

Gender and ethnic differences in hand hygiene practices among college students

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Background: Poor hand hygiene on college campuses can be improved by promoting handwashing behavior. This observational study was conducted to evaluate gender and race/ethnic differences in hand hygiene practices among college students.

Methods: Hand hygiene practices in college students were evaluated in 4 settings (soap and water; soap and water and visual prompts; soap and water and hand sanitizers; and soap and water, hand sanitizers, and visual prompts). The degree of hand hygiene (ie, adequate handwashing time, use of hand sanitizer, and hand-drying method) also was evaluated at various locations on campus.

Results: Overall, 72.9% of students washed their hands, 58.3% practiced hand hygiene (using either soap or hand sanitizer), and 26.1% washed their hands adequately. Hand sanitizer use was low when students were given the option, and paper towel was the most common hand-drying method. In general, hand hygiene practices were better in academic buildings than in the student recreation center. Visual prompts improved handwashing behavior only among students in the "other" ethnic category, but not by gender.

Conclusions: Handwashing is the most effective way of preventing the spread of infectious diseases, and our findings have implications for the design of effective hand hygiene education programs in college students. (*Am J Infect Control* 2008;36:361-8.)

Hand hygiene, a key in preventing transmission of colds, diarrhea, and flu viruses,^{1,2} is considered a social norm.³ Whereas our parents introduce us to the handwashing concept, our teachers, health professionals, and peers⁴ confirm its importance as a habit to help reduce the spread of infectious disease.^{5,6} But although proper hand hygiene is a well-established norm, maintaining good hand hygiene is considered a major challenge in infection control.⁷

Proper hand hygiene, the simplest infection prevention measure, can reduce outbreaks of pathogen transmission and foodborne illness and also increase antibiotic resistance.^{4,7-15} Although these practices are currently required in employee training, epidemiologic and inspection data have demonstrated low hand

hygiene compliance in retail food establishments and hospital settings;^{4,7,10,13-16} for example, one study of 12 different hospital settings estimated compliance as < 50%.⁷ Whereas half of all foodborne illnesses could be eliminated through proper handwashing,^{5,17} nosocomial infections affect hospital patients.⁸ Multidrug-resistant pathogens,¹⁸ foodborne illnesses, and viruses also are commonly transmitted due to poor handwashing practices in health care and food establishment workers.¹⁹

Low hand hygiene compliance among college students has contributed to outbreaks of upper respiratory illness,⁹ group B *Streptococcus* colonization,²⁰ and Norwalk-like viruses (the leading cause of acute epidemic gastroenteritis in the United States).^{8,21} Infrequent handwashing (less than 4 times per day), along with engaging in sexual activity, was found to be associated with group B *Streptococcus* in a random sample of 150 university students.²⁰ A message campaign along with provision of gel hand sanitizers in restrooms improved hand hygiene among students in campus residence halls.⁹ Although low hand hygiene compliance was identified in the college population and message campaigns were shown to improve compliance, a search of the current literature revealed only 5 studies assessing hand hygiene practices among college students,^{8,9,20,22,23} none of which comprehensively assessed gender/ethnic variation in and the effect of message campaigns on hand hygiene compliance.

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0196-6553/\$34.00

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doi:10.1016/j.ajic.2007.09.007

The purpose of this observational study was to evaluate hand hygiene practices by gender/ethnicity among college students at a large public university in Texas in 4 different settings: (1) soap and water, (2) soap and water and visual prompts, (3) soap and water and hand sanitizers, and (4) soap and water, hand sanitizers, and visual prompts. Each setting included 350 observations in different campus locations. The methodology was based on a previous observational study on hand hygiene practices among health care workers.¹⁶ We hypothesized that hand hygiene compliance would be improved with the addition of visual prompts and hand sanitizers in the restrooms.

METHODS

Study sample

Students from a large public university in Texas were observed for a 3-weeks period in May and June 2006. A total of 1400 observations of hand hygiene were made at various campus restrooms located in academic buildings, the student center, and the student recreation center.

Data collection

Seven graduate students observed hand hygiene ($n = 200/\text{student}$) during the day and evening hours in 9 different locations using standardized data collection protocol. Data included observation date, location, gender, race/ethnicity, handwashing behavior/adequacy (ie, 20 seconds), hand hygiene preference, and hand-drying method. The hand-drying method was noted to evaluate whether students who washed their hands were reluctant to touch unsanitary dispensers. Toilet use was not assessed, because it was impossible to determine whether persons exiting restroom stalls had used the toilet. Observations were made from a safe distance for obscure monitoring and clustered into 4 settings. The visual prompts used for the study read: "Wash your hands. It prevents infectious disease." The hand sanitizer provided for 2 settings was a vitamin E/alcohol-based hand sanitizing gel. Students' hand hygiene preference (ie, soap vs sanitizer gel) was noted. An interrater reliability of 0.857 was calculated from the scores of observers who watched hand hygiene practices simultaneously and independently rated the relevant variables according to the instruction sheet.

Data analysis

Descriptive measures were used to assess students' hand hygiene, handwashing/sanitizing frequency, preference, adequacy, and hand drying method. Chi-squared tests measured association between handwashing

behavior and gender/ethnicity. Student's *t*-test and analysis of variance (ANOVA) were used to evaluate differences in hand hygiene by gender, race/ethnicity, and handwashing/sanitizing frequency in the presence of a visual prompt. Effect size (η_p^2) was used to estimate the magnitude of differences between groups. The data were analyzed using SPSS version 14.0 (SPSS Inc, Chicago, IL).

In the present study, handwashing is defined as washing the hands with or without soap.²⁴ Hand sanitizing is defined as killing bacteria on the hands using an alcohol-based sanitizing gel.²⁵ Hand hygiene includes washing the hands with soap and/or sanitizing the hands with an alcohol-based gel.²⁶

RESULTS

Demographic characteristics

Approximately 86% of the observations were made in female college students; the remaining 14% of observations were in male students. Data skewness is attributed to observers' gender (6 females and 1 male). The study sample was predominantly Caucasian (78%), with 6% African-American, 6% Hispanic, and 9% Asian students. Students whose ethnicity could not be determined by the observers were classified as "other" (2%).

Hand hygiene

Overall, 58.3% of all students performed hand hygiene (Table 1). Of those students who performed hand hygiene, 85.6% washed with soap and water, 8.44% sanitized their hands with an alcohol-based gel, and 5.87% used both. Therefore, $0.856 * 0.583 = 0.500$, or 50.0%, of all students washed with soap and water; $0.084 * 0.583 = 0.049$, or 4.9%, of all students sanitized with alcohol; $0.058 * 0.583 = 0.034$, or 3.4%; of all students used both soap and water and sanitizer; and 41.6% did not perform any hand hygiene.

Race/ethnic distribution by hand hygiene practice demonstrated that 53.5% of the Caucasian students, 77.5% of the African-American students, 66.3% of the Hispanic students, 47.2% of the Asian students, and 42.9% of the "other" students used either soap or sanitizing gel. Few students used both hand hygiene agents (3.6% Caucasian, 5% African-American, 2.4% Hispanic, 2.4% Asian). African-American students had significantly a higher rate of hand hygiene practice compared with the Caucasian, Asian, and "other" students. Hispanic students ranked second in hand hygiene practice, and those in the "other" category ranked last. The female students had a higher rate of hand hygiene practice (59%) than the males (32%); only females (4%) used both hand hygiene agents.

Table I. Hand hygiene by gender and ethnicity

| | White (n = 1089) | African- American (n = 80) | Asian (n = 127) | Hispanic (n = 83) | Other (n = 21) | Total |
|------------------------|---------------------|----------------------------------|--------------------|----------------------|-------------------|-------|
| No | | | | | | |
| n | 467 | 14 | 64 | 26 | 12 | 583 |
| % | 42.9 | 17.5 | 50.4 | 31.3 | 57.1 | 41.6 |
| Yes | | | | | | |
| n | 622 | 66 | 63 | 57 | 9 | 817 |
| % | 57.1 | 82.5 | 49.6 | 68.7 | 42.9 | 58.3 |
| Use soap (%) | 48.0 | 76.3 | 41.7 | 65.1 | 42.9 | 50.0 |
| Use sanitizer (%) | 5.5 | 1.3 | 5.5 | 1.2 | 0.0 | 4.9 |
| Soap and sanitizer (%) | 3.6 | 5.0 | 2.4 | 2.4 | 0.0 | 3.4 |
| F value | 7.531 | | | | | |
| P value | < .001 | | | | | |
| η^2 | 0.021 | | | | | |
| | Males | Females | | | Total | |
| No | | | | | | |
| n | 137 | | 446 | | 583 | |
| % | 68.5 | | 37.2 | | 41.6 | |
| Yes | | | | | | |
| n | 63 | | 754 | | 817 | |
| % | 31.5 | | 62.8 | | 58.3 | |
| Use soap (%) | 29.0 | | 53.5 | | 50.0 | |
| Use sanitizer (%) | 2.5 | | 5.3 | | 4.9 | |
| Soap and sanitizer (%) | 0.0 | | 4.0 | | 3.4 | |
| t value | 8.530 | | | | | |
| P value | < .001 | | | | | |
| η^2 | 0.049 | | | | | |

Handwashing behavior

Overall, 72.9% of the students washed their hands before exiting the restroom (Table 2). Of those students who washed their hands, 71.9% used soap. Therefore, $0.729 * 0.719 = 0.524$, or 52.4%, of all students washed with soap and water; $0.729 * 0.281 = 0.204$, or 20.4%, of all students washed without soap; and 27.1% of all students did not wash their hands.

A significant association was found between gender and handwashing behavior ($\chi^2 = 29.98, P < .001$), with more female students washing their hands (76%) compared with their male peers (57%). ANOVA indicated significant ethnic differences in handwashing behavior ($F = 5.90; P < .001$). The African-American students exhibited the highest handwashing frequency (93.8%), whereas the students in the “other” category had the lowest handwashing frequency (57.1%). However, the magnitude of difference was small ($\eta_p^2 = 0.01$).

Handwashing behavior was further evaluated for adequacy and hand-drying method (Table 2). Of those students who washed their hands, 35.8% did so adequately and 88.1% dried their hands. Therefore, $0.729 * 0.358 = 0.261$, or 26.1%, of all students washed their hands adequately, and $0.729 * 0.881 = 0.643$, or 64.3%, of all students dried their hands. Using a paper towel was the most common hand-

drying method (96%) followed by personal clothing (2%), hand dryer (1%), and towel (1%). The use of towel was recorded only in the student recreation center.

The racial/ethnic breakdown of handwashing adequacy is as follows: Caucasian, 22.9%; African American, 58.8%; Hispanic, 37.3%; Asian, 26.8%; “other,” 23.8%. African-American students performed adequate handwashing significantly more often than their peers ($F = 14.25; P < .001$). Once again, however, the magnitude of difference was small ($\eta_p^2 = 0.03$). No significant gender difference in handwashing adequacy was noted.

Visual prompt

Half of the observations (n = 700) were made in the presence of a visual prompt. No significant improvement in hand hygiene compliance was noted in the male, female, Caucasian, African-American, Hispanic and Asian students (Table 3); however, significant improvement was seen in students in the “other” ethnic category ($t = 2.67; P = .01$). The magnitude of this improvement was moderate ($\eta_p^2 = 0.27$). African-American students had significantly higher hand hygiene compliance than Caucasians and Asians, and female students had significantly higher hand hygiene compliance than males.

Table 2. Handwashing behavior by gender and ethnicity

| | White (n = 1089) | African American (n = 80) | Asian (n = 127) | Hispanic (n = 83) | Other (n = 21) | Total |
|-------------------|---------------------|---------------------------------|--------------------|----------------------|-------------------|--------------|
| No | | | | | | |
| n | 315 | 5 | 31 | 19 | 9 | 379 |
| % | 28.9 | 6.3 | 24.4 | 22.9 | 42.9 | 27.1 |
| Yes | | | | | | |
| n | 774 | 75 | 96 | 64 | 12 | 1021 |
| % | 71.1 | 93.8 | 75.6 | 77.1 | 57.1 | 72.9 |
| F value | 5.90 | | | | | |
| P value | < .001 | | | | | |
| η^2 | 0.01 | | | | | |
| Use soap (%) | 50.5 | 81.3 | 44.1 | 65.1 | 42.9 | 52.4 |
| Adequate time (%) | 22.9 | 58.8 | 26.8 | 37.3 | 23.8 | 26.1 |
| Dry hands (%) | 62.6 | 88.8 | 63.0 | 67.5 | 52.4 | 64.3 |
| Paper towel (%) | 59.4 | 91.3 | 61.4 | 67.5 | 38.1 | 61.6 |
| Hand dryer (%) | 0.6 | 0.0 | 0.0 | 1.2 | 9.5 | 0.7 |
| Clothing (%) | 1.6 | 0.0 | 0.8 | 1.2 | 4.8 | 1.4 |
| Other (%) | 0.6 | 0.0 | 0.8 | 0.0 | 0.0 | 0.6 |
| | Males | | | Females | | Total |
| No | | | | | | |
| n | 86 | | | 293 | | 379 |
| % | 43.0 | | | 24.4 | | 27.1 |
| Yes | | | | | | |
| n | 114 | | | 907 | | 1021 |
| % | 57.0 | | | 75.6 | | 72.9 |
| t value | 5.53 | | | | | |
| P value | < .001 | | | | | |
| η^2 | 0.02 | | | | | |
| Use soap (%) | 28.5 | | | 56.4 | | 52.4 |
| Adequate time (%) | 23.0 | | | 26.7 | | 26.1 |
| Dry hands (%) | 38.0 | | | 68.7 | | 64.3 |
| Paper towel (%) | 34.0 | | | 66.2 | | 61.6 |
| Hand dryer (%) | 2.5 | | | 0.4 | | 0.7 |
| Clothing (%) | 0.0 | | | 1.7 | | 1.4 |
| Other (%) | 3.5 | | | 0.1 | | 0.6 |

Table 3. Hand hygiene and visual prompt by gender and ethnicity

| | No visual prompt | | Visual prompt | | t value | P value | η^2 |
|------------------|------------------|-------------|---------------|-------------|---------|---------|----------|
| | n | Mean (SD) | N | Mean (SD) | | | |
| White | 555 | 0.58 (0.49) | 534 | 0.55 (0.49) | 1.22 | .22 | 0.00 |
| African American | 42 | 0.76 (0.43) | 38 | 0.89 (0.31) | -1.56 | .12 | 0.03 |
| Asian | 53 | 0.47 (0.50) | 74 | 0.51 (0.50) | -0.46 | .64 | 0.00 |
| Hispanic | 39 | 0.66 (0.47) | 44 | 0.70 (0.46) | -0.36 | .71 | 0.00 |
| Other | 11 | 0.18 (0.40) | 10 | 0.70 (0.48) | -2.67 | .01 | 0.27 |
| F value | 4.25 | | 5.59 | | | | |
| P value | .002 | | < .001 | | | | |
| η^2 | 0.02 | | 0.03 | | | | |
| Males | 100 | 0.35 (0.47) | 100 | 0.28 (0.45) | 1.06 | .28 | 0.00 |
| Females | 600 | 0.62 (0.48) | 600 | 0.62 (0.48) | 0.00 | 1.00 | 0.00 |
| t value | 5.37 | | 7.07 | | | | |
| P value | < .001 | | < .001 | | | | |
| η^2 | 0.03 | | 0.06 | | | | |
| Total | 700 | 0.58 (0.49) | 700 | 0.57 (0.49) | 0.37 | .70 | 0.00 |

Table 4. Handwashing and visual prompt by gender and ethnicity

| | No visual prompt | | Visual prompt | | t value | P value | η^2 |
|------------------|------------------|-------------|---------------|-------------|---------|---------|----------|
| | n | Mean (SD) | n | Mean (SD) | | | |
| White | 555 | 0.73 (0.44) | 534 | 0.69 (0.46) | 1.27 | .20 | 0.00 |
| African American | 42 | 0.93 (0.26) | 38 | 0.95 (0.22) | -0.34 | .73 | 0.00 |
| Asian | 53 | 0.70 (0.46) | 74 | 0.80 (0.40) | -1.28 | .20 | 0.01 |
| Hispanic | 39 | 0.77 (0.42) | 44 | 0.77 (0.42) | -0.03 | .97 | 0.00 |
| Other | 11 | 0.36 (0.36) | 10 | 0.80 (0.42) | -2.13 | .04 | 0.19 |
| Males | 100 | 0.56 (0.49) | 100 | 0.58 (0.49) | -0.28 | .77 | 0.00 |
| Females | 600 | 0.76 (0.42) | 600 | 0.75 (0.43) | 0.60 | .54 | 0.00 |
| Total | 700 | 0.73 (0.44) | 700 | 0.72 (0.44) | 0.42 | .67 | 0.00 |

Table 5. Hand hygiene and location by gender and ethnicity

| | Academic buildings | | Student recreation center | | t value | P value | η^2 |
|------------------|--------------------|-------------|---------------------------|-------------|---------|---------|----------|
| | n | Mean (SD) | n | Mean (SD) | | | |
| White | 513 | 0.68 (0.46) | 576 | 0.46 (0.49) | 7.41 | < .001 | 0.04 |
| African American | 51 | 0.90 (0.30) | 29 | 0.68 (0.47) | 2.46 | .01 | 0.07 |
| Asian | 84 | 0.55 (0.49) | 43 | 0.37 (0.48) | 2.01 | .04 | 0.03 |
| Hispanic | 52 | 0.73 (0.44) | 31 | 0.61 (0.49) | 1.11 | .26 | 0.01 |
| Other | 9 | 0.55 (0.52) | 12 | 0.33 (0.49) | 0.99 | .33 | 0.04 |
| Males | 38 | 0.52 (0.50) | 162 | 0.26 (0.44) | 3.17 | < .01 | 0.04 |
| Females | 671 | 0.69 (0.45) | 529 | 0.54 (0.49) | 5.65 | < .001 | 0.02 |
| Total | 709 | 0.68 (0.46) | 691 | 0.47 (0.49) | 8.73 | < .001 | 0.04 |

Analysis of handwashing behavior in the presence of the visual prompt yielded results similar to those noted for hand hygiene. No significant improvement was noted by gender (Table 4); however, students in the "other" ethnic group demonstrated significantly improved handwashing behavior in the presence of a visual prompt ($t = 2.13$; $P = .04$).

Location

Hand hygiene also was evaluated by location (Table 5). Hand hygiene frequency was significantly higher in the academic buildings/student center (68%) than in the student recreation center (47%; $t = 8.2$; $P < .001$). Male, female, White, African-American, and Asian students exhibited significantly higher hand hygiene frequency in academic buildings than in the student recreation center ($P < .05$).

Handwashing behavior was evaluated by location as well (Table 6). Handwashing frequency was significantly higher in academic buildings (81%) than in the student recreation center (65%; $t = 6.836$; $P < .001$). Male, female, White, and Asian students exhibited significantly higher handwashing frequency in academic buildings than in the student recreation center ($P < .05$). No differences were noted in the African-American, Hispanic and "other" students.

DISCUSSION

This observational study was conducted to examine hand hygiene practice among college students. Although the study considered hand hygiene to be either handwashing with soap or hand sanitizing with alcohol-based gel, it is important to note that > 20% of the students in this study washed their hands without soap. This finding underscores the need for hand hygiene campaigns emphasizing the importance of soap in cleansing the hands.

The better hand hygiene in the female students in this study agrees with previous findings.^{9,22,27} White et al⁹ reported better hand hygiene in females than in males. Johnson et al²⁷ suggested that females' higher compliance is associated with their tendency to practice socially acceptable behaviors. These gender differences highlight the need for gender-specific educational hand hygiene campaigns.

Overall, the minority students exhibited better hand hygiene practices than the Caucasian students. Thus, hand hygiene programs targeted at college students should be tailored to improve hand hygiene in Caucasian students. No previous studies have evaluated hand hygiene practices by racial/ethnic group. Considering the association between hand hygiene and food-borne illness, our findings may provide valuable

Table 6. Handwashing behavior and location by gender and ethnicity

| | Academic buildings | | Student recreation center | | t value | P value | η^2 |
|------------------|--------------------|-------------|---------------------------|-------------|---------|---------|----------|
| | n | Mean (SD) | n | Mean (SD) | | | |
| White | 513 | 0.80 (0.40) | 576 | 0.63 (0.48) | 6.03 | < .001 | 0.03 |
| African American | 51 | 0.94 (0.23) | 29 | 0.93 (0.25) | 0.17 | .85 | 0.00 |
| Asian | 84 | 0.81 (0.39) | 43 | 0.65 (0.48) | 1.98 | .05 | 0.03 |
| Hispanic | 52 | 0.81 (0.39) | 31 | 0.71 (0.46) | 1.02 | .31 | 0.01 |
| Other | 9 | 0.67 (0.50) | 12 | 0.50 (0.53) | 0.73 | .47 | 0.02 |
| Males | 38 | 0.79 (0.41) | 162 | 0.52 (0.50) | 3.09 | < .01 | 0.04 |
| Females | 671 | 0.81 (0.39) | 529 | 0.69 (0.46) | 4.80 | < .001 | 0.02 |
| Total | 709 | 0.81 (0.39) | 691 | 0.65 (0.47) | 6.83 | < .001 | 0.03 |

information for researchers investigating racial/ethnic disparities in foodborne illness.²⁸⁻³⁰

Handwashing behavior in this college student population was only slightly higher than that reported in middle school and high school students.³¹ In terms of adequacy, only a small proportion of those who washed their hands did so for 20 seconds. This finding concurs with a 2003 study reporting that 63% of female college students washed their hands, but only 2% did so adequately.²² Consequently, further emphasis on efforts to improve handwashing adequacy is critically important.

Supplementing hand sanitizing gel in the restrooms was ineffective in improving hand hygiene practices, a finding at variance with an earlier study by White et al²³ that found an increase in hand hygiene behavior after installation of gel sanitizer dispensers at observation sites. In the present study, the sanitizer bottles were new additions to the observation sites, and thus the students may have been unfamiliar with and reluctant to use them. A few students apparently did not realize that the bottles contained hand sanitizer and used the gel as though it was soap.

White et al⁹ reported that college students who were exposed to hand hygiene campaigns had significantly better hand hygiene than those who were not. In the present study, the use of visual prompts did little to improve hand hygiene compliance. Contrary to previous studies,²⁷ visual prompts did not improve hand hygiene compliance among female students. Likewise, visual prompts did not improve hand hygiene among males; however, that finding concurs with earlier studies.²⁷ Perhaps visual prompts in addition to educational campaigns may promote greater hand hygiene compliance by more strongly emphasizing its importance.

Hand hygiene practice was higher in academic buildings compared with the student recreation center. Perhaps students do not view performing hand hygiene as important before working out and using a pool/hot tub. Alternatively, students may be using the restroom before showering. The observers were unable to assess

whether the students used the restroom before or after using recreation center facilities; future studies may explore this in greater detail.

Better hand hygiene compliance and hand drying could be achieved through adaptations to the restrooms, such as automatic water, soap, and hand sanitizer dispensers as well as hand dryers that eliminate the need to touch the units. These amenities not only limit exposure to bacteria, but also improve the convenience and attractiveness of handwashing, which help increase compliance.^{32,33} But how these automatic dispensers will influence hand hygiene practice in those students hesitant to perform the action is unknown.

Our findings have implications for health educators and public health professionals aiming to design creative, effective programs to educate college students on hand hygiene practices. Use of the PRECEDE (predisposing, reinforcing, and enabling factors in educational and health diagnosis and evaluation) or other theoretical frameworks for these programs is encouraged. The PRECEDE model has been successfully used in numerous health education programs to effect change in other complex behaviors, such as seat belt use.^{33,34} Using this framework will allow health educators to influence behavior change by focusing on predisposing, enabling, and reinforcing factors. Although education programs can improve hand hygiene behaviors, a lack of reinforcement lowers compliance.³³ Thus, programs for college students need to include innovative approaches to achieve sustained improvement in hand hygiene practices.

The present study has some limitations. Although the observers made efforts to be obscure, their presence may have influenced hand hygiene practices in the students. Previous research has demonstrated that the presence of others can influence an individual's handwashing behavior.²² For example, whereas soap and water use could be observed discreetly by standing further away and observing/listening to cues, monitoring hand sanitizer use was more difficult, because the observers had to be in close proximity to the students.

In addition, the observers were unable to assess whether students used the toilet when in restroom stalls. Because females visit restrooms for cosmetic and toileting reasons, the lower hand hygiene rate in males, especially after toilet use, can provide additional impetus for gender-specific hand hygiene campaigns.

Six of the 7 observers were females, resulting in skewed gender observations in this study. In addition, observations were made during the summer school session; this could explain the overrepresentation of African-American, Asian, and Hispanic students in the sample compared with the university population as a whole. Besides the standard protocol, additional factors, such as time (semester and seasonal illnesses) and location (residence halls and dining areas), may provide more detailed information on hand hygiene practices.

CONCLUSION

This study examined hand hygiene among male and female college students at various locations and times of day on a university campus. The findings show that the majority of students practiced good hand hygiene, favoring soap and water over hand sanitizers; however, handwashing adequacy was poor. Hand hygiene compliance was higher in academic buildings than in the student recreation center, but visual prompts did not improve hand hygiene by gender or race/ethnicity, except in those students in the "other" ethnic group. Using paper towels was the most frequent hand-drying method among the students.

Our findings have implications for effective targeted health education programs to improve hand hygiene in college students, particularly male and Caucasian students. These programs also should emphasize efforts to improve handwashing adequacy and soap use in cleansing the hands. Visual prompts in addition to educational campaigns may promote better hand hygiene compliance by improving awareness of its importance.

References

1. Luby SP, Agboatwalla M, Feikin DR, Painter J, Billhimer W, Altaf A, et al. Effect of handwashing on child health: a randomised controlled trial. *Lancet* 2005;366:225-33.
2. American Society for Microbiology. Women better at hand hygiene habits, hands down. 2005. Available from: http://www.cleaning101.com/newsroom/2005_survey/handhygiene/womenshands.cfm. Accessed June 30, 2006.
3. Edwards D, Monk-Turner E, Poorman S, Rushing M, Warren S, Willi J. Predictors of hand-washing behavior. *Soc Behav Personal* 2002;30:751-6.
4. Green LR, Selman C. Factors impacting food workers and managers' safe food preparation practices: a qualitative study. *Food Prot Trends* 2005;25:981-90.
5. American Society for Microbiology (ASM). Handwashing fact sheet. 2005. Available from: http://www.cleaning101.com/newsroom/2005_survey/handhygiene/factsheet2005.cfm. Accessed June 30, 2006.
6. Centers for Disease Control and Prevention. Stopping germs at home, work and school. 2004. Available from: http://www.cdc.gov/germstopper/home_work_school.htm. Accessed June 30, 2006.
7. Pittet D. Improving adherence to hand hygiene practice: a multidisciplinary approach. *Emerg Infect Dis* 2001;7:234-40.
8. Moe CL, Christmas WA, Echols LJ, Miller SE. Outbreaks of acute gastroenteritis associated with Norwalk-like viruses in campus settings. *J Am Coll Health* 2001;50:57-66.
9. White C, Kolbe R, Carlson R, Lipson N. The impact of a health campaign on hand hygiene and upper respiratory illness among college students living in residence halls. *J Am Coll Health* 2005;53:175-81.
10. Allwood PB, Jenkins T, Paulus C, Johnson L, Hedberg CW. Handwashing compliance among retail food establishment workers in Minnesota. *J Food Prot* 2004;67:2825-8.
11. Collins JE. Impact of changing consumer lifestyles on the emergence/reemergence of foodborne pathogens. *Emerg Infect Dis* 1997;3:471-9.
12. Kendall P, Medeiros LC, Hillers V, Chen G, DiMascola S. Food handling behaviors of special importance for pregnant women, infants and young children, the elderly, and immune-compromised people. *J Am Diet Assoc* 2003;103:1646-9.
13. Centers for Disease Control and Prevention. Guideline for hand hygiene in health care settings. *MMWR Morb Mortal Wkly Rep* 2002;51:1-44.
14. Clayton DA, Griffith CJ, Price P, Peters AC. Food handlers' beliefs and self-reported practices. *Intl J Environ Health Res* 2002;12:25-39.
15. Larson E. Skin hygiene and infection prevention: more of the same or different approaches? *Clin Infect Dis* 1999;29:1287-94.
16. Bischoff WE, Reynolds TM, Sessler CN, Edmond MB, Wenzel RP. Handwashing compliance by health care workers: the impact of introducing an accessible, alcohol-based hand antiseptic. *Arch Intern Med* 2000;160:1017-21.
17. Center for Food Safety and Applied Nutrition, US Food and Drug Administration. Handwashing. 2001. Available from: <http://www.cfsan.fda.gov/%7EEdms/a2z-h.html#handwashing>. Accessed June 30, 2006.
18. Trampuz A, Widmer AF. Hand hygiene: a frequently missed lifesaving opportunity during patient care. *Mayo Clin Proc* 2004;79:109-16.
19. Desorbo M. Hands for hygiene. *Food Quality*, 2005. Available from: http://www.foodquality.com/mag/04052005/fq_04052005_cover.html. Accessed June 30, 2006.
20. Bliss SJ, Manning SD, Tallman P, Baker CJ, Pearlman MD, Marrs CF, et al. Group B *Streptococcus* colonization in male and nonpregnant female university students: a cross-sectional prevalence study. *Clin Infect Dis* 2002;34:184-90.
21. Glass RI, Noel J, Ando T, Fankhauser R, Belliot G, Mounts A, et al. The epidemiology of enteric caliciviruses from humans: a reassessment using new diagnostics. *J Infect Dis* 2000;181(Suppl 2):S254-61.
22. Drankiewicz D, Dundes L. Handwashing among female college students. *Am J Infect Control* 2003;31:67-71.
23. White C, Kolbe R, Carlson R, Lipson N, Dolan M, Ali Y, et al. The effect of hand hygiene on illness rate among students in university residence halls. *Am J Infect Control* 2003;31:364-70.
24. Handwashing. In: Online Medical Dictionary. The Centre for Cancer Education; 1998. Available from: <http://cancerweb.ncl.ac.uk/cgi-bin/omd?query=handwashing>.
25. Simonne A. Hand hygiene and hand sanitizers. University of Florida, Institute of Food and Agricultural Sciences; 2005. Available from: <http://edis.ifas.ufl.edu/FY732>. Accessed July 29, 2007.
26. Hand Hygiene Resource Center. Glossary terms. Available from: <http://www.handhygiene.org/glossary.asp>. Accessed July 29, 2007.
27. Johnson HD, Sholcosky D, Gabello K, Ragni R, Ogonosky N. Sex differences in public restroom handwashing behavior associated with visual behavior prompts. *Percept Mot Skills* 2003;97:805-10.
28. Lay J, Varma J, Vugia D, Jones T, Zansky S, Marcus R, et al. Racial and ethnic disparities in foodborne illness, 2000. Chicago, IL: Infectious Diseases Society of America; 2000.

29. Marcus R, Rabatsky-Ehr T, Lay J, Mohle-Boetani J, Farley M, Medus C, et al. Age, ethnic and racial disparity in *Salmonella* serotype enteritidis (SE): FoodNet, 1998–2000. Presented at the Second International Conference on Emerging Infectious Diseases, Atlanta, GA; 2002.
30. Vugia DJ, Samuel M, Farley MM, Marcus R, Shiferaw B, Shallow S, et al. Invasive *Salmonella* infections in the United States, FoodNet, 1996–1999: incidence, serotype distribution, and outcome. *Clin Infect Dis* 2004;38(Suppl 3):S149-56.
31. Guinan ME, McGuckin-Guinan M, Severeid A. Who washes hands after using the bathroom? *Am J Infect Control* 1997;25:424-5.
32. Earl ML, Jackson MM, Rickman LS. Improved rates of compliance with hand antisepsis guidelines: a three-phase observational study. *Am J Nurs* 2001;101:26-33.
33. Larson EL, Bryan JL, Adler LM, Blane C. A multifaceted approach to changing handwashing behavior. *Am J Infect Control* 1997;25:3-10.
34. Eriksen MP, Gielen AC. The application of health education principles to automobile child restraint programs. *Health Educ Quart* 1983;10:30-55.

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