Aiello et al noted that infectious agents that children contract in schools can result in infections in up to 50% of household members.

There has been a significant focus on handwashing in day care centers in Denmark and abroad, where different initiatives have resulted in fewer episodes of infection. Similar results have been found and cited in studies of secondary transmission in private homes and in university student groups that have been encouraged to improve hand hygiene.

Denmark, studies of disease occurrence and frequency of illness in preschool children (age 0 to 6 years) have been performed, but no similar data exist for school pupils. Schools are committed to recording all attendance and permitted or illness-related absences, but data are recorded only locally, with no centralized overview.

Studies of hand hygiene interventions in school settings, performed mainly in the United States, have shown an overall reduction in the number of infectious disease events. No comparable studies have been reported in Denmark or Europe, however. A review by Rabie et al on handwashing and respiratory infections in the community noted that “the poor geographical distribution of studies is surprising and may reflect the fact that in US, handwashing is commonly believed to protect against colds and flu, but not elsewhere (anecdotal evidence).”
Many Danish school buildings are old and have inadequate sanitary facilities, hindering optimal hand hygiene. This makes a focus on hand hygiene in school settings even more important. The objective of the present study was to determine the effect of mandatory, scheduled handwashing on actual absences due to infectious illness in pupils.

METHODS

The study was conducted at two 100-year-old elementary schools situated 10 km apart in North Zealand, Denmark. The intervention period (IP) was January 4 to March 30, 2007. The study participants (level 0 to 7, age 5 to 15 years) included 294 pupils in school A and 366 pupils in school B. Both schools were located in upper–middle-class areas, and most of the pupils were ethnic Danish. Sanitary provisions in both schools included mild, nonperfumed liquid soap and disposable paper towels at every wash basin. School A had 17 toilets and 25 wash basins; school B had 19 toilets and 27 wash basins.

In January 4 to March 31, 2006, a baseline survey was performed to determine the frequency and causes of pupil absences (eg, influenza, injury) and to define pupils’ normal handwashing practices during school hours at the 2 schools, as such data were not publicly available. Data on the frequency and cause of absenteeism, as well as handwashing habits, were similar for the 2 schools.

Based on absenteeism during the previous year, each pupil had an average absenteeism due to infectious illness of approximately 1 episode per 3 months. We hypothesized that handwashing would reduce this number by 25%, corresponding to 0.75 episodes per pupil per 3 months. A sample size of 300 at each school provided approximately 86% statistical power to demonstrate this difference at a significance level of .05.

The principals and boards of both schools approved the schools’ participation in the study. All parents received written information about the study. The 2 schools were randomly allocated to the intervention arm (school A) or the control arm (school B). Parents at the intervention school (IS) signed participation agreements. After several reminders, a parental response rate of 93% was achieved (294/317).

At the IS, pupils were required to wash their hands (1) before beginning the first lesson, (2) before lunch, and (3) before leaving school for home. These scheduled handwashing times were considered those most likely to reduce the transmission of microbial agents from home to school and vice versa and at lunch time, because pupils commonly eat hand-held sandwiches.

All 16 classes (8 levels) received 2 lessons in hand hygiene, including theoretical and practical training at the beginning of the IP. Levels 0 to 4 received a 23-page workbook and certificates confirming that each pupil had demonstrated to the study manager how to wash their hands thoroughly in accordance with the study requirements and Danish standards.

Levels 5 to 7 received theoretical training according to values clarification (a teaching method requiring the pupils’ physical participation by indicating their reactions to the subject in question), as well as practical training similar to that provided for the younger group. A poster displaying step-by-step handwashing practice was placed at each wash basin. Parents were requested to remind their children to wash their hands before the first lesson, and the pupils were given a sample perfume-free hand cream with few preservatives. According to the Danish standards, skin care moisturizing cream is prescribed as needed after handwashing.

At the CS, all parents received written information about a hygiene study and about collection of data on illness-related absenteeism, with no reference to hand hygiene. No further information was provided intentionally, so that pupils and parents remained as unaware of the mandatory handwashing at the IS as possible.

Data were collected each week by the study manager, a health visitor, and an infection control nurse, who visited all classes at both schools to interview pupils who had an illness-related absence during the previous week. Together they completed a questionnaire to determine the reason(s) for the absence in collaboration with the pupil’s report book, the teacher, and/or a phone call to parents if necessary. The questionnaire recorded absenteeism categorized into 5 main groups: respiratory infections (RIs), gastrointestinal infections (GIs), skin infections, other infections, and noninfectious illness (eg, injury), all of which included subgroups. The questionnaire was identical to that used in the 2006 Danish study. Hereinafter, the 5 main groups together are referred to as “all illness,” and the first 4 main groups together are termed “infectious illness.”

An absence period was defined as the number of days absent due to a single cause, with at most 2 days of school attendance or a weekend between events. The recording of absence periods was considered a more precise measurement of pupils’ morbidity than counting the number of days absent, which can be biased by the parents’ ability to nurse pupils at home.

In late March, compliance with the intervention was investigated through anonymous questionnaires distributed in each classroom. Possible pupils’ responses to questions about frequency of handwashing included “every day,” implying consistent compliance; “once in a while,” interpreted to mean 50% compliance; or “never,” interpreted to reflect poor compliance or noncompliance. A total of 267 questionnaires were answered by 290 pupils, a response rate of 92% (8% of the pupils were absent on this day).
Table 1 gives the distribution of all illness periods stratified by school and the reasons for absence, the difference between the percentages in relation to the CS for each number of absence periods, infectious illness periods stratified by gender, and \( P \) values for the \( \chi^2 \) test for trend. It can be seen that in the IS, the proportion of pupils with no absence periods (0) was higher for absence due to infections, whereas the opposite was seen for pupils with 2 or more absence periods. The table also shows the total number of days absent due to infectious illness for the IS and CS. The difference between the schools was greater for girls than for boys; however, the trend was the same in both genders.

Figure 1A shows the percentages of infectious illness periods (the primary outcome) grouped by class level at the IS and CS for girls. Figure 1B shows the corresponding figure for boys.

Multivariate analysis of the primary endpoint (the number of infectious illness periods) using the Poisson distribution model, adjusted for gender and class level, demonstrated significant differences between the 2 schools (\( P = .002 \)). The total number of infectious illness periods was 280 (290 pupils) for the IS and 449 (562 pupils) for the CS. Gender was not a statistically significant factor (\( P = .11 \)) in the multivariate model. Table 2 gives the estimated mean incidence rates, with 95% confidence intervals (CIs), for boys and girls. A similar analysis of the total number of infectious illness days showed a significant difference between the schools (\( P = .004 \)), with 567 for the IS and 960 for the IS. Again, gender was not a significant factor (\( P = .30 \)). The results of the multivariate analysis in Table 2 show that the average absences due to infectious causes were 0.97 periods and 1.95 days per pupil for the IS and 1.24 periods and 2.65 days for the CS. No significant interaction between school and gender was detected in the multivariate analyses. Multivariate analyses of the primary outcome using the proportional odds model comparing schools and adjusted for gender and class level demonstrated a significant difference between the 2 schools (odds ratio [OR] = 0.69; 95% CI = 0.52 to 0.92; \( P = .011 \), IS vs CS). Gender was not statistically significant (OR = 0.74; 95% CI = 0.52 to 1.06; \( P = .11 \), boys vs girls). The assumption of proportional odds was not rejected (\( P = .69 \)). A similar analysis of the secondary outcome showed a significant difference between the schools (OR = 0.66; 95% CI = 0.48 to 0.92; \( P = .01 \), IS vs CS). Again, gender was not significant (\( P = .30 \)). No significant interaction between school and gender was detected for this model.

School records showed a usual monthly consumption of 36 packs (250 sheets per pack) of paper towels and 2 to 2.5 L of liquid soap at the IS. During the IP, consumption increased to 187 packs of paper towels (92 packs in January, 59 packs in February, and 36 packs) and 16 L of liquid soap. Because soap was continuously replenished, accurate monthly measurement was not possible. No reliable measure of soap consumption was available from the CS.

Compliance with mandatory handwashing was seen mostly “once in a while” in 58% of the pupils, “every day” in 20%, and “never” in 22% (Table 3).

### DISCUSSION

The main causes of absence due to infectious illness in the IS and CS were RIs and GIs. Rabie et al.27 found that handwashing can decrease the risk of RIs by 16%. Curtis et al.31 reported that handwashing using soap can reduce the risk of diarrheal disease by 42% to 47%. Master et al.25 found a relative risk of 0.43 of GIs in a group that practiced strict handwashing. A 2008 Cochrane review found that handwashing reduced the incidence of diarrheal episodes in children and adults by 30%.32 Bloomfield et al.33 in a study of hand hygiene in reducing infections in the community, found a nearly 50% reduction in GIs and a 23% reduction in RIs associated with handwashing. No review of the effect of handwashing in school settings has been published to date, but a review by Meadows et al.34 of the effectiveness of antimicrobial, rinse-free hand sanitizers in reducing illness-related absences in school children found a 20% to 49% decrease in the number of illness-related absenteeism events in study participants.

The criticisms of the aforementioned reviews were considered when planning the present study, which included 652 pupils and a randomly chosen IS. The sample size was calculated following a survey of both schools during the previous year.5 Information was collected on the availability of washing facilities and soap consumption, and absenteeism was defined by more precise absence periods than days absent.

| Table 2. Estimated incidence of infectious illness absence periods and days using a Poisson model adjusted for gender and including class as a random effect |
|------------------|------------------|------------------|
|                   | IS               | CS               |
|                   | Rate             | 95% CI           | Rate             | 95% CI           |
| Infectious illness periods |
| Females           | 1.05             | 0.90 to 1.22     | 1.35             | 1.26 to 1.44     |
| Males             | 0.87             | 0.72 to 1.05     | 1.12             | 0.92 to 1.36     |
| Infectious illness days |
| Females           | 2.02             | 1.66 to 2.45     | 2.74             | 2.52 to 2.98     |
| Males             | 1.88             | 1.44 to 2.47     | 2.56             | 2.15 to 3.04     |

NOTE. The \( P \) value testing for equality between IS and CS was .002. The \( P \) value testing for equality between IS and CS was .004.
Pupils at the IS received 2 hours of professional instruction and were given guidance workbooks. When attempting to identify the reasons for absences, it was found that data collected by a person with medical experience (the study manager) were more valid than data collected by teachers or parents. Furthermore, data collected of the questionnaires was 100% compared to 71% in the previous year when teachers and parents completed the questionnaires. There was no significant difference between the schools in the category of “all nonillness periods” (group 5), as was expected (Table 1). The multivariate statistical analysis using the proportional odds model is dependent on the scoring of the number of infectious illness periods and total days absent due to infectious illness.

In this study, the proportional odds model found an OR of 0.69 when comparing the IS to the CS. The multivariate model demonstrated fewer infectious illness periods for the IS. Although girls had more absences than boys, the difference was not statistically significant.

One limitation of the present study is that compliance was self-reported, but this was inevitable. Day et al reported the difficulty of maintaining handwashing compliance over time in children. The decreasing consumption of soap and paper towels during the IP indicates that the survey of compliance most likely reflects the actual compliance levels in the last few weeks of the IP. Had the parents of the pupils in the IP filled out the questionnaires about infectious illness, the survey would have provide more information on the amount of infectious agents that pupils bring home from school. Moreover, probably because of a lack of power, the study showed significant results only in the GI group and among girls.

A child’s school absence due to infection that requires a parent to stay home from work entails high costs to the community. According to Statistics Denmark (www.statistikbanken.dk), a Dane employed in the private sector works an average of 220 days per year and earns an average salary of 422.645 DKK (US $76.845); numbers are not available for the public sector. The pupils at the IS had 0.7 fewer days of absence due to infection, amounting to a cost savings of 389.963 DKK (US $70.902) for 290 pupils over a 3-month period. The cost of the intervention was 2 hours of teaching per class at 200 DKK per hour (US $36), for a total of 6400 DKK (US $1,164). Asking pupils to wash their hands carries no cost. Therefore, in the IP each pupil saved almost 1323 DKK (US $241) for the community with just 20% compliance. These calculations suggest that handwashing is a cost-beneficial activity, as has been reported by Guinan et al.

### CONCLUSION

School absenteeism is a recognized problem for pupils, teachers, parents, and the wider community, and the institution of improved hand hygiene has been shown to be a cost-beneficial action. Our data indicate that even with the barriers in the school environment and only 20% compliance, the handwashing program reduced absences due to infectious illness in the IS. This study demonstrates that the benefit of handwashing is most pronounced in pupils with the highest rate of absenteeism and in girls.

In the future, Danish communities could benefit from an increased focus on hand hygiene in school settings by making disposable hand towels and fluid soap available for all pupils and by teaching good hand hygiene practices. Teachers and principals should act as role models. Because poor compliance with hand hygiene is a well-documented problem, schools need a clearly defined policy on good hand hygiene and general hygiene to be practiced by all.

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### Table 3. Compliance with mandatory handwashing, n (%)

<table>
<thead>
<tr>
<th>Question</th>
<th>Every day</th>
<th>Once in a while</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>How often have you washed your hands before the first lesson the last 3 months?</td>
<td>50 (19%)</td>
<td>183 (69%)</td>
<td>34 (13%)</td>
</tr>
<tr>
<td>How often have you washed your hands before lunch in the last 3 months?</td>
<td>83 (31%)</td>
<td>143 (54%)</td>
<td>41 (15%)</td>
</tr>
<tr>
<td>How often have you washed your hands before leaving school the last 3 months?</td>
<td>25 (9%)</td>
<td>138 (52%)</td>
<td>103 (39%)</td>
</tr>
</tbody>
</table>

NOTE. “Every day” implies consistent compliance; “once in a while” is interpreted as 50% compliance; “never” is interpreted as poor compliance or noncompliance.