The effect of hand hygiene on illness rate among students in university residence halls

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Background: Several studies have indicated a connection between hand sanitization and infection control in numerous settings such as extended care facilities, schools, and hospitals. The purpose of this study was to assess the effectiveness of both a hand-hygiene message campaign and the use of an alcohol gel hand sanitizer in decreasing the incidence of upper-respiratory illness among students living in university residence halls.

Method: This study involved a total of 430 students recruited from 4 residence halls during the fall semester at the University of Colorado at the Boulder campus. Dormitories were paired into control and product groups. In the product groups, alcohol gel hand–sanitizer dispensers were installed in every room, bathroom, and dining hall. The data were statistically analyzed for the differences between product and control groups in reported symptoms, illness rates, and absenteeism from classes.

Results: The overall increase in hand-hygiene behavior and reduction in symptoms, illness rates, and absenteeism between the product group and control group was statistically significant. Reductions in upper respiratory–illness symptoms ranged from 14.8% to 39.9%. Total improvement in illness rate was 20%. The product group had 43% less missed school/work days.

Conclusion: Hand-hygiene practices were improved with increased frequency of handwashing through increasing awareness of the importance of hand hygiene, and the use of alcohol gel hand sanitizer in university dormitories. This resulted in fewer upper respiratory–illness symptoms, lower illness rates, and lower absenteeism. (Am J Infect Control 2003;31:364-70.)

Absenteeism as a result of illness from transmissible infections is a major problem in educational institutions. Among students in kindergarten through 12th grade at public schools, the transmission of communicable diseases such as viral and bacterial infections is responsible for more than 164 million lost school days per school year.[1] At the elementary school level, the major contributor to absenteeism is illness caused by the spread of microorganisms.[1-3] On college campuses, upper-respiratory illness (URI) is an important concern because URI occurs frequently among young adults.[4] Such illnesses may interfere with class attendance, which may, in turn, affect academic performance. In addition, college health centers may have to devote significant resources to assisting students who have URI. For instance, at the university where this study was conducted, the health center saw 3121 students for URI in the fall semester of 2001; however, many of the students who were seen had viral infections that did not require medical intervention and would abate by themselves. Reducing the occurrence of URI has the potential to benefit students and to help health centers better use their resources.

Hands are the primary mode of transmission of many infectious diseases, particularly among those living and working in close proximity to one another such as in military barracks, college dormitories, and summer camps. As with hospitals and extended care facilities, dormitories and schools have significant predisposing factors for microbial cross-contamination and transmission. Close environments, doorknobs and other inanimate objects serving as resting grounds for microbes, and contaminated hands serving as vehicles of transmission all contribute to increased infection rates among these groups. According to the US Centers for Disease Control and Prevention and the Association for Professionals in Infection Control and Epidemiology, simple handwashing is the single most important and effective method of preventing the spread of transmissible diseases.[5,6] Teaching appropriate hand-hygiene practices can promote wellness and have numerous benefits in a wide variety of settings including learning institutions such as child-care centers, elementary and high schools, and universities. Appropriate hand-hygiene practices such as handwashing and hand sanitization can potentially result in the reduction of the spread of infection and the resulting lost days because of absenteeism. Education combined with a conve-

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nient hand-hygiene regimen was found to significantly increase the frequency of handwashing among elementary school students.[7] Several studies have demonstrated that appropriate handwashing can reduce URI and diarrhea rates among children in day-care settings.[8-11] The efficacy of handwashing in reducing URI has also been demonstrated in a study of US Navy recruits during basic training.[12]

Conventional handwashing with soap and water is an excellent component of a hand-hygiene program to reduce the risk of infection through hand contact; however, the complexity of behavior and the difficulty of maintaining compliance to basic handwashing practices are challenges to overcome, especially in the school environment.[13,14] Hand-hygiene practices are difficult to perform as a result of factors such as time constraints and the lack of sinks in most classroom environments. In these situations, an alternative to the conventional hand-hygiene practice of handwashing with soap and water is the use of a waterless alcohol gel hand sanitizer. Waterless hand sanitizers, such as alcohol gels, offer quick, easy, and effective hand hygiene. Hammond et al[15] demonstrated that elementary school absenteeism as a result of illness was significantly reduced when students practiced good hand hygiene by using an alcohol gel sanitizer. In another study, Fendler et al[16] showed that alcohol gel hand sanitizers also reduced the infection rate in an extended care facility where propinquity and direct contact between residents and care givers provide ideal situations for microbial transfer and cross-contamination.

Group living environments, such as residence halls, make the spread of transmissible diseases and URI more likely. As in classroom situations, students in residence halls may be less likely to regularly wash their hands as a result of the absence of sinks in their rooms and the inconvenience of walking to the washrooms to do so. Alcohol hand sanitizers have been shown to offer an effective alternative to conventional handwashing in elementary schools.[15] The objective of this study was to determine the effectiveness of hand-hygiene education and the use of an alcohol gel hand sanitizer in university residence halls as a hand-hygiene methodology to decrease the incidence of URI and absenteeism. A waterless alcohol gel hand sanitizer was used in this study as a supplement to existing handwashing with soap and water.

METHODS

Participants

A total of 430 students living in 4 residence halls were recruited during fall semester on the University of Colorado at Boulder campus. This sample size was selected because a sample of approximately 400 participants (200 in each group) was sufficiently large enough to detect moderate effect size differences in illness rates comparing across groups.[17] The 4 resident halls that participated in this study were selected because the hall directors were willing to assist with the study and because the student populations in the halls were typical of students living in resident halls on the campus. We did make an attempt to match halls on one key factor: academic emphasis. Two of the residence halls included academic programs as part of their learning environment, so we assigned one of these halls to the product group and one to the control group. The other 2 halls, one of which was assigned to product group and one to control group, included no special emphasis.

Table 1. Demographics of the student participants

Average age (y)	18.29 (±0.69)
Freshmen	85.6%
Ethnicity	
Caucasian	88%
African-American	1.7%
Hispanic/Latino	4.2%
Asian/Pacific Islander	2.8%
American Indian/Alaskan Native	0.3%
Other	3.1%
Sex	
Male	38.1%
Female	61.9%
Out-of-state	45%

With the exception of age and sex, the profile of students in the study roughly matched that of the student population on campus. This is presented in Table 1. The sex breakdown of the study was 61.9% female and 38.1% male. This differs from the student population on campus (52% male; 48% female). The participation in the study was voluntary and the slightly larger proportion of females in the study may reflect the tendency of women to be aware of and interested in health issues.

Overall, there were no significant differences in demographics between product and control groups except in the reported number of roommates. The average number of roommates for students living in the product halls was 1, whereas the students living in the control halls had an average of 0.87 roommates ($P < .05$). Although this difference is statistically significant, it is not likely to reflect an important difference in the living arrangement of most students in the study. Residence halls at the University of Colorado are coeducational, with each floor having separate male and female sections and sex-specific washrooms.

Prevalence of allergies was not significantly different between the groups (19.5% of all participants experienced allergies during the fall). Students who had asthma composed 9.2% of the participant pool. There was no significant difference between product and control groups in terms of number of participants who smoked

Table 2. Frequency of handwashing and hand sanitizer use in product and control groups

Group	Average frequency of handwashing ($P < .02$)	Average frequency of hand sanitizer use ($P < .0001$)
Product	0.48 times/h	0.26 uses/h
Control	0.43 times/h	0.03 uses/h

(17.4% of the sample smoked). Seasonal variations in illness rates were not considered for this investigation.

Out of the 430 students recruited, 188 participants from the product group and 203 participants from the control group completed at least 3 weekly reports for the study. Participation in the study was rewarded with cash incentives totaling a maximum of $65 and weekly nonmonetary incentives.

Materials

Both in vitro and in vivo antibacterial efficacy of the alcohol gel hand sanitizer used in this study (Purell, Gojo Industries Inc, Akron, Ohio) were determined by Bioscience Laboratories Inc (Bozeman, Mont) using 15-second timed exposure kill tests and the health care personnel handwash protocol (a modification of the American Society for Testing and Materials Standard Method E 1174-87), respectively. Independent Test Laboratory (Minneapolis, Minn) similarly evaluated the product for antiviral efficacy by using 30-second timed exposure kill evaluations for viruses. In addition, the irritation potential of the product was measured during the course of 15 additional product application cycles, results of which can be found in a technical guide.[18]

Approximately 1 to 2 weeks before the beginning of the study, alcohol-gel dispensers were installed in every room, washroom, and dining hall in the product group residence halls to be used as an adjunct to handwashing. In addition, 1 week before the start of the study, a handwashing message campaign consisting of bulletin boards and weekly messages was implemented in the product group residence halls. The messages were designed to encourage regular handwashing and sanitizer use to prevent colds and flu. Students in the control group were informed that they were participating in a wellness study, but they did not receive hand-hygiene messages or alcohol gel hand sanitizers. However, they completed the same surveys as the product group.

Protocol

Informed consent was completed by the participants at the time they agreed to participate in the study. The study involved prestudy and poststudy assessments of participants' health knowledge, attitudes, and behaviors; social support for health practices; and weekly assessments of URI symptoms, some health practices, and absenteeism across 8 weeks. The health attitude, knowledge, and behavior survey assessed handwashing practices; smoking frequency; exercise behaviors; and diet, water-consumption, and sleeping practices. The social-support survey addressed social-support structures for health practices within the college environment. These prestudy and poststudy surveys allowed for examination of the relationship between wellness and general health behavior. Knowledge items regarding the relationship between handwashing and illness included true-or-false items such as: "You cannot get a cold or flu from touching faucets and door handles" and "Washing your hands with soap and water can remove up to 99% of the germs from your hands." Attitude items asked about the extent to which participants thought it was easy and good to wash or use a sanitizer, and included items such as: "Washing my hands before eating a meal is inconvenient" and "It is convenient to carry gel sanitizer with me" (rated on a 5-point scale from strongly disagree to strongly agree). Behavior items asked participants to indicate whether they engaged in a behavior all the time, most of the time, sometimes, rarely, or never; these items asked about things such as washing hands after using the bathroom or washing hands before preparing food. The measures for hand-health attitudes and hand-health behaviors achieved adequate reliability (Cronbach α above .70); the knowledge measure was not assessed for reliability. Results regarding knowledge, attitudes, and specific behaviors are reported elsewhere.[19] It is important to remember that knowledge, attitudes, and behaviors were also assessed for smoking, exercise, and eating habits. This means that although participants knew the study examined hand health, these other items should have reduced the likelihood that the presurvey changed behavior or made participants self-conscious in reporting hand-health behavior and illness later in the study.

The weekly survey included 8 items regarding URI symptoms, 3 items regarding frequency/timing of handwashing and sanitizer use, 2 items about smoking frequency/timing, and 1 item about the frequency of exercise. Weekly reports were collected for 8 weeks because of the academic calendar. The study began approximately 2 weeks into the 15-week semester. The 8-week window of data collection reflected the majority of the remaining time in the semester before examination periods. A previous pilot study had indicated that completion of weekly reports declined sharply as students were concerned with other responsibilities. Thus, data collection ended just before the end of the semester.

Data analysis

Analyses of the data involved examining the differences between the product and control groups in sev-

Table 3. Reported symptoms

Symptom	Product group %	Product group n	Control group %	Control group n	Improvement over control (%)	χ^2 value (*P*)
Sore throat	21.9	290	25.7	359	14.8	5.19 (.02)
Stuffy nose	43.7	561	51.3	702	14.8	15.27 (.0001)
Ear pain	5.4	72	8.2	115	34.1	7.76 (.004)
Painful/swollen neck	9.8	131	16.3	228	39.9	24.18 (.0001)
Cough	14.6	194	21	293	30.5	18.82 (.0001)
Chest congestion	10.5	139	15.4	214	31.8	14.28 (.0001)
Sinus pain	11.2	148	16.4	229	31.7	15.05 (.0001)
Fever	11.1	147	16.3	228	31.9	15.56 (.0001)

Table 4. Weekly illness rates*

Week	Product group %	Product group n	Control group %	Control group n	Improvement over control (%)	χ^2 value
1†	50	87	63.8	104	21.6	5.98
2†	45	67	56.5	87	20.4	3.58
3	40.9	74	45	85	9.1	0.48
4	37.5	66	45.3	87	17.2	2.00
5	32.6	56	41.1	74	20.7	2.41
6‡	30.4	52	44	81	30.9	6.44
7	29.4	50	38.5	70	23.6	2.81
8	32.3	50	40.8	71	20.8	2.22
Total§	37.2	502	46.5	659	20	23.81

*A variety of definitions of illness have been offered identifying upper-respiratory illness (URI). Carabin et al[20] define URI as 2 or more upper-respiratory symptoms, both of which must last at least 2 to 3 days. We also analyzed the data using this more stringent definition of URI. Results revealed a significant different in illness rate for the product group vs the control group (χ^2 = 19.97 , $P < .0001$), with lower rates of illness for the product group (20.2%) than for the control group (27.5%). Results for the weekly analyses showed significantly less illness for the product group on weeks 2 and 4 only.
†$P < .05$; ‡$P < .06$; §$P < .0001$.

Table 5. Absenteeism data shown as missed school and/or work days

	Product group %	Product group n	Control group %	Control group n	Improvement over control (%)
Missed school/work days*	5.7	76	9.5	134	40

*$P < .01$.

eral categories: reported handwashings and hand sanitizer use; reported symptoms; illness rate as determined by the researchers on the basis of symptom reports; and absenteeism. Analyses by χ^2 using a continuity correction were conducted.

Frequency of handwashing and hand sanitizer use was determined using the following equations:

$$\frac{\text{Number of reported handwashings for the day}}{\text{Reported number of hours awake for the day}}$$

$$\frac{\text{Number of reported hand sanitizer uses for the day}}{\text{Reported number of hours awake for the day}}$$

Analysis of reported symptoms for the product and control groups examined total participant reports of the presence or absence of 8 symptoms typical of URI across the duration of the study. The χ^2 analyses using a continuity correction were conducted for each emerged symptom. The differences in reports of symptoms between product and control groups were compared.

Analysis of illness rates of the product and control groups was on the basis of symptom reports. A participant was classified as having an illness if they reported at least 2 symptoms, and one of the symptoms lasted at least 2 to 3 days. This classification criteria was

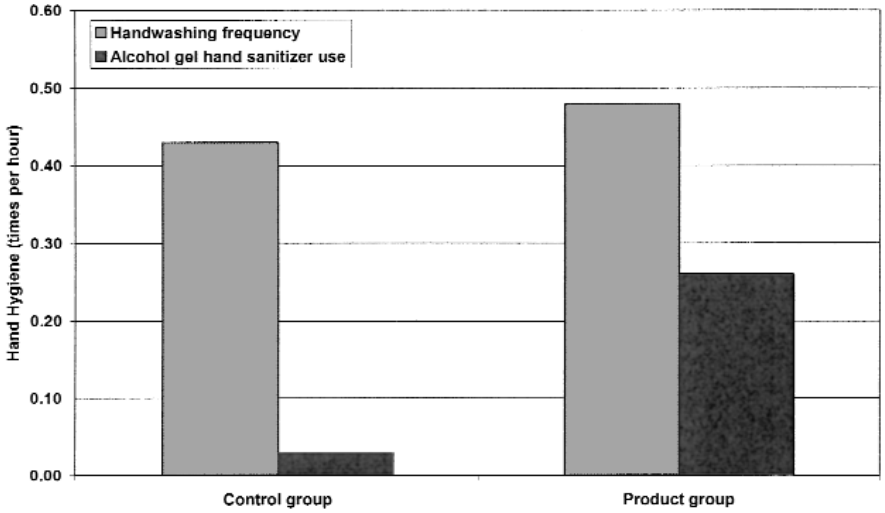

Fig 1. Hand-hygiene practices among control and test groups.

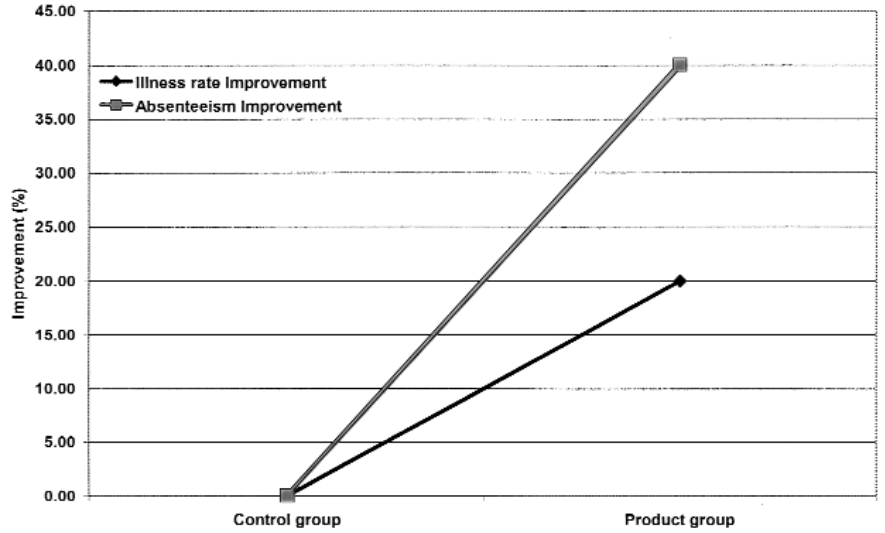

Fig 2. Improvement in illness and absenteeism rates in product group.

determined in consultation with the university wellness program staff and reflects one diagnostic standard for suspecting URI. Again, a χ^2 analysis using continuity correction was used. Illness data were also analyzed for each week of the study. Lastly, the number of reported days absent was compared between product and control group.

RESULTS

Hand-hygiene practices

Results of the frequency of handwashing and hand sanitizer use are presented in Table 2. Results are given as an average number of handwashing sessions per hour and average number of hand sanitizer uses per hour. The difference was statistically significant as determined by *t* test analysis. During the course of the study, the product group washed their hands 10.4% more often than the control group. As expected, the frequency of hand sanitizer use was also significantly greater in the product group (0.26 uses/h vs 0.03 uses/h).

Illness data

Significant results between the product group and control group emerged for each reported symptom,

percentages for the presence of which are shown in Table 3. The χ^2 values are also included.

The illness data for product and control groups for each week of the study were analyzed. Results are shown in Table 4. Significant differences in illness rates emerged for only 3 of the 8 weeks although illness rates were higher in the control group each week. Overall, there was a statistically significant difference between the product and control groups. The product group had a 20% improvement in illness rate over the control group.

Lastly, absenteeism or missed school/work data were collected and analyzed. The results are shown in Table 5. The χ^2 analysis confirmed a statistical difference between the product and control group. With $P < .01$, there was 40% improvement absenteeism for the product group.

DISCUSSION

The results of this study clearly show a statistically significant increase in handwashing and hand sanitizer use among students who were provided with messages on hand hygiene and had an alcohol gel hand sanitizer available to them. Interestingly, there was some hand sanitizer use among students in the control group. This is attributed to the growing popularity of instant hand sanitizers. Some students may have had nonstudy bottles in their room, purse, or pockets. The product group, however, used the hand sanitizer more often and had statistically significant decreases in the incidence of URI symptoms. The illness rate in the hand-hygiene group was also significantly lower. It should be mentioned that illness incidents were on the basis of self-reporting by students and that no clinical confirmation of these illnesses were obtained for either product or control groups.

The increase in hand-hygiene episodes is illustrated in Fig 1. Improvement in illness and absenteeism rates in the product group is shown in Fig 2.

A relationship between hand hygiene, illness rate, and missed school days is shown in the results. Although limited and generally pertaining to preschool and elementary school environments, the current literature substantiates the positive effect of various hand-hygiene programs on illness-related absenteeism in school populations.[13-15,21-23] Studies by the Buckeye Institute indicate attendance is a key prognostic factor of academic success for elementary school children.[24,25] This finding can also be extended to the higher education environment. The current study suggests that both handwashing and the use of hand sanitizers have a positive effect on the wellness of university hall residents. It should also be noted that whereas the average number of roommates was higher in the product group (which would tend to increase the likelihood of microbial transmission), the product group still had fewer URI symptoms, lower illness rates, and fewer missed school days.

The outcomes of improved hand-hygiene habits have far-reaching implications. For the student, reduced absenteeism as a result of an improvement and increase in hand-hygiene behavior can result in improved academic performance. This potentially helps the student succeed in college and improves the likelihood that the student will have a positive college experience. For the University, this behavior can result in reduced health care costs because fewer students may need to use health center resources. Because increased attendance results in better academic performance, the university could boast higher average student grades and better retention of students. However, a number of other factors have the potential to influence the occurrence of URI and should be kept in mind when considering the results of this study. Smokers in this study experienced higher rates of URI than nonsmokers. Exercise, sleep, and eating habits also influence illness rates. Thus, the impact of improved hand hygiene should be considered within the context of general health behaviors and universities should think about hand-hygiene promotion as one aspect of general wellness promotion.

CONCLUSION

Through hand-hygiene education and availability of an alcohol gel hand sanitizer product, hand-hygiene behavior was improved among residents of university housing. This resulted in fewer symptoms of URI, lower illness rates, and fewer missed school days. This outcome has benefits for both students and the university.

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