International Journal of Sciences & Applied Research

www.ijsar.in

GENDER DIFFERENCES IN HAND-WASHING AWARENESS AND BEHAVIOR OF COLLEGE STUDENTS

Jong-Gyu Kim[1] and Joong-Soon Kim[2*]

1Faculty of Food and Health Sciences, Keimyung University, Republic of Korea, jgkim@kmu.ac.kr
2Department of Industrial and Management Engineering, Keimyung University, 1095 Dalgubeol-daero, Dalseo-gu, Daegu 42601, Republic of Korea, jskim@kmu.ac.kr

Abstract

We evaluated gender differences in hygienic behavior of college students focusing on awareness and practice of hand-washing. A self-administered questionnaire survey and a separate direct observation in public restrooms on campus were performed. Overall 95.5% of the respondents (male 93.6%, female 97.4%) claimed to wash their hands after using toilet. In the separate observation, 16.9% of males actually did so compared with 98.2% of females ($p < 0.001$). Among the students who washed their hands in the direct observation, males exhibited higher frequency in the use of soap, and washing more parts of the hands than females ($p < 0.05$); 75.0% of males washed for more than 5 seconds; 37.8% of females did so although all the females responded to washing more than 5 seconds in the questionnaire survey ($p < 0.05$). There were noticeable differences in awareness and behavior of hand-washing between males and females. Females had greater practice of hand-washing after using toilet than males. Males washed more thoroughly than females. Males tend to be encouraged to wash in a new and neat restroom. These gender differences highlight the need for gender-specific educational programs or campaigns.

Keywords: Hand-washing, awareness, practice, gender, students

INTRODUCTION

Hand-washing is an essential practice for personal and public hygiene. More than one and half century has passed since Semmelweis demonstrated the effectiveness of hand-washing in prevention of nosocomial infections (Haas and Larson, 2007; Best et al., 2004; Jarvis, 1994). From this historical lesson and studies on public health afterward, hand-washing is commonly recommended to decrease the spread of pathogens and infection and food-borne diseases via cross-contamination. The US Centers for Disease Control and Prevention (US CDC) has stated: "It is well-documented that the most important measure of preventing the spread of pathogens is effective hand-washing" (US CDC, 2008). However, it is noted that hand-washing practice is still low among school children (Catalina, 2009), adolescents (Yalcin et al., 2004), and even in health care professionals (Rome et al., 2007; Pittet, 2001; Bischoff et al., 2000; Sproat and Inglis, 1994).

Hand-washing after toilet use is especially regarded as a social norm for all individuals. However, a low rate of hand-washing practice has been observed in a

general population (Jeong et al, 2007), school children (Guian et al., 1997), and college students (Johnson et al., 2003; Drankiewicz and Dundes, 2003; Anderson et al, 2008). These studies have shown that in nonhospital environments, girls and women were more likely to do hand-washing and scored higher on hand-washing techniques than boys and men. A study conducted in public restrooms in a hospital found that women were more likely to wash their hands than men (Stender and Rosenberg, 1998). Even in health care workers in a critical care unit of hospitals, a gender influenced difference was found in hand-washing rates (van de Mortel et al., 2001).

Hand-washing practices on university campuses also pose public health concerns. Low hand-washing practice of college students has been linked to the spread of Norwalk-virus on campus (Moe et al, 2001). Also low practice of hand hygiene of college students has contributed to outbreak of upper respiratory disease, group B *Streptococcus* colonization (White et al., 2005; Bliss et al., 2002). Several other studies reported that hand-washing or hand hygiene practice was relatively low in a college population. Only a few of these studies assessed gender differences or differences between the knowledge/attitude and practice. Anderson et al. reported gender differences in hand hygiene practices among college students; the study was conducted in population skewness (female 86% and male 14%), and was done during a summer school session (Anderson et al, 2008).

We aim to evaluate gender differences in hygienic behavior of college students focusing on awareness and practice of hand-washing by survey. People are prone to incline towards socially desirable behavior when answering a questionnaire; they may answer what they desire rather than what they actually do. Due to this proneness, we consider that self-reported practices collected by questionnaire may lead to incorrect assessment and subsequently produce false reports. We therefore designed both a questionnaire survey and a separate unnoticed direct observational study, and carried them out together in order to assess hand-washing awareness and behavior of college students by gender.

METHODS

Population

Undergraduate students from a large private university in Daegu, South Korea were selected for a questionnaire survey or an observational study. A total of 308 students (157 males and 151 females) completed a questionnaire about hand-washing awareness and behavior. The total of 231 observations (118 of males and 113 of females) of hand-washing practices was made at restrooms located in various academic buildings on campus. The members of the two populations were randomly chosen in the same spatial environment and temporal duration.

Data Collection

Both data of the questionnaire survey and data of direct observation on hand-washing awareness and behavior were collected for a four week period. The questionnaire survey was self-administered and anonymous. The survey tool was developed specifically for our study, with reference to US CDC and US FDA/CFSAN recommendations (US CDC, 2008; Center for Food Safety and Applied Nutrition, 2001). Variables measured in the study include demographics and hand-washing awareness; the frequency of hand-washing a day, the duration of washing, use of soap, washing parts of the hands, the methods of hand-drying, the type and temperature of water, and what situation they wash their hands. In our study, we

define five parts of the hands as follows: the front and back of the hands, between fingers, fingernails and the wrists.

Observations of hand-washing practice were conducted over the same four week period by placing a trained observer in each of three different male restrooms and four different female restrooms in three academic buildings on campus during day times. In order to keep accurate observations, each observer took a rest every 30 minutes during his/her task. Measurements of observational study include hand-washing practice after using toilet and hand-washing techniques; namely, duration of washing, use of soap, washing parts of the hands, the method of hand-drying, the type and temperature of water, and the method of turning off water. The duration of hand-washing was recorded with a digital wrist stopwatch.

Data Analysis

All data of responses to questions and observed measurements were analyzed by frequency and valid percentage. For the nominal scale data, Chi-squared test or t-test were used to compare the hand-washing awareness and behavior between male and female students. For the ordinal scale data, the Kruskal-Wallis test was used to evaluate differences in hand-washing awareness and behavior by gender. The data were analyzed using Minitab (R) 15.1 (Minitab Inc.).

RESULTS

Awareness on the Hand-washing Based on a Questionnaire Survey

In order to evaluate the students' awareness, responses to asking whether or not surveyees washed their hands before or after a range of activities were collected (Table 1). Overall 95.5% of the respondents (male 93.6% versus female 97.4%) claimed to wash their hands after using toilet. More than two thirds of students responded that they washed their hands after returning to residence, after coughing or sneezing, before handling food, and before eating. About 50% of students responded that they washed their hands after handling food; and after playing with pets. More than one third of students responded that they washed their hands after studying/working. The survey revealed that they rarely washed their hands after using some of frequently touched items of personal equipment, such as a mobile phone or computer mouse.

Although the frequency and percentage were different, the top five situations of responded activities were the same in both male and female students. For males, the top five situations reported for hand-washing were: after using toilet (93.6 %), after coughing or sneezing (77.1%), after returning to residence (71.3%), before handling food (65.6%), and before eating (65.0%). For females, the top five situations reported for hand-washing were: after using toilet (97.4 %), after returning to residence (82.8%), before handling food (75.5%), before eating (69.5%), and after coughing or sneezing (69.5%) (Table 1). The analysis of χ^2 method was used to compare the probability of hand-washing for a range of activities between male and female students (Table 1). Females were significantly more likely to wash their hands after handling food; after returning to residence; after studying/working; or after handling money ($p < 0.05$).

Table 2 compares the responses to their hand-washing techniques in daily life. Overall 75.0% of respondents (male 75.8% versus female 74.2%) wash their hands 5~7 times a day. While more males than females responded that they washed their hands less than four times a day, more females than males responded that they washed hands more than eight times a day. Therefore, a significant difference was observed in the frequency of hand-washing between males and females ($p < 0.05$).

In our survey, 21.4% of the students (male 42.0% versus female 0.0%) responded that they washed their hands for less than 5 seconds. About 50% of the students (male 47.1% versus female 53.6%) responded that they washed their hands for more than 5 seconds and less than 10 seconds. However, none of the females responded that they washed their hands for less than 5 seconds, and none of the males for more than 30 seconds. These numbers indicate that there was a significant difference between males and females in the time breakdown of duration of hand-washing ($p < 0.05$).

The total of 68.5% of the respondents (male 75.8% versus female 60.9%) responded that they used soap at washing, and 9.1% (male 10.2% versus female 8.0%) responded that they washed the whole five parts of the hands (the front and back of the hands, between fingers, fingernails, and the wrists). Significant differences in these activities were found between males and females ($p < 0.05$).

About one third of the male and also female students responded that they dried their hands with paper towel (male 36.3% versus female 35.8%) or handkerchief (male 32.5% versus female 27.8%) after washing hands. About two thirds of the respondents (male 68.2% versus female 62.2%) preferred cold water and almost all of the respondents used running water at washing their hands. No significant difference was found in these three activities.

Hand-washing Behavior Based on Observational Study

Table 3 shows the results of our observational study. Overall, 56.7% of the students washed their hands after using toilet (Table 3). A significant difference was found between males and females in this hand-washing behavior ($p < 0.001$); much more females washed their hands after using toilet (98.2%) than males (16.9%).

Hand-washing behavior in restrooms was further evaluated for adequacy in washing techniques: duration of hand-washing, use of soap, washing parts of the hands, the type and temperature of water, and the method of turning off water (Table 3). More than half of the students who washed their hands (56.5%) completed within 5 seconds, 35.9% for 5~10 seconds, and 7.6% for 10~20 seconds. The gender breakdown of duration (d) of hand-washing is as follows: less than 5 seconds, male 25.0% versus female 62.2%; $5 \leq d < 10$ seconds, male 60.0% versus female 31.5%; $10 \leq d < 20$ seconds, male 15.0% versus female 6.3%. Males generally washed their hands longer than females, while no male or female washed the hands for more than 20 seconds in the direct observation. Significant gender difference in duration of hand-washing was noted ($p < 0.01$).

Only 4.6% of the students who washed their hands used soap; 25.0% of males versus 0.9% of females. The gender difference in this activity was significant ($p < 0.05$).

At washing, the students mostly washed two parts of their hands (overall 71.0%); the front and back of the hands, 70.2%; between fingers and the front of the hands, 0.8%. About one fourth of the students who washed their hands, washed three parts of their hands (25.2%); the front and back of the hands and between fingers, 19.1%; the front and back of the hands and the wrists, 6.1%. Only 1.5% of the students washed four parts of their hands (the front and back of the hands, between fingers, and the wrists). Fifty-five percent of males washed two parts of their hands and 73.0% of females; 40.0% of males washed three parts of their hands and 22.5% of females; 5.0% of males washed four parts of their hands

and 0.9% of females. None of the students washed whole five parts of their hands (the front and back of the hands, between fingers, fingernails, and the wrists) in the direct observation. The gender difference was significant ($p < 0.05$).

The most common method of hand-drying was using paper towel and a significant gender difference was found ($p < 0.05$). At drying, 60.0% of males used disposable paper towel while 90.1% of females did. None of the males and 1.8% of females used hand-dryers. These numeric values indicate that 10.0% of males and 1.8% of females did not use any material or tool to dry their hands after washing.

No significant gender difference was found in the type and temperature of water at hand-washing; all used running and cold water. Most of males (95.0%) and females (85.5%) turned off water with fingers after hand-washing; the difference between genders was small.

Hand-washing practice in a restroom was also evaluated by location. No difference in location was noted for females. However, hand-washing frequency of males was remarkably higher in a restroom of a particular academic building (about 33.3% of washing students) than in other buildings ($p < 0.05$) in the direct observation; the building of the higher frequency is the most recent building on campus.

DISCUSSION

In the questionnaire survey, both male and female students responded mostly to five situations of hand-washing although the frequency and percentage vary by gender. The top five situations of hand-washing are: after using toilet (male 93.6 % versus female 97.4%), after coughing or sneezing (male 77.1% versus female 69.5%), after returning to residence (male 71.3% versus female 82.8%), before handling food (male 66.9% versus female 75.3%), and before eating (male 65.6% versus female 69.5%). Therefore, it is understood that both of males and females are aware of the importance of hand-washing practice at these situations. In the responses, however, significant gender differences are found in the frequency of hand-washing a day, in the duration of hand-washing, in the use of hand-washing agents, and in numbers of washing parts of the hands; but neither in the hand-drying method nor in the type and temperature of water. More females tended to wash their hands more frequently and longer, while more males tended to use soap and to wash more parts of the hands.

In direct observation, females showed higher practice of hand-washing after using toilet as much as in the responses to the questionnaire survey. The direct observation showed that males had very poor practice of hand-washing after using toilet, and that their responses to questionnaire survey disagreed with their actual practice; survey 93.6% vs. observation 16.9%. However, among the students who washed their hands, males exhibited higher frequency in the use of soap, and washing three or four parts of the hands than females. This agrees on the responses to the questionnaire survey, where more males responded to the use of soap at washing and to washing more than three parts of the hands. Also, 75.0% of washing males washed longer than 5 seconds in comparison to 37.8% of washing females in our direct observation. In contrast, all of the females responded that they washed their hands for more than 5 seconds in the questionnaire survey. The most common method of had-drying was the use of paper towel for both males (60.0%) and females (90.1%). The use of hand dryer was rare, and observed only in females. All the males and females used running and cold water.

This is because the university did not provide warm water at the season.

It has been reported that self-reported data and observed data on hand-washing did not satisfy the recommendations for appropriate hand-washing behavior (O'Boyle et al., 2001). Differences between knowledge and practice on hand-washing were also pointed out (Scott and Vanick, 2007). In our study, overall 95.5% of students (male 93.6% versus female 97.4%) claimed to wash their hands after using toilet in the questionnaire survey, however, a hand-washing practice rate after using toilet was overall 56.7% (male 16.9% versus female 98.2%) in the direct observation. The inconsistency in awareness and practices on hand-washing was also found in the reports by American Society for Microbiology (ASM) and Detergent Association (SDA) based on a telephone survey of adult Americans and an observation survey of an adult population using public restrooms at six different locations in four cities in the U.S. In 1,013 telephone interviews, 91% of adults answered they always washed their hands after using public restrooms; just 83% of 6,336 individuals however did so in the observation (ASM, 2005a).

On the contrary, data of our study showed the consistency in responses to awareness the questionnaire and the actual sanitation practices of females. The better hand-washing practice of females in our study agrees with previous findings: The survey of ASM and SDA of adults' public restroom behaviors also found that more women (90%) washed their hands than men (75%) (ASM, 2005b). Further, observation of middle and high school students' hand-washing after using toilet indicated that girls (58%) washed their hands more than boys (48%), and were more likely to use soap when washing their hands than boys (Guian et al., 1997). An observation of 175 individuals (95 women and 80 men) using restrooms on a university campus indicated that 61% of the women and 37% of the men washed their hands (Johnson et al., 2003). Another observation of 583 university students at various campus restrooms indicated that more females washed their hands (76%) than their male peer (57%) (Anderson et al, 2008). These reports also found that females were more likely to use soap and to wash more thoroughly at washing than males.

In the direct observation of our study, unexpected differences between genders were found significantly in the key hand-washing techniques, which have not been reported in previous studies listed above. Although fewer male students washed their hands than female students, they exhibited higher frequency in the duration of hand-washing for more than 5 seconds, in the use of soap, and in washing the three or four parts of hands. These results indicate that males wash their hands more thoroughly than females, when they once practice hand-washing.

A noticeable finding is that most males washed their hands after using toilet in a restroom of a particular building, the most recently constructed building on campus. Such noticeable practice of hand washing of males seems to result in a new building effect. We can therefore suppose that neat and new atmosphere of the restroom may influence their emotional concepts and encourage them to wash their hands.

No previous study has evaluated hand-washing practices with washing parts of the hands, to the authors' knowledge. In the questionnaire survey of our study, about 30% of the students responded that they washed four or five parts of their hands. However, only 1.5% of students washed four parts at washing in the direct

observation. None of the population of our observation washed all five parts of their hands: the front and back of the hands, between fingers, the wrists, and fingernails, though washing all the five parts is the recommendations of US CDC (US CDC, 2008) and US FDA/CFSAN (Center for Food Safety and Applied Nutrition, 2001).
In the direct observation of our study, most of the males (83.1%) did not wash their hands after using toilet. Although 98.2% of females washed their hands after using the toilet, most of them (99.1%) did not use soap. Also two thirds of the washing males did not use soap. In order to turn off water, most of washing students used bare hands (fingers), while only 6.1% of washing students showered the faucet at turning off water. Unclean items such as faucet can be considered as a primary vehicle of transmission of pathogens. Better hand-washing practice and an adequate method of turning off water could be achieved through adaptations to restrooms, such as automatic faucets and hand sanitizer dispensers whose units need not be touched for operating.

We discuss further aspects of a gender difference in hand-washing practice of our study. More than 98% of females in our study washed their hands after using toilet, but only 17% of males did so. This difference in hand-washing could be explained by a gender difference in accepting social norms as mentioned by Johnson et al. (Johnson et al., 2003). From our findings, females are more likely to practice socially acceptable behaviors such as hand-washing, and males are more likely to behave as they like, even if the behavior contradicts social norms. Most males in restrooms located in the most recently constructed building washed their hands, in contrast to the observation that majority of males ignored observers and left without hand-washing in the other restrooms. Therefore, our study seems to reveal gender differences in hand-washing in association to the atmosphere of restrooms, contrary to a generally recognized concept that females are more influenced by emotional environment.

In this study, there are several limitations. The direct observation of our study was partly conducted at break times between classes during a semester. At break times, the numbers of students are usually pushed to use a limited number of toilets in a short time, 10 minutes or less. This could explain the low frequency of hand-washing practice of males, a low rate of use of soap, short duration of hand-washing, and leaving the restroom without drying wet hands in both males and females. Hence, we admit that our findings are limited to such university environment.

In our study, the presence of an observer may have influenced students, especially females over hand-washing practices, although the observers of our study made great efforts to be obscure. There was a report that the presence of others can affect individual's hand-washing behavior (Drankiewicz and Dundes, 2003). Further, Pederson et al. and Munger and Harris have shown that the presence of other person in a restroom is associated with an increase in hand-washing practice (Munger and Harris, 1989; Pedersen et al., 1986). In our study, however, many of males did not wash their hands after using toilet even though there was an observer. Findings from our study indicated that gender differences in hand-washing in association to the presence of someone were significant.

Considering that our study took place in a small number of locations, three different male restrooms in three buildings on campus, the biased practice of males on hand-washing may be disagree on a study of bigger number of locations or population.

Besides these limitations, other factors, such as time (semester-time) and season (April) might affect on hand-washing behaviors. Therefore, these limitations should be considered when interpreting our findings. Further research should examine hand-washing practice of students at restrooms outside the campus.

CONCLUSIONS

Our study showed significant differences between male and female students in hand-washing awareness and behavior, as well as differences between awareness and practices. Although information about the importance of hand-washing after using toilet seemed to be well recognized, males practiced very poorly. In contrast, almost females fully practiced in the direct observation. Our study has demonstrated that females washed their hands more often than males after using toilet. On the other hand, males washed their hands more thoroughly, and were more likely to use soap than females. Also, hand-washing practice of males was much higher in a restroom of the most recently constructed academic building than restrooms of other buildings. The new, clean, and comfortable atmosphere of the restroom might remind and encourage the males to wash their hands. Socialization and emotional factors that may contribute to gender differences in hand-washing practice should be examined further. Our findings have implications for public health professionals and health educators aiming to plan and design effective programs to educate college students on hand-washing.

REFERENCES

1. Jarvis, W.R. 1994. Handwashing—the Semmelweis lesson forgotten? *Lancet* 344,1311-1312.
2. Best, M., Neuhauser, D. 2004. Ignaz Semmelweis and the birth of infection control. *Qual Saf Health Care*. 13, 233-234.
3. Haas, J.P., Larson, E.L. 2007. Measurement of compliance with hand hygiene. *J Hosp Infect*. 66, 6-14.
4. US Centers for Disease Control and Prevention (CDC). 2004. Stopping germs at home, work and school. Available at: http://www.cdc.gov/germstopper/home_work_school.htm. Accessed September 30, 2008.
5. Catalina, L. 2009. Hand washing among school children in Bogotá, Colombia. *Am J Public Health*. 99,,94-101.
6. Yalcin, S.S, Yalcin, S., Altin, S. 2004. Hand washing and adolescents. A study from seven schools in Konya, Turkey. *Int J Adolesc Med Health*. 16,m371-376.
7. Sproat, L.J., Inglis, T.J.J. 1994. A multicentre survey of hand hygiene practice in intensive care units. *J Hosp Infect*. 26, 137-148.
8. Bischoff, W.E., Reynolds, T.M., Sessler, C.N., Edmond, M.B., Wenzel, R.P. 2000. Handwashing compliance by health care workers: the impact of introducing an accessible, alcohol-based hand antiseptic. *Arch Intern Med*. 160, 1017–1021.
9. Pittet, D. 2001. Improving adherence to hand hygiene practice: a multidisciplinary approach. *Emerg Infect Dis*. 7, 234–240.
10. Rome, M., Sabel, A., Price, C.S., Mehler, P.S. 2007. Hand hygiene compliance. *J Hosp Infect*. 65, 173.
11. Jeong, J.S., Choi, J.K., Jeong, I.S., Baek, K.R., In, H.K., Park, K.D. 2007. A nationwide survey on the hand washing behavior and awareness. *J Prev Med Public Health*. 40, 197-204 (Korean).
12. Guian, M.E., McGuckin-Guinan, M., Sevareid, A. 1997. Who washes hands after using the bathroom? *Am J Infect Control*. 24, 424-425.
13. Johnson, H.D., Sholcosky, D., Ragni, R., Ogonosky, N. 2003. Sex differences in public restroom handwashing behavior

associated with visual behavior prompts. *Percept Mot Skills*. 97, 805-810.
14. Drankiewicz, D., Dundes, L. 2003. Handwashing among female college students. *Am J Infect Control*. 31, 67-71.
15. Anderson, J.L., Warren, C.A., Perez, E., Louis, R.I., Phillips, S., Wheeler, J., Cole, M., Misra, R. Gender and ethnic differences in hand hygiene practices among college students. 2008. *Am J Infect Control*. 36, 361-368.
16. Stender, J., Rosenberg, F.A. 1998. Study of handwashing procedures in the bathrooms of Boston-area hospitals. *Am J Infec Control*. 26, 451-452.
17. van de Mortel, T., Bourke, R., McLoughlin, J., Nonu, M., Reis, M. 2001. Gender influences handwashing rates in the critical care unit. *Am J Infect Control*. 29, 395-399.
18. Moe, C.L, Christmas, W.A., Echols, L.J., Miller, S.E. 2001. Outbreaks of acute gastroenteritis associated with Norwalk-like viruses in campus settings. *J Am Coll Health*. 50, 57–66.
19. White, C., Kolble, R., Carlson, R., Lipson, N. 2005. The impact of a health campaign on hand hygiene and upper respiratory illness among college students living in residence halls. *J Am Coll Health*. 53, 175–181.
20. Bliss, S.J., Manning, S.D., Tallman, P., Baker, C.J., Pearlman, M.D., Marrs, C.F., Foxman B. 2002. Group B *Streptococcus* colonization in male and nonpregnant female university students: a cross-sectional prevalence study. *Clin Infect Dis*. 34, 184–190.
21. Center for Food Safety and Applied Nutrition, US Food and Drug Administration: Handwashing. 2001. Available at: http://www.cfsan.fda.gov/%7Edms/a2z-h.html#handwashing. Accessed September 30, 2008.
22. O'Boyle, C.A., Henly, S.J., Larson, E. 2001. Understanding adherence to hand hygiene recommendations: the theory of planned behavior. *Am J Infect Control*. 29, 352-360.
23. Scott, E., Vanick, K. 2007. A survey of hand hygiene practices on a residential college campus. *Am J Infect Control*. 35, 694-696.
24. American Society for Microbiology (ASM). 2005a. Handwashing fact sheet. Available at: http://www.cleaning101.com/newsroom/2005_survey/handhygiene/factsheet2005.cfm. Accessed September 30, 2015.
25. American Society for Microbiology. 2005b. Women better at hand hygiene habits, hands down. Available at: http://www.cleaning101.com/newsroom/2005_survey/handhygiene/womenshands.cfm. Accessed September 30, 2015.
26. Pedersen, D., Keithly, S., Brady, K. 1986. Effects of an observer on conformity to handwashing norm. *Percept Mot Skills*. 62, 169-170.
27. Munger, K., Harris, S.J. 1989. Effects of an observer on handwashing in a public restroom. *Percept Mot Skills*. 69, 733-734.

Table 1. The numbers and percentages of students by gender who claimed to wash their hands following particular activities: a multiple-choice questionnaire survey

The situation of hand-washing	Male	Female	Total	p value
	No. (%)	No. (%)	No. (%)	
Before eating	102	105	210	p = 0.392
After eating	54	54	108	p = 0.802
Before handling food	103	114	217	p = 0.055
After handling food	71	92	163	p = 0.005
After using a restroom	147	147	294	p = 0.113
After returning to residence	112	125	237	p = 0.016
After studying/working	53	72	125	p = 0.012
After coughing or sneezing	121	105	226	p = 0.134
After handling money	19	39	58	p = 0.002
After using mobile phone	4 (2.6)	2 (1.3)	6 (1.95)	p = 0.434
After playing with pets	80	72	152	p = 0.565
After contact with infected	25	28	53	p = 0.543
Others	16	19	35	p = 0.509

Table 2. The results of questionnaire survey on hand-washing habit of students by gender

Techniques of hand-washing	Male	Female	Total
	No. (%)	No. (%)	No. (%)
Frequency of hand-washing (*f*) (per	H = 4.12, *df* = 1, p = 0.042		
$f \leqq 4$	15 (9.6)	7 (4.6)	22 (7.1)
$5 \leq f \leq 7$	119 (75.8)	112 (74.2)	231 (75.0)
$f \geqq 8$	23 (14.6)	32 (21.2)	55 (17.9)
Duration of hand-washing (*d*)	H = 4.90, *df* = 1, p = 0.027		
$d < 5$	66 (42.0)	0 (0.0)	66 (21.4)
$5 \leq d < 10$	74 (47.1)	81 (53.6)	155 (50.3)
$10 \leq d < 20$	13 (8.3)	61 (40.4)	74 (24.0)
$20 \leq d < 30$	4 (2.6)	6 (4.0)	10 (3.3)
$d \geqq 30$	0 (0.0)	3 (2.0)	3 (1.0)
Use of hand-washing agents	$\chi^2 = 9.12$, *df* = 3, p = 0.028		
Water only	34 (21.6)	56 (37.1)	90 (29.2)
Water and soap	119 (75.8)	92 (60.9)	211 (68.5)
Water and sanitizer	2 (1.3)	3 (2.0)	5 (1.6)
Water, soap, and sanitizer	2 (1.3)	0 (0.0)	2 (0.7)
Number of washing parts of the hands [a]	H = 5.44, *df* = 1, p = 0.020		
1	11 (7.0)	27 (17.9)	38 (12.3)
2	15 (9.6)	18 (11.9)	33 (10.7)
3	80 (51.0)	65 (43.1)	145 (47.1)
4	35 (22.2)	29 (19.1)	64 (20.8)
5	16 (10.2)	12 (8.0)	28 (9.1)
Hand-drying method	$\chi^2 = 1.89$, *df* = 4, p = 0.594		
Just shaking water off	29 (18.5)	23 (15.2)	52 (16.9)
Paper towel (disposable)	57 (36.3)	54 (35.8)	112 (36.0)
Handkerchief	51 (32.5)	42 (27.8)	94 (30.2)
Hand dryer	20 (12.7)	11 (7.3)	50 (10.1)
Clothing	0 (0.0)	0 (0.0)	0 (0.0)
Others	0 (0.0)	21 (13.9)	21 (6.8)
Temperature of water	$\chi^2 = 1.26$, *df* = 2, p = 0.532		
Cold water	107 (68.2)	94 (62.2)	201 (65.3)
Lukewarm water	42 (26.7)	49 (32.5)	91 (29.5)
Warm water	8 (5.1)	8 (5.3)	16 (5.2)
Type of water	$\chi^2 = 0.004$, *df* = 1, p = 0.950		
Running water	152 (96.8)	147 (97.4)	298 (96.7)
Still water	5 (3.2)	4 (2.6)	10 (3.3)

[a]The five parts of hands are: the front of the hands, the back of the hands, between fingers, fingernails, and the wrists.

Table 3. The results of direct observation on the hand-washing practice of students by gender

Techniques of hand-washing	Male	Female	Total
	No. (%)	No. (%)	No. (%)
Do hand-washing after using	$\chi^2 = 29.68$, *df* =1, p < 0.001		
Yes	20 (16.9)	111 (98.2)	131 (56.7)
No	98 (83.1)	2 (1.8)	100 (43.3)
Duration of hand-washing (*d*)	H = 7.03, *df* =1, p = 0.008		
$d < 5$	5 (25.0)	69 (62.2)	74 (56.5)
$5 \leq d < 10$	12 (60.0)	35 (31.5)	47 (35.9)
$10 \leq d < 20$	3 (15.0)	7 (6.3)	10 (7.6)
$20 \leq d < 30$	0 (0.0)	0 (0.0)	0 (0.0)
$d \geqq 30$	0 (0.0)	0 (0.0)	0 (0.0)
Use of hand-washing agents	$\chi^2 = 14.82$, *df* =1, p < 0.05		
Water only	15 (75.0)	110 (99.1)	125 (95.4)
Water and soap	5 (25.0)	1 (0.9)	6 (4.6)
Water and sanitizer	0 (0.0)	0 (0.0)	0 (0.0)
Water, soap, and sanitizer	0 (0.0)	0 (0.0)	0 (0.0)
No.of washing parts of the	H = 4.74, *df* =1, p = 0.029		
1	0 (0.0)	3 (2.7)	3 (2.3)
2	11 (55.0)	82 (73.9)	93 (71.0)
3	8 (40.0)	25 (22.5)	33 (25.2)
4	1 (5.0)	1 (0.9)	2 (1.5)
5	0 (0.0)	0 (0.0)	0 (0.0)
Hand-drying method	$\chi^2 = 12.20$, *df* =4, p < 0.05		
Just shaking water off	2 (10.0)	2 (1.8)	4 (3.1)
Paper towel (disposable)	12 (60.0)	100 (90.1)	112 (85.5)
Handkerchief	0 (0.0).	0 (0.0)	0 (0.0)
Hand dryer	0 (0.0)	2 (1.8)	2 (1.5)
Clothing	0 (0.0)	7 (6.3)	7 (5.3)
Others	6 (30.0)	0 (0.0)	6 (4.6)
Temperature of water			
Cold water	20 (100.0)	111 (100.0)	131 (100.0)
Lukewarm water	0 (0.0)	0 (0.0)	0 (0.0)
Warm water	0 (0.0)	0 (0.0)	0 (0.0)
Type of water			
Running water	20 (100.0)	111 (100.0)	131 (100.0)
Still water	0 (0.0)	0 (0.0)	0 (0.0)
Method of turning off water	$\chi^2 = 2.95$, , *df* =3, p = 0.229		
With bare hands: fingers	19 (95.0)	93 (83.8)	112 (85.5)
With bare hands: the front of the	0 (0.0)	2 (1.8)	2 (1.5)
With bare hands: the back of the	1 (5.0)	8 (7.2)	9 (6.9)

With bare hands after showering	0 (0.0)	8 (7.2)	8 (6.1)
With a paper towel	0 (0.0)	0 (0.0)	0 (0.0)

[a]The five parts of hands are: the front of the hands, the back of the hands, between fingers, fingernails, and the wrists