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## Major article

## Poor hand hygiene by college students linked to more occurrences of infectious diseases, medical visits, and absence from classes



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Hand hygiene  
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**Background:** Proper hand hygiene has been linked to lower susceptibility to infectious diseases in many types of communities, but it has not been well established on college campuses. This study investigated the hand hygiene statuses of college students and their occurrences in relation to infectious diseases, medical visits, and absence from classes or work. It also examined the effects of education on hand-washing technique to improve hand hygiene.

**Methods:** College students enrolled at a university in Northwestern Ohio were recruited as study subjects. Microbial samples were collected 3 times from each of the 220 valid volunteers before washing their hands, after washing with their own procedures, and after washing with a procedure recommended by the Centers for Disease Control and Prevention (CDC). Each volunteer also answered a survey including questions on their health conditions, medical visits, and absence from classes or work.

**Results:** Hands of 57.7% volunteers were colonized by an uncountable number of microbial colonies, which were significantly linked to more occurrences to infectious diseases ( $P < .05$ ), medical visits ( $P < .05$ ), and arguably more absence from classes or work ( $P = .09$ ). The handwashing procedure provided by the CDC significantly improved hand hygiene.

**Conclusion:** It is critical to promote education on proper handwashing in colleges, in grade schools, and at home to improve health and learning outcomes.

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Understanding the role of infectious disease in our society is crucial in the aim to improve public health. Developing and practicing preventative efforts against infectious diseases may further in achieving this goal. The Centers for Disease Control and Prevention's (CDC's) summary for notifiable diseases is changing every year with reported updates of emerging or re-emerging diseases.<sup>1</sup> Each disease is well characterized, and each has remained a high priority on disease reports. One important aspect to prevent these diseases lies in investigating disease transmission.

Infectious diseases can be transmitted from person-to-person by indirect or, more commonly, direct contact. Among the different ways of transmission, person-to-person contact via the

hands is critical in the spread of bacterial infection.<sup>2-4</sup> This demonstrates the importance of basic infection-prevention interventions, with an emphasis on one of the most prevalent sources of infection transmission, hand hygiene. In fact, it has been shown multiple times that proper hygiene is the key to reducing occurrence of infectious diseases in many different types of communities, including hospitals, daycare centers, and grade schools.<sup>5</sup> However, interestingly, there were very few previous studies addressing hand hygiene practice on college campuses.<sup>6</sup> There were even fewer studies addressing whether proper hand hygiene could reduce occurrence of infectious diseases among college students<sup>7,8</sup>; therefore, it should still be considered as an open question.

The CDC and many other organizations (eg, World Health Organization) have published simple-to-follow handwashing guidelines.<sup>9,10</sup> However, incorrect handwashing practices and low compliance are prevalent,<sup>11-14</sup> even among health care workers.

College campuses are at a high risk for spreading infectious disease. Students live in close proximity with numerous chances of close contact and are constantly subjected to environmental and indoor pathogens as a result of constant traveling among different areas on campus. However, among the few studies which address

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handwashing among college students, the compliance has been found to be low and inadequate<sup>15</sup> by unobtrusive observation, whereas in another study, through self-reporting,<sup>16</sup> most students claimed to wash their hands frequently.

This study seeks to investigate the statuses of hand hygiene to evaluate the relationship of proper handwashing and reduced occurrences of infectious diseases on a college campus and to disseminate the procedures and techniques of proper hand hygiene. Study findings argue for a need to better disseminate the importance and the correct technique of basic hand hygiene.

## METHODS

### Study subjects

This research was performed according to a procedure approved by the institutional review board at the university in which the authors were affiliated (project no. 679). The research was conducted anonymously, and the data were stored according to guidelines setup by the institutional review board. Student volunteers were recruited from a campus in Northwestern Ohio to participate in the study through public announcements across campus. Each volunteer received and signed a written consent and was assigned an identification number. The volunteers were then instructed to answer a survey sheet, including questions about their sex, class classification, living conditions, whether they received an influenza vaccination, whether they had become sick during the winter of 2014–2015, and if so, whether they sought help from their health care provider, and whether they missed school or work because of the illness.

### Data collections

Each volunteer was asked to press the 5 fingertips of their dominant hand on one side of a Tryptic Soy Agar (TSA) (Sigma-Aldrich, St. Louis, MO)<sup>17</sup> plate to collect a microbial sample. The volunteer was then instructed to wash their hands as they normally would, and a second sample was collected in the same way on the other side of the same TSA plate. They were then instructed a proper way of hand sanitation, as suggested by the CDC,<sup>9</sup> and were asked to wash their hands using this procedure. A third bacterial sample was collected. All plates were incubated at 37°C under aerobic conditions for 24 hours. Six representative samples were selected, photographed, and used as the standard throughout this research. Each sample was then compared with the standard and assigned a number by 3 researchers independently. The average of the 3 scores provided by the 3 researchers was used as the score for that sample. Plates were returned back to the incubator after scoring and were scored again another 24 hours later, by comparing with the same standard photograph. The plates were then disposed as biohazard materials according to campus regulations.

### Statistical analysis

Paired *t* tests and *z* statistics were chosen to analyze the collected data and were performed using Microsoft Excel (Microsoft, Redmond, WA), using standard procedure.<sup>18</sup> A cutoff of  $P = .05$  was used to signify statistical significance.

## RESULTS

### Demographic profiles of volunteers

A total of 226 volunteers were recruited to participate in this research, 6 of which were deemed as invalid data because of

**Table 1**

Demographic profiles of volunteers (N = 220)

Demographic	n (%)
Sex	
Female	152 (69.1)
Male	66 (30)
Unanswered	2 (0.9)
Classification	
Freshman	39 (17.8)
Sophomore	42 (19.1)
Junior	36 (16.4)
Senior	66 (30)
Graduate	36 (16.4)
Unanswered	1 (0.5)
Living	
On campus	121 (55)
Off campus	99 (45)
Influenza vaccination?	
No	79 (35.9)
Yes	141 (64.1)
Infectious diseases?	
No	165 (75)
Yes	55 (25.0)
Seek help?	
No	24 (43.6)
Yes	31 (56.4)
Miss classes?	
No	29 (52.7)
Yes	26 (47.3)

various reasons, including incomplete answers on the survey sheets or a major mistake during the experimental process (data not shown). The demographic data of the 220 valid volunteers are shown in Table 1. Volunteers were mostly women, consistent with the sex distribution of the campus, with a rather even distribution of student classifications and living conditions. Of the volunteers, 64.1% received an influenza vaccination during the previous winter, and 25% reported being sick with infectious diseases. Among the 55 volunteers who were sick with infectious diseases, 31 (56.4%) sought help from their health care providers, and 26 (47.3%) were absent from classes or work for at least 1 day because of the infectious diseases.

### Hand hygiene status

All the TSA plates were incubated at 37°C aerobically for 24 hours, and most of which were found to contain too many colonies to be counted consistently and accurately (data not shown). Because of this, an alternative scoring procedure was used to assess the samples, as previously described. The hand hygiene status and the effects of handwashing varied among volunteers. Plates of 4 representative volunteers are shown in Figure 1B as examples, taken 48 hours after sample collection. In this research, B designates before washing, A designates after washing, and 2nd designates the second handwashing (with the CDC procedure,<sup>9</sup> which was not labeled on the plates). The hands of a small percentage of volunteers were found to contain higher microbial counts after handwashing, which is consistent with a previous study showing extensive bacterial contamination in public restrooms.<sup>19</sup> It was likely that those volunteers inadvertently touched highly contaminated areas after handwashing.

The average scores of all samples at 24 and 48 hours are shown in Figure 2A. At 24 hours (indicated by 1D), on average, microbial scores improved after volunteers washed their hands with their own procedure (A1D/B1D). However, the difference was not statistically significant with  $P = .14$ , according to the paired *t* test (Fig. 2B). A paired *t* test was chosen here and thereafter because it was designed and commonly used to compare 2 observations of the

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