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Outcomes of a Pilot Hand Hygiene Randomized Cluster Trial to Reduce Communicable Infections Among US Office-Based Employees

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Objective: To determine the effectiveness of an office-based multimodal hand hygiene improvement intervention in reducing self-reported communicable infections and work-related absence. **Methods:** A randomized cluster trial including an electronic training video, hand sanitizer, and educational posters ($n = 131$, intervention; $n = 193$, control). Primary outcomes include (1) self-reported acute respiratory infections (ARIs)/influenza-like illness (ILI) and/or gastrointestinal (GI) infections during the prior 30 days; and (2) related lost work days. Incidence rate ratios calculated using generalized linear mixed models with a Poisson distribution, adjusted for confounders and random cluster effects. **Results:** A 31% relative reduction in self-reported combined ARI-ILI/GI infections (incidence rate ratio: 0.69; 95% confidence interval, 0.49 to 0.98). A 21% nonsignificant relative reduction in lost work days. **Conclusions:** An office-based multimodal hand hygiene improvement intervention demonstrated a substantive reduction in self-reported combined ARI-ILI/GI infections.

Each year communicable diseases, including acute respiratory infections (ARIs), influenza-like illness (ILI), and gastrointestinal (GI) infections, exact a considerable toll on society. The global annual attack rate of influenza has been estimated at 5% to 10% in adults and 20% to 30% in children.[1] Costs for communicable infectious diseases, which include seasonal influenza,[2] noninfluenza acute respiratory tract infections,[3] and GI infections,[4] have been estimated in the tens of billions of US dollars each year. Collectively, a large proportion of these burdens has been shifted to employers, which include the costs of medical intervention for self-insured organizations, rising health insurance premiums, absenteeism, employee replacement, reduced productivity due to working while ill, increases in overtime from higher workloads carried by healthy employees on the job, and reduced morale. One systematic review from the United Kingdom that utilized laboratory and physician confirmed cases found that the mean number of self-reported lost work days due to influenza and ILI ranged from less than 1 to 5.9 days.[5] A study conducted in the United States connected ILI-related *International Classification of Diseases, Ninth Revision* codes from a large database containing nationwide insurance claims to workplace absences; consistent with the UK review, these researchers found a mean work loss of 23.6 and 23.9 hours per ILI episode in the 2007 to 2008 and 2008 to 2009 flu seasons, and called for attention from policymakers and health care professionals to design strategies to reduce this burden among employees.[6]

The burdens of nonfoodborne GI infections have been less well quantified in the literature because most surveillance is performed on foodborne illness, and milder cases of GI infections are not reported.[7] In the United States, Mead et al[8] estimated 250 million annual GI cases occur annually of which 60% are nonfoodborne. More recently, a random digit dialing telephone study consisting of 52,840 persons found a weighted prevalence of 5.1% reporting at least one episode of acute diarrheal illness with lost time from work, school, or recreation in the prior 30 days; although the source of the episodes (foodborne versus nonfoodborne) were not determined, the case definition excluded those with chronic GI disease.[9] In comparison, it has been estimated that approximately 9.4 million cases of GI infections occur in the United Kingdom, with 50% of nonfoodborne origin.[10]

Hands are an important pathway for the transfer of pathogens associated with the spread of communicable diseases because contaminated hands come in contact with portals of entry such as the nose, mouth, and conjunctiva of the eyes.[11,12] One office-based study that utilized videotaping found a mean hand contact rate with the eyes, nostrils, and mouth of 15.7 times per hour among employees.[13] Hand hygiene is the most important strategy in clinical settings to reduce the spread of pathogens associated with nosocomial infections.[14] In addition, community hand hygiene guidelines have been issued by the US Centers for Disease Control (CDC).[15] Systematic reviews and meta-analyses of hand hygiene improvement interventions in community settings such as day care centers, schools, and homes in developed and developing countries have shown a reduction in GI infections and ARIs. One systematic review published in 2003 found a reduction of 47% in GI infections.[16] A second systematic review published in 2006 found a relative reduction in ARIs of 16%.[17] Although studies included in these systematic reviews contained methodological weaknesses, both research teams noted a consistent pattern in their findings and called for additional rigorous studies. A third systematic review published in 2008 assessed the effect of hand hygiene improvement interventions from only randomized control trials in reducing GI infections and found a reduction ranging from 32% to 39%.[18] In the same year, a published meta-analysis of community hand hygiene interventions that included schools, day care settings, and homes found an overall reduction in GI and ARIs of 21% and 31%, respectively, with effectiveness that varied according to intervention approaches.[19] Most recently, a systematic review published in 2012 found that the effectiveness of hand hygiene interventions for preventing influenza and ARIs varied by the type of community setting and the income of the country, although a pooled estimate of effects was not conducted due to heterogeneity across studies.[20]

The workplace is a key location in the community to reach healthy adults because adults typically spend up to half of their waking hours in this setting. Moreover, they often work in close proximity

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and share equipment, creating the potential for the spread of infectious disease. The CDC has recommended a threefold strategy to reduce influenza among employees in the workplace that includes (1) obtaining an influenza vaccine; (2) practicing proactive hand hygiene and respiratory etiquette; and (3) recognizing symptoms of the flu and staying home when ill.[21] Moreover, in 2006 the World Health Organization asserted a need to research the efficacy of nonpharmaceutical interventions, including protective hand hygiene behaviors and respiratory etiquette, because in the event of a pandemic influenza outbreak these approaches will become primary strategies for containment until a suitable vaccine is available.[22]

Nevertheless, at the time of the writing of this manuscript, only two hand hygiene improvement interventions among office-based employees have been published in peer-reviewed journals, neither of which was conducted in the United States. Hubner and colleagues[23] found a reduction in the common cold among employees working in a public administration setting in Germany, whereas Savolainen-Kopra and colleagues[24] found a reduction in infectious illness among employees in an office-based setting in Finland among an arm that utilized soap and water along with behavioral recommendations.

This publication reports the results of a multimodal hand hygiene improvement randomized cluster trial that was piloted among office-based employees in a US Midwestern government center. Two primary aims were to achieve a relative reduction among employees in the intervention group as compared to the control group in self-reported ARI-ILI and GI infections and in related lost days of work as determined by responses from follow-up surveys across a four-month period. A secondary aim was to achieve a relative improvement in self-reported daily hand hygiene behaviors in the work setting among those in the intervention group as compared to the control group.

METHODS

Study Design

A matched pair, parallel, cluster randomized trial was developed and implemented among four office buildings in a US Midwestern government center between February 25 and June 11, 2013. Eligibility criteria included that employees be 18 years or older and work in office-based departments selected for participation and randomized in the study. Departments consisting of employees who were not office-based personnel, such as police, correction officers, and community workers, were excluded. A wide variation in size was found between departments, which consisted of small departments of 5 to 25 employees who were specialized, such as accountants who had limited daily interaction with the public, and larger departments ranging between 100 and 400 employees who were less specialized staff, such as clerks who had more contact with the public. To assure balance in department size and interaction with the public, departments were paired by size and then randomized within pairs to either the intervention or control group using random numbers generated from Excel. On the basis of sample size calculations from Donner and Klar[25] and results from previous studies by Stedman-Smith et al,[26,27] it was determined that a total of 16 departments would be required to detect a reduction of 15% in the incidence of respiratory and GI infections in the intervention group as compared to the control group with 80% power at an alpha equal to 0.05 and an intracluster correlation of $P = 0.18$. In addition, it was also assumed that at least eight interventions and control departments would agree to participate and that an average of 25 employees per department would be recruited and retained.

Survey

A baseline enrollment survey was sent electronically to employee e-mail addresses that explained—the purpose of the study; that participation was voluntary, confidential, and anonymous; and the requirements for participating, which included completing a short baseline questionnaire with a link to view a 4-minute online training video and filling out three brief monthly surveys. The survey contained items informed by a modified model of the Theory of Planned Behavior[28] developed previously that included demographics, usual hand hygiene performance, beliefs pertaining to hand hygiene effectiveness, self-identification of contracting an ARI-ILI and/or GI infection during the past 30 days, and related lost work days.[26,27] Self-reported hand hygiene performance in the work setting was measured through a construct composed of six questions, whereas beliefs about expert recommendations regarding when to perform hand hygiene to protect health was measured by a construct of four questions. These questions elicited responses on a 0 to 4 scale, with items measured from 0 (strongly disagree) to 4 (strongly agree) and 0 (never) to 4 (always). Responses to questions for each construct were averaged to create an overall score. To measure the relative frequency of the use of hand sanitizer, subjects were asked to describe how often they clean their hands with soap and water versus hand sanitizer, on a 0 (100% soap and water) to 4 (100% hand sanitizer) scale. For analysis purposes, this variable was dichotomized to 0 (100% soap and water) and 1 (using hand sanitizer at least 25% of the time).

The first primary outcome was measured by two questions that elicited information about the presence of self-reported ARI-ILI and GI infections in the prior 30 days. Because symptoms can overlap between ARIs and ILI, and the survey was based on self-report instead of clinical diagnosis, these two conditions were not separated and were defined consistent with CDC definitions as runny nose, sore throat, cough, feverish, or fever.[29,30] Gastrointestinal infections were framed as a "stomach or intestinal infection" and defined as nausea, vomiting, and/or diarrhea. Subjects who reported having an ARI-ILI and/or a GI infection were then asked how many scheduled days of work they missed due to this condition. After these questions, employees were asked a number of descriptive questions (age, sex, race, and education) and questions related to ARI-ILI and GI infections (time spent working with the public, influenza vaccine uptake status, and raising school-aged children). At 30, 60, and 90 days after the baseline survey, participants were e-mailed links to a follow-up survey that measured beliefs about hand hygiene effectiveness, usual hand hygiene performance, getting an ARI-ILI or GI infection, and related lost work days over the previous 30 day-time period. The constructs and questions used in these surveys had previously demonstrated validity and reliability in two prior studies by the researchers.[26,27] The study was approved by the Kent State University Institutional Review Board.

Interventions

After consenting and completing the baseline enrollment survey, participants were exposed to a multimodal intervention. Those in the intervention group viewed a 4-to-5–minute hand hygiene training video, produced in consultation with the research team for this study by GoJo Industries, Akron, Ohio. The video briefly discussed the CDC three-tiered recommendations to prevent influenza in the workplace (vaccination, hand and respiratory hygiene, and staying home when ill) and then focused on the importance of hand hygiene, including the role of hand hygiene in reducing the spread of pathogens associated with infectious disease, recommendations of when to perform hand hygiene in the workplace to interrupt the spread of pathogens, and a demonstration of effective technique for cleaning hands with soap and water and hand sanitizer.

Environmental components included the on-site installation of hand hygiene supplies at participating departments, including free standing canisters of hand sanitizer, 2-ounce bottles of hand sanitizer for personal use by employees, and 12-ounce bottles of hand sanitizer for employees with extensive public contact. (Hand sanitizer contained 62% ethyl alcohol [GoJo Industries, Akron, Ohio].)

Hand sanitizer canisters and motivational/educational hand hygiene posters[31] were placed in prominent locations, such as in break rooms, kitchens, copy machines areas, conference rooms, and near time clocks.

Enrollees in the control group received a 4-minute multicultural training video to promote more effective communication with health care providers, called "Ask Me 3_{TM}" along with program key chains and brochures.[32] Also, posters containing information about the Ask Me 3 program were hung in high use office areas. In addition to receiving the same questions that were included in surveys for the intervention group, extra questions were added for participants in the control group about the usage and perceived efficacy of the Ask Me 3 program.

Statistical Methods

The statistical analysis included all employees who enrolled in the study and completed the baseline questionnaire in both intervention and control departments on an intent-to-treat basis. Baseline demographic characteristics in the intervention and control groups were compared using *t* tests for continuous variables and chi-square tests for categorical variables. Because some employees were lost to follow-up, multiple imputation with data augmentation under the multivariate normal model was conducted under the assumption that the data are missing at random, which means that missing values do not depend on unobserved data, given the availability of observed outcome data and covariates.[33] Imputation of missing data was conducted using variables from all available surveys, including demographics, self-reported hand hygiene attitudes and behaviors, hand sanitizer use, and ARI-ILI/GI infections. Ten multiple imputations were created using Mplus 7.2[34] because it is capable of accounting for the clustered nature of the data, with separate imputations for intervention and control conditions to permit the modeling of interactions of the intervention with other variables.[35] Following imputation, each imputed data set was analyzed separately using the statistical methods described below, and parameter estimates were combined using the Rubin variance formula to produce estimates and standard errors that incorporate missing-data uncertainty.[33,36]

The study had two primary outcomes. The first was the incidence of combined ARI-ILI and GI infections. In calculating incidence rates for both intervention and control groups, the number of person days observed (PDO) was determined from the date an employee completed the baseline survey to the date of the completion of the third follow-up survey. For the second primary outcome of lost work days, the calculation of PDO excluded weekends and holidays. Incidence rates from both primary outcomes were calculated by counting the number of ARI-ILI/GI infections and lost work days from the three follow-up surveys then dividing by the PDO. Incidence rates for the intervention and control groups were expressed per 90 days observed. To compare incidence rates across the intervention and control groups, incidence rate ratios (IRRs) were calculated using a generalized linear mixed model (GLMM) with a Poisson distribution and log link function because the incidence rate is a count of events per subject.[37] The mixed model permits adding random cluster effects to account for the correlation of responses expected among employees within departments that occurs as a result of the design of the study. The GLMMs also adjusted for baseline self-reported ARI-ILI and GI infection, education level, age, and having school-age children. The intercluster correlation, a measure of the correlation between employee responses that share the same department, was calculated using the method of Stryhn et al.[38]

The secondary outcome for both intervention and control groups was compared at the first 30-day follow-up because it is believed that intervention effects would be strongest at this time. Self-reported usual hand hygiene performance and beliefs about hand hygiene effectiveness were expressed as averages for both intervention and control groups on a 0 to 4 scale, with differences between the groups estimated using a linear mixed model that accounted for the design effect of clustering and potential confounders, as was done with the primary outcomes. The proportion of employees using hand sanitizer at least 25% of the time was calculated for the intervention and control groups, and the relative risk ratio comparing the groups was estimated using a GLMM with a Poisson distribution and log link function, as was done with the primary outcomes. More complex GLMMs that modeled change in the secondary outcomes over the 60- and 90-day follow-up were also created, but these models showed no evidence of intervention effects and are not presented.

RESULTS

A flow diagram of departments and employees through the study is shown in Fig. 1. Eighteen departments containing 1708 employees met the study inclusion criteria and were then paired by size and randomized. Two small departments of 5 and 15 employees were discovered to have been moved together into a larger office space and were excluded, leaving 16 departments in the study. The intervention departments had a median of 40 employees (range: 11 to 278) and a total of 732 employees, whereas the control departments had a median of 33 employees (range: 12 to 489) and a total of 956 employees.

Of these employees who were e-mailed the link to the baseline survey, 38 in the intervention group and 14 in the control group reported that they had transferred out of the randomized departments and were removed from the study. In the intervention group, 131 (17.9%) employees consented to enroll in the study and completed the baseline questionnaire, whereas 193 (20.2%) of the control group employees consented to enroll and completed the baseline questionnaire. In follow-up surveys conducted 30, 60 and 90 days after baseline, completion rates across the intervention and control groups were very similar, ranging from 75% for the first follow-up survey to 64% for the final 3-month survey. The amount of missing data seen in the baseline survey was minimal for those employees who consented to participate in the study; the majority of missingness occurred in the follow-up surveys in a loss to follow-up format, where once an employee stopped filling out the survey they were unlikely to fill out further surveys. There was little evidence of differential missingness across the intervention and control groups, making the assumption used in multiple imputations reasonable, that the data were missing at random given the availability of observed outcome data and covariates.

The characteristics of departments in the intervention and control groups are shown in the top "cluster level" portion of Table 1, whereas the characteristics of employees is shown in the lower "individual level" part of the table. Little difference existed in the size, age grouping, or proportion of time spent working with the public across the departments. Unfortunately, the size of the departments, a median of 14 in the intervention and 11.5 in the control, was much smaller than desired from a statistical power perspective. When comparing employees in the intervention and control groups, a small difference in the average age was seen, with employees in the intervention group being 3 years older than those in the control group ($P < 0.01$). Employees in the intervention group reported a substantially lower proportion of children in school (23.7%) compared with employees in the control group (37.8%) ($P < 0.01$). In other characteristics, employees across the intervention and control groups were very similar with some ethnic and education diversity; most were black or white with nearly equal numbers self-identifying in either category; approximately one out of three indicated completion of a college degree, whereas 15% to 20% indicated completion of graduate education. No one identified as having less than a high school education. Baseline hand hygiene practices and flu vaccination rates were approximately equal for both groups. The self-reported 30-day incidence of ARI-ILI was high and similar in both groups (36% vs 34%).

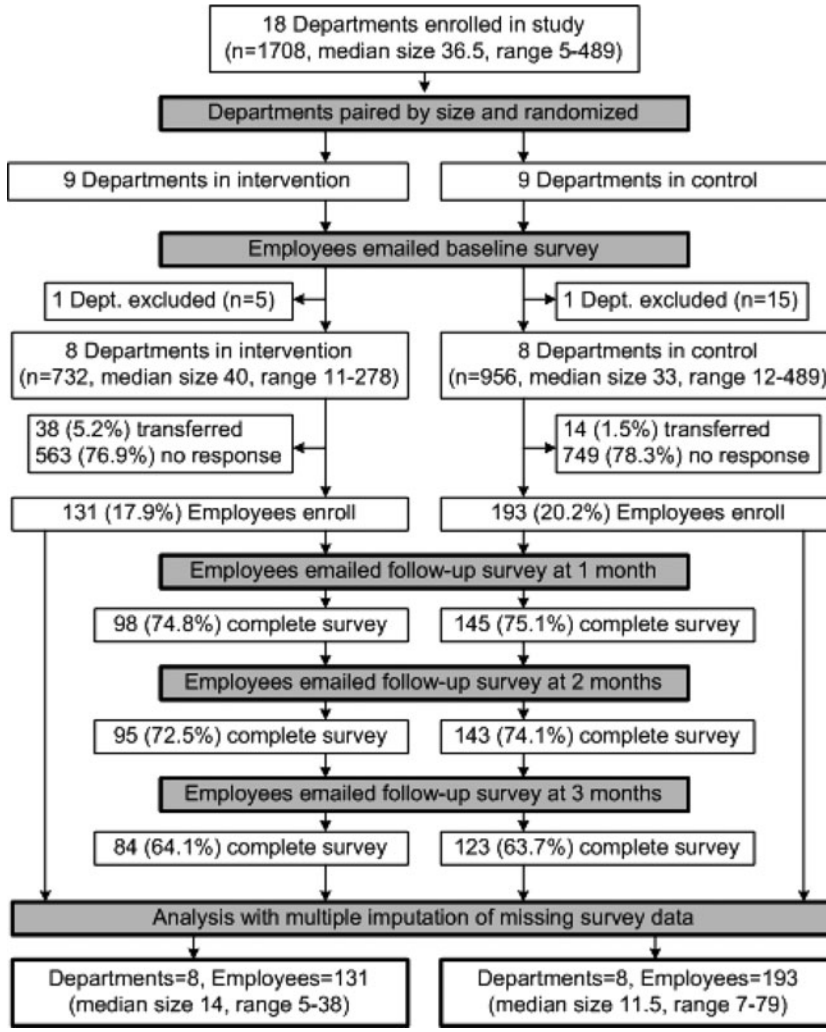

FIGURE 1. Flow diagram of study design with data collection.

Table 2 contains the results of the study for the primary outcomes of combined ARI-ILI and GI illness and lost work days. The 131 employees in the intervention group contributed 11,790 PDO over the 90-day data collection period. During this time, employees in the intervention group reported a total of 111 ARI-ILI and GI illnesses, resulting in a crude incidence rate of 0.85 occurrences of ARI-ILI and GI illness per 90 PDO (95% confidence interval [CI], 0.68 to 1.59). In the control group, the 193 employees contributed 17,370 PDO and reported 230 ARI-ILI and GI illnesses, resulting in a crude incidence rate of 1.19 of ARI-ILI and GI illness per 90 PDO (95% CI, 1.04 to 1.35). The adjusted IRR, controlling for clustering and potential confounders, shows a statistically significant relative reduction of 31% (IRR: 0.69; 95% CI, 0.49 to 0.98; $P = 0.037$) in the incidence of ARI-ILI and GI infections among intervention employees compared with control employees. The 95% CI translates to a true reduction that is somewhere between 2% and 51%.

For the second primary outcome of lost work days, employees in the intervention group contributed 8253 PDO and reported 124 days of work lost, resulting in a crude incidence rate of 1.35 days of work lost per 90 PDO (95% CI, 1.11 to 1.59). Employees in the control group contributed 12,159 PDO and reported 231 days of work lost, resulting in a crude incidence rate of 1.71 days of work lost per 90 PDO (95% CI, 1.49 to 1.93). The adjusted IRR shows a relative reduction of 21% (IRR: 0.79; 95% CI, 0.51 to 1.22; $P = 0.279$) in the number of ARI-ILI and GI infection related lost days of work among intervention employees compared with control employees that is not statistically significant. Intercluster correlations values were 0.014 for ARI-ILI and GI illnesses and 0.0454 for lost work days, which were smaller than expected given past research and the highly infectious nature of respiratory infections.

Table 3 contains the results that compare the intervention and the control groups on the secondary outcomes. For both the self-reported hand hygiene behavior score and the agreement with experts score, very small, statistically insignificant differences were seen across the intervention and control group employees. The agreement with experts score, in particular, showed high values of greater than 3.7 on the 0 to 4 point scale, suggesting ceiling effects. For the self-reported frequency of using hand sanitizer at least 25% of the time, both intervention and control employees reported greater than 80% frequency of this level of hand sanitizer use, which was also not statistically significant.

DISCUSSION

The study reports the results of the first US office-based employee randomized cluster hand hygiene improvement pilot published in peer-reviewed journals. The results demonstrate that a relatively simple multimodal hand hygiene improvement campaign among office-based employees can result in a significant reduction in self-reported ARI-ILI and/or GI infections. Although the effect is modest, the findings may be clinically important given the

TABLE 1. Baseline Characteristics for Intervention and Control Groups Given at Cluster (Department) and Individual (Employee) Levels*

Variable	Intervention	Control	P
Cluster level	$n = 8$	$n = 8$	
Median cluster size (range)	14 (5–38)	11.5 (7–79)	0.44
Proportion age groups			
<40 yrs	0.23 (0.13)	0.18 (0.14)	0.47
≥40–50 yrs	0.28 (0.13)	0.38 (0.21)	0.30
≥50 yrs	0.49 (0.12)	0.44 (0.25)	0.65
Proportion spending at least 50% time working with the public	0.59 (0.23)	0.52 (0.21)	0.56
Individual level	$n = 131$	$n = 193$	
Age in years, mean (SD)	48.2 (10.0)	45.2 (9.1)	<0.01
Proportion of time spent working with the public, mean (SD)	0.52 (0.3)	0.57 (0.3)	0.18
Hand hygiene score, mean (SD)	2.79 (2.8)	2.74 (0.8)	0.55
Combination of soap and water vs hand sanitizer, mean (SD)	0.32 (0.16)	0.30 (0.11)	0.33
Female	109 (83.9%)	161 (84.7%)	0.83
Education			0.50
High school/GED	68 (50.0%)	140 (50.0%)	
Bachelor degree	47 (34.6%)	85 (30.4%)	
Graduate degree	21 (15.4%)	55 (19.6%)	
Have children in school	31 (23.7%)	73 (37.8%)	< 0.01
Race/ethnicity			0.60
Black	63 (48.1%)	83 (43.1%)	
White	58 (44.3%)	91 (47.2%)	
Other†	10 (7.6%)	19 (9.8%)	
Received flu shot during 2012–2013 flu season	59 (45.7%)	77 (40.53)	0.36
Respiratory illness in past 30 d	47 (36.2%)	66 (34.4%)	0.75
Gastrointestinal (GI) illness in past 30 d	24 (18.5%)	30 (15.6%)	0.50

*Values at the cluster level are means (standard deviations) and at the individual level are numbers (percentages) unless stated otherwise.

†Includes Hispanic, Asian and, mixed race/ethnicity.

GED, General Education Development; GI, gastrointestinal; SD, standard deviation.

substantial annual burden from communicable infections that employers bear along with workers, families, and society at large. Although a reduction in related lost work days was seen, the effect estimate did not reach statistical significance.

This intervention advocated the use of alcohol-based hand sanitizer to supplement soap and water, along with education. The effect estimate is consistent with the results from a meta-analysis by Aiello and colleagues,[19] which found a 20% reduction in the proportion of combined illnesses prevented among hand hygiene interventions evaluating both respiratory and GI infection outcomes ($n = 10$). A subset of these studies utilizing hand sanitizer to supplement soap and water and education showed a reduction of 21% (relative risk: 0.79; 95% CI, 0.67 to 0.93) in the proportion of combined infections prevented; although, caution is warranted in interpretation because this subgroup consisted of just three studies, two of which were randomized control trials.

Several limitations were present in this pilot intervention. First, although the effect showed a significant reduction, the CI was wide due to a smaller than anticipated enrolled sample. Second, implementation circumstances prevented the launch of the intervention until late February to early March. As such, the study missed the peak 2012 to 2013 seasonal influenza epidemic. This was evident in the numbers of self-identified cases at baseline, which captured self-reported cases in the prior 30 days and was twofold higher than those reported in the subsequent two monthly follow-up surveys. Nevertheless, although the peak of the flu season was not represented, the epidemic of 2012 to 2013 remained higher for several weeks during this study period than had been seen in peaks from previous past flu seasons (Fig. 2).

Third, it was not possible to compare the demographic characteristics of those who self-selected to enroll from departments that were randomized in this cluster trial to those who did not; thus, it is possible that those who chose to participate may have systematically differed from those who declined, in one or more characteristics related to the intervention and the outcome of this investigation.

Fourth, the primary outcome relied on self-report instead of laboratory or clinical diagnosis. Nevertheless, prior research has found acceptable validity and reliability among lay persons regarding recognition and self-report of infectious disease.[39–42]

Fifth, self-report was used as a measurement for hand hygiene. The performance of hand hygiene has been overestimated by the public and health care professionals in past research.[43,44]

In both groups, self-reported hand hygiene was relatively high and improved slightly, with no significant improvement in the intervention group compared with the control group over time. Therefore, as a measurement, self-reported hand hygiene did not explain the findings of a relative reduction in combined infections seen among those in the intervention group compared with the control group. Additional research is needed to explore the effectiveness of strategies to measure hand hygiene improvements over shorter retrospective time periods than 30 days (such as the use of the Internet/cell phone–related applications [apps]) that would be appropriate for office-based employees in future interventions.

Factors that may have influenced the relatively high baseline of self-reported usual hand hygiene practices in both groups include the organizational culture and the severity of the influenza season. The culture of the organization was seemingly health conscious; this was noted before onset of the intervention due to the observation of wall-mounted hand sanitizer containers located at several public elevators outside of individual departments, and hand hygiene information posters applied on the walls of many restrooms. In addition, it cannot be ruled out that considerable media coverage about the 2012 to 2013 influenza season may have increased the overall awareness of employees in both groups regarding the importance of hand hygiene.

Finally, although enrollment was lower than anticipated, lost to follow-up was relatively small. Retention ranged between 64% and 75% across both groups over time with very little difference between them; this may have been in part due to a nonmonetary incentive for the submission of every survey that could be redeemed as points toward health promotion items within a larger employee wellness program.

CONCLUSIONS

This pilot randomized cluster trial demonstrated that a US office-based multimodal hand hygiene improvement intervention had a modest, yet potentially important effect in reducing self-reported combined ARI-ILI/GI infections within a 90-day period. Given the considerable social and economic burdens of these infections, and the identification by the World Health Organization of protective hand hygiene behaviors as a nonpharmaceutical strategy in the early phases of a pandemic influenza outbreak before a

TABLE 2. Comparison of the Primary Outcomes of Incidence of Respiratory and Gastrointestinal Illness and Lost Work Days Across Intervention and Control Groups*

	Intervention			Control					
Outcome	**No.**	**PDO**	**Crude Rate (95% CI)**	**No.**	**PDO**	**Crude Rate (95% CI)**	**Adjusted IRR (95% CI)**	***P***	**ICC**
Respiratory and GI illness	111	11,790	0.85 (0.69–1.00)	230	17,370	1.19 (1.04–1.35)	0.69 (0.49–0.98)	0.037	0.014
Lost work days	124	8,253	1.35 (1.11–1.59)	231	12,159	1.71 (1.49–1.93)	0.79 (0.51–1.22)	0.279	0.045

*PDO for work days does not include weekends and holidays. Crude incidence rates are per 90 person days observed. The IRR is adjusted for the design effect and potential confounders.
CI, confidence interval; GI, gastrointestinal; ICC, inter-cluster correlation; IRR, incident rate ratio; PDO, person days observed.

TABLE 3. Comparison of the Intervention and Control Groups on Secondary Outcomes of Hand Hygiene Score, Agreement With Experts Score, and Hand Sanitizer Use

Outcome	**Intervention Mean/*n* (SD/%)**	**Control Mean/*n* (SD/%)**	**Adjusted Difference/ RR (95% CI)**	***P***	**ICC**
Hand hygiene score, 0–4 scale	2.63 (0.90)	2.54 (0.88)	0.07 (−0.15–0.29)	0.529	0.001
Agreement with experts score, 0–4 scale	3.72 (0.45)	3.75 (0.43)	− 0.04 (−0.16–0.08)	0.492	0.017
Hand sanitizer use at least 25% of the time	115 (87.5%)	111 (84.9%)	RR = 1.03 (0.95–1.12)	0.496	0.001

CI, confidence interval; ICC, inter-cluster correlation; RR, relative risk; SD, standard deviation.

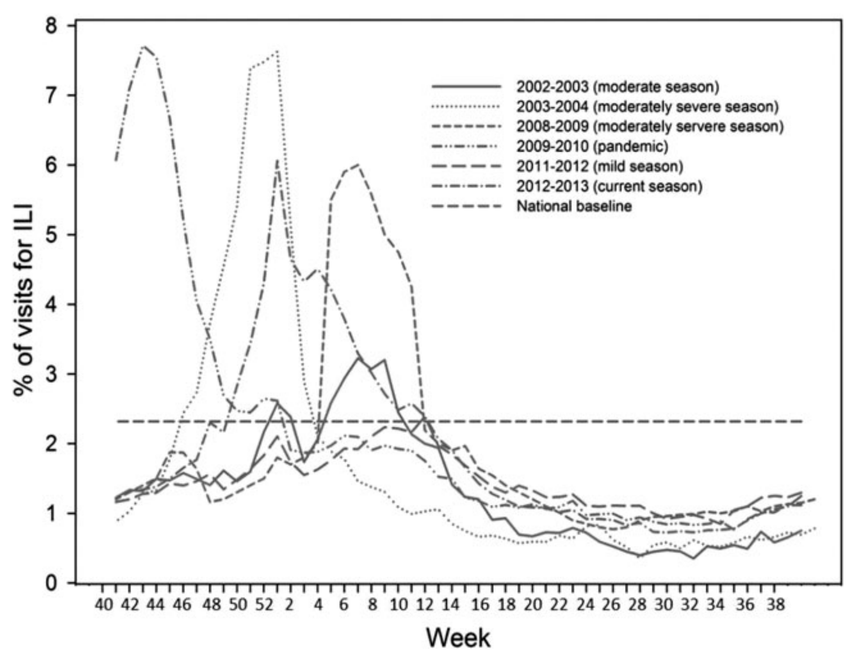

FIGURE 2. Percentage of visits for influenza-like illness (ILI) reported to CDC. Source: figure adapted from CDC.[45]

suitable vaccine can be developed. These findings support the need for conducting further larger office-based hand hygiene improvement trials among employees, which address the limitations of this pilot. Larger trials would benefit by analyzing single health conditions as outcomes and include cost-benefit evaluations.

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