

Poster as Tool to Improve Hand Hygiene Among Health Science Students: Case-control Study

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Abstract

Background/Purpose:

Hand hygiene is the most effective method for preventing nosocomial infections. Numerous educational interventions have been implemented to improve adherence to hand hygiene and its effectiveness among nursing students, with mixed results. To assess the effectiveness of posters as a tool for teaching hand hygiene and factors associated with the quality of hand hygiene among nursing students.

Methods

An experimental pre-post intervention study was carried out with second-, third-, and fourth-year nursing students randomly assigned to two groups (experimental and control). The two groups performed the handrubbing technique using alcohol-based hand rub. The experimental group was simultaneously shown the poster on hand hygiene produced by the WHO. Before and after the hand rubbing, students took cell samples from their non-dominant hands, which were cultured in Petri dishes for 48 hours. The number of bacterial colony-forming units per cm^2 determined the degree of cleanliness of their hands (< 10 = pass; ≥ 10 = fail).

Summary/Results:

A total of 293 students participated. In the experimental group ($n = 161$), significant differences were observed by age, with a higher percentage of fails (15.7% vs. 3.6%) among students aged > 22 years. Viewing the poster was associated with passing, all other variables being equal, albeit without statistical significance ($\text{ORa} = 2.07$). Hand contamination prior to the practices was weakly associated with lower hand hygiene quality ($\text{ORa} = .99$).

Conclusions

The use of posters as a teaching method for improving hand hygiene shows indications of effectiveness. Prior contamination of the hands slightly affects the quality of hand hygiene after the practice. Evaluation of new hand hygiene teaching methods at College setting ensures that future nurses are educated and sensitised to the spread of infectious diseases during the COVID-19 pandemic.

1. Background

The effectiveness and utility of hand hygiene (HH) for infection prevention in healthcare is undisputed and this is all the more true during the COVID-19 pandemic (1–5). While nurses generally tend to comply with HH recommendations (6), this form of hygiene is not always performed correctly (7–10).

Numerous interventions have been proposed to maintain adherence over time, with inconclusive results (11, 12). A number of interventions have been based on performance feedback or on placing alcohol-based hand rub (ABHR) at key points of care (11, 13). However, there is insufficient evidence to make specific recommendations on the content and implementation of such interventions (13).

Nursing students can act as potential vectors of infectious diseases during their clinical placements (7, 8), which is why theory and practical training in HH is provided from the very beginning of their academic studies (7, 14, 15). Overall, nursing students' attitudes towards HH are favourable (7, 10, 16, 17), but conventional teaching methods do not seem to provide a proper understanding of HH (7, 18, 19). Additionally, Løyland, Peveri, Hessevaagbakke, Taasen & Lindeflaten (2020) (20) confirmed that the adherence to HH in the medical personnel, including nursing students, had a negative balance, which affected to the prevention of nosocomial infections and even prevented the reduction of the instructions of the antibiotic treatment in patients. In studies such as the one developed by Sundal et al., (2017) (19), estimate the degree of general compliance in HH in nursing students in an 83,5% during their clinical internship. In these studies, the 5 moments of the HH of the WHO were evaluated. Elola-Vicente et al., (2008) (21) evaluated the effectiveness of the HH technique in medical personnel. It would be advisable to consider it in the nursing students. A large body of research stresses the need to improve the training of future healthcare workers (8, 10, 18, 22). In addition to knowledge, other factors such as students' sex, age, academic year, work experience, beliefs, perceived barriers, and attitudes influence the adoption of effective HH behaviours (7, 8, 23–25).

Innovative, multidisciplinary interventions have been proposed in the search for effective learning methods, with mixed results (7, 9, 14, 15, 18, 26–28).

Posters have traditionally been used in health and social care as a resource to promote HH, albeit with poor results (29, 30). However, the WHO recommends the use of posters as reminders in the workplace and as tools for training healthcare workers (31). To the best of our knowledge, there are no studies to date assessing the effectiveness of posters as a teaching method for improving the HH technique among nursing students.

This study has two aims. Firstly, to evaluate the effectiveness of the poster as a tool for improving the quality of HH among nursing students. Secondly, to determine the factors associated with correct HH among nursing students.

2. Methods

2.1. Study design and participants

An experimental pre-post intervention study was carried out at a public university in southern Spain during the 2019–2020 academic year. The nursing degree in Spain is divided into four years and students receive basic HH training in the first year, with clinical placements starting in the third year.

All undergraduate nursing students who had passed their basic HH training during the second, third, and fourth years and who voluntarily agreed to participate were invited to do so.

For a population of 321 students, the necessary sample size was estimated to be 140 participants, with a power of 95%, a 5% level of accuracy, and an expected proportion of 80%. Students were allocated to the intervention and control groups using random sampling stratified per academic year. To ensure that the practices ran smoothly, students were divided into groups of 20. The last group of fourth-year students, who were assigned to the control group, were not able to participate in the study due to the suspension of face-to-face tuition caused by the COVID-19 pandemic. However, the participation rate for that academic year was 74%. This study was performed according to the STROBE statement, Strengthening the Reporting of Observational studies in Epidemiology.

2.2. Description of the intervention and data collection

The intervention consisted of a two-session practices per group conducted by the research team and an accredited laboratory technician. The first session lasted one hour and presented HH techniques, the 5 moments recommended by the WHO, and the importance of keeping nails short, clean, and free from polish or gel. Each student was given two sterile swabs and a Petri dish with a pre-identified agar culture. They then divided the plate into two equal parts to differentiate between the pre-HH and post-HH seeding, and proceeded to sample and culture the non-dominant hand. Škodová et al. (2015) (25) confirmed that the most contaminated areas after HH are the thumbs and interdigital areas of the non-dominant hand. The decision was made to sample only that hand, in line with Cruz & Bashtawi (2016) (32), Elola-Vicente et al. (2008) (21), Silva et al. (2017) (33), and Škodová et al. (2015) (25).

This was followed by hand cleaning using ABHR. Disinfectants with alcohol concentrations above 60% have proven to have a similar efficacy to hand washing with soap and water. These were used given their current availability in healthcare facilities (11, 13). All students were administered the same amount of ABHR with a 75% alcohol concentration and performed the handrubbing technique. The intervention group did so with the WHO poster displayed (34) and the control group did so without it. Finally, they performed a second sampling and seeding using the same hand (post-HH), and the plates were placed in a culture oven at 35°C for 48 hours. This was followed by the second session, which lasted 15 minutes. Each student checked their plate and manually counted the colony-forming units (CFU) under the supervision of their instructors. The results were recorded on a data sheet, including sociodemographic and academic data.

Figure 1 shows the group selection process. Image 1 depicts the procedure for collecting and evaluating the results of the practice.

The variables to be considered were: group (intervention and control), age (continuous and dichotomised: ≤ 22 and > 22), sex (male, female), academic year (second, third, fourth), conducting a clinical placement (yes, no), and pre-HH and post-HH contamination assessed using the number of CFU/cm².

2.3. Data analysis

HH effectiveness was assessed by classifying students as either pass or fail. The classification was conducted according to the recommendations of the Chinese Centre for Disease Control and Prevention, i.e. by counting the number of CFU/cm². Aerobic bacterial counts are required to be under 10 CFU/cm² among healthcare workers in general clinical units(35, 36).

Descriptive statistics were applied using frequency and dispersion measures depending on the nature of each variable. Bivariate and multivariate logistic regression explanatory models were designed to fit all study variables by calculating crude and adjusted odds ratios respectively, and their 95% CIs. Statistical analyses were performed using SPSS (version 25.0) software for Mac.

3. Results

3.1. Characteristics of the participants

After the CFU count, 6 plates (2 belonging to the intervention group and 4 to the control group) were found to be contaminated and were therefore excluded. As a result, the final number of participants was 287. Their sociodemographic and academic characteristics are shown in Table 1.

Table 1
Characteristics of the participants

	Participants (<i>n</i> = 287)	Control Group (<i>n</i> = 126)	Intervention Group (<i>n</i> = 161)	
	<i>M</i>(<i>SD</i>)	<i>M</i>(<i>SD</i>)	<i>M</i>(<i>SD</i>)	<i>p</i>
Age (years)	22.5 (4.43)	22 (2.81)	22.89 (5.34)	.686
	n (%)	n (%)	n (%)	
Age (dichotomised)				
≤ 22	185 (64.5)	83 (65.9)	102 (63.4)	.658
> 22	102 (35.5)	43 (34.1)	59 (36.6)	
Sex				
Male	119 (41.5)	59 (46.8)	60 (37.3)	.103
Female	168 (58.5)	67 (53.2)	101 (62.7)	
Academic year				
Second	110 (38.3)	52 (41.3)	58 (36)	.660
Third	95 (33.3)	40 (31.7)	55 (34.2)	
Fourth	82 (28.2)	34 (27)	48 (29.8)	
Conducting a clinical placement				
No	110 (38.3)	52 (41.5)	58 (36.5)	.364
Yes	177 (61.7)	74 (58.7)	103 (64.1)	
Values are shown as means (standard deviations) or frequencies (percentages).				

3.2. Outcome of the intervention

Table 2 shows the numbers and percentages of students in each group who were classified as either pass or fail before and after the intervention. A significant improvement was observed.

Table 2
Intervention data (HH).

Participants (<i>n</i> = 287)			Control Group (<i>n</i> = 126)			Intervention Group (<i>n</i> = 161)			
	Pre-HH n (%)	Post-HH n (%)	<i>p</i>	Pre-HH n (%)	Post-HH n (%)	<i>p</i>	Pre-HH n (%)	Post-HH n (%)	<i>p</i>
Pass	24 (8.4)	262 (91.3)	.001**	8 (6.3)	119 (94.4)	.001**	16 (9.9)	143 (88.8)	.001**
Fail	263 (91.6)	25 (8.7)		118 (93.7)	7 (5.6)		145 (90.1)	18 (11.2)	

p compares the pre- and post-test in the control group, intervention group, and total group. ***p* < .01.

No differences in results were identified between the experimental group and the control group before and after performing HH with ABHR (Table 3).

Table 3
Intervention data (HH). Independent sample results.

	Control Group (<i>n</i> = 126)	Intervention Group (<i>n</i> = 161)	<i>p</i>	Control Group (<i>n</i> = 126)	Intervention Group (<i>n</i> = 161)	<i>p</i>
	Pre-HH n (%)	Pre- HH n (%)		Post- HH n (%)	Post- HH n (%)	
Pass	8 (6.3)	16 (9.9)	.276	119 (94.4)	143 (88.8)	.094
Fail	118 (93.7)	145 (90.1)		7 (5.6)	18 (11.2)	

Pre-test *p* compares the pre-test between the control group and the intervention group. Post-test *p* compares the post-test between the control group and the intervention group.

Table 4 shows the distribution of sociodemographic and academic variables by study group after the practices. In the experimental group, significant differences are observed by age (*p* = .017; *V* = .188), with students aged over 22 showing a higher percentage of fails (15.7%). A moderate association was found between pre-HH hand contamination and HH outcomes between the two groups (*p* = .005; *d* = .418), meaning that students who passed obtained a lower mean number of CFUs compared to those who failed.

Table 4
 Post-HH data: comparisons based on sociodemographic and academic variables

	Control Group (<i>n</i> = 126)			Experimental Group (<i>n</i> = 161)			
	Post- HH		<i>p</i>	Post- HH		<i>p</i>	<i>V</i>
	Pass <i>n</i> (%)	Fail <i>n</i> (%)		Pass <i>n</i> (%)	Fail <i>n</i> (%)		
Sex							
Male	57 (96.6)	2 (3.4)	.319	50 (83.3)	10 (16.7)	.089	
Female	62 (92.5)	5 (7.5)		93 (92.1)	8 (7.9)		
Age							
≤ 22	39 (90.7)	4 (9.3)	.186	57 (96.6)	2 (3.4)	.017*	.188
> 22	80 (96.4)	3 (3.6)		86 (84.3)	16 (15.7)		
Academic year							
Second	49 (94.2)	3 (5.8)	.983	52 (89.7)	6 (10.3)	.589	
Third	38 (95)	2 (5)		47 (85.5)	8 (14.5)		
Fourth	32 (94.1)	2 (5.9)		44 (91.7)	4 (8.3)		
Conducting a clinical placement							
No	70 (94.6)	4 (5.4)	.930	91 (88.3)	12 (11.7)	.801	
Yes	49 (94.2)	3 (5.8)		52 (89.7)	6 (10.3)		
	<i>M</i> (SD)	<i>M</i> (SD)		<i>M</i> (SD)	<i>M</i> (SD)		<i>d</i>
Pre-HH hand contamination	84.29 (77.79)	112.57 (44.56)	.344	91.18 (85.30)	156.56 (131.02)	.005**	.418
P compares the pre- and post-test in the control group & intervention group.							
* <i>p</i> < .05. ** <i>p</i> < .01. (<i>V</i>) = Cramér's <i>V</i> . (<i>d</i>) = Cohen's <i>d</i>							

The results of the bivariate and multivariate logistic regression are shown in Table 5. The use of posters as a teaching method for improving HH shows indications of effectiveness when adjusting for the other variables, although these are not statistically significant (OR = 2.07; 95% CI = .810-5.264). The number of CFUs prior to hand rubbing was slightly associated with the degree of cleanliness of the hands after the practice (OR = .99; 95% CI = .991-.999).

Table 5
Logistic regression for students who passed (post-HH)

	ORc	95% CI	ORa	95% CI
Poster				
No	1		1	
Yes	.47	(.189–1.157)	2.07	(.810-5.264)
Sex				
Male	1		1	
Female	1.34	(.588-3.043)	.69	(.282-1.679)
Age				
≤ 22	1		1	
> 22	.18	(.707-4.743)	.50	(.188-1.328)
Conducting a clinical placement				
No	1		1	
Yes	.90	(.382-2.106)	1.18	(.464-3.022)
Pre-HH hand contamination	.99	(.991-.998)	0.99	(.991-.999)
Hosmer-Lemeshow goodness-of-fit test: $\chi^2 (8) = 8.42; p = .394$. OR: Odds Ratio; CI: Confidence Interval.				

4. Discussion

This study explored the potential association between the use of a poster as a teaching tool and the quality of HH among nursing students in response to the need to find an effective method to improve the HH technique to control nosocomial infections among this group (25, 32, 37, 38).

Our findings are in line with the results of numerous studies showing that the use of ABHR considerably reduces microbial burden and is thus considered a suitable procedure for nosocomial infection control (25, 27, 32, 39–41).

We observed no sex-based differences in the level of HH after using the poster as a teaching tool. Nonetheless, the available evidence on the influence of this variable based on various interventions remains controversial. Anderson et al. (2008) (42) and Pérez-Pérez et al. (2015) (38) point out that, regardless of the techniques used, women performed HH better than men in all cases. In contrast, Cruz & Bashtawi (2016) (32) report that being male and being in the first years of university study were predictive of greater knowledge of the technique. Recently, Merino-Plaza et al. (2020) (43) studied adherence to HH among healthcare professionals. Initially, men scored more poorly than women on adherence to HH.

However, when targeted improvements in care services based on monitoring and feedback were implemented, men's scores improved to match those of women. These strategies, which were also included in our training practices, may be behaving in a similar way in our study.

In the intervention group, we identified a relationship between age and the number of CFUs, whereby students aged 22 years and older had higher numbers of CFUs, perhaps as a result of being overconfident during the HH procedure (21, 44). Minervini (2005) (45) and Sancho (2010) (46) suggest that visual tools used for teaching, such as infographics, must be tailored to the characteristics of the students, including their age. Our findings suggest the need to adapt HH practices to take into account students' ages.

Second-year students achieved the same results as those in senior years. This may be explained by the fact that knowledge of the subject increases in line with the academic year, resulting in an improvement in HH performance among senior students. However, Cruz & Bashtawi (2016) (32) failed to observe this relationship. Surprisingly, a number of authors argue that the closer undergraduates are to entering the labour market, the more confident they may feel about performing the technique, resulting in poorer performance (21, 44). According to Fernández-Prada et al. (2012) (37), the use of infographics as a teaching tool tends to improve the teaching-learning process during the first academic years. However, the overexposure to digital teaching materials that our students are currently experiencing may be diminishing the effect of posters with the passing of the academic years, leading to a shift away from the results reported by other researchers (47, 48).

The multivariate model designed to explain the association between displaying the poster and the likelihood of passing has shown signs of effectiveness when adjusting for the other study variables, although it has not reached statistical significance. Visual tools certainly seem to be useful for optimising and accelerating comprehension processes and are often highly valued by students (29, 47). However, as Bicen & Behesti (2017) (49) point out, the main obstacle to the effectiveness of these tools is a lack of precise theoretical knowledge of the subject matter among students and excessive time required to analyse visual tools. The same may be said of infographics. Further studies are required to better assess the impact of these variables on the results obtained in our study.

Pre-HH hand contamination was slightly associated with a lower likelihood of passing. However, we agree with several authors in recommending that HH should be performed with soap and water whenever hands are visibly soiled or have been in contact with contaminants (34, 50, 51).

5. Limitations

A potential classification bias may have been introduced by using the same Petri dish for pre- and post-HH culture. To avoid this limitation, we should have used one culture plate for each sample. However, only 6 plates were contaminated and excluded from the study. If this bias was present, it would be a non-differential bias across all comparison groups.

The last group of fourth-year students, who were assigned to the control group, were not able to participate in the study due to the suspension of face-to-face tuition caused by the COVID-19 pandemic. However, the participation rate for that academic year was 74%, which was satisfactory.

Conclusions And Implications

This practice-based teaching method combining HH with ABHR and the display of a specific poster on HH shows indications of being effective in improving the quality of HH among nursing students. However, further research is required to confirm this association. A high level of hand contamination prior to the practices decreased the likelihood of achieving a good level of cleanliness. Further evaluation of teaching methods to ensure good technical performance of HH at university level is required to prevent the spread of infectious diseases during the COVID-19 pandemic.

Evaluation of new HH teaching methods at College setting ensures that future nurses are educated and sensitised to the spread of infectious diseases during the COVID-19 pandemic.

Declarations

Ethics approval and consent to participate

The study complies with the good clinical practice regulations, as stated in the European Directive 2001/20/CE and Law 14/2007, of July 3, on biomedical research. Treatment of personal data in health research is governed by Organic Law 3/2018, of December 5, on Data Protection and Guarantee of Digital Rights. Every participant checked a box giving their indicating consent to participate in the study. This study was approved by the university centre and the Granada Research Ethics Committee (code number: 0100-N-21).

Consent for publication

Every participant checked a box giving their indicating consent to participate in the study and the consent to publish photograph.

Availability of data and material

All data generated or analysed during this study are included in this published article and its supplementary information files.

Competing interests

The authors have no conflicts of interest to disclose.

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Authors' contributions

Conceptualisation: M.G.-L, E.M.-G, and M.A.P.-M; methodology: M.G.-L, E.M.-G, A.M.-S, M.A.P.-M, R.A.C.-G, and M.A.A.-S; formal analysis: M.A.A.-S and I.G.-G; investigation: M.G.-L and M.A.A.-S; data curation: I.G.-G and M.A.A.-S; writing—original draft preparation: M.G.-L, E.M.-G, A.M.-S, I.G.-G, M.A.P.-M, R.A.C.-G, and M.A.A.-S; writing—review and editing: M.G.-L, E.M.-G, A.M.-S, I.G.-G, M.A.P.-M, R.A.C.-G, and M.A.A.-S; visualization: M.G.-L and A.M.-S; supervision: M.G.-L. All of the authors have read and approved the final manuscript and its submission to the journal.

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Figures

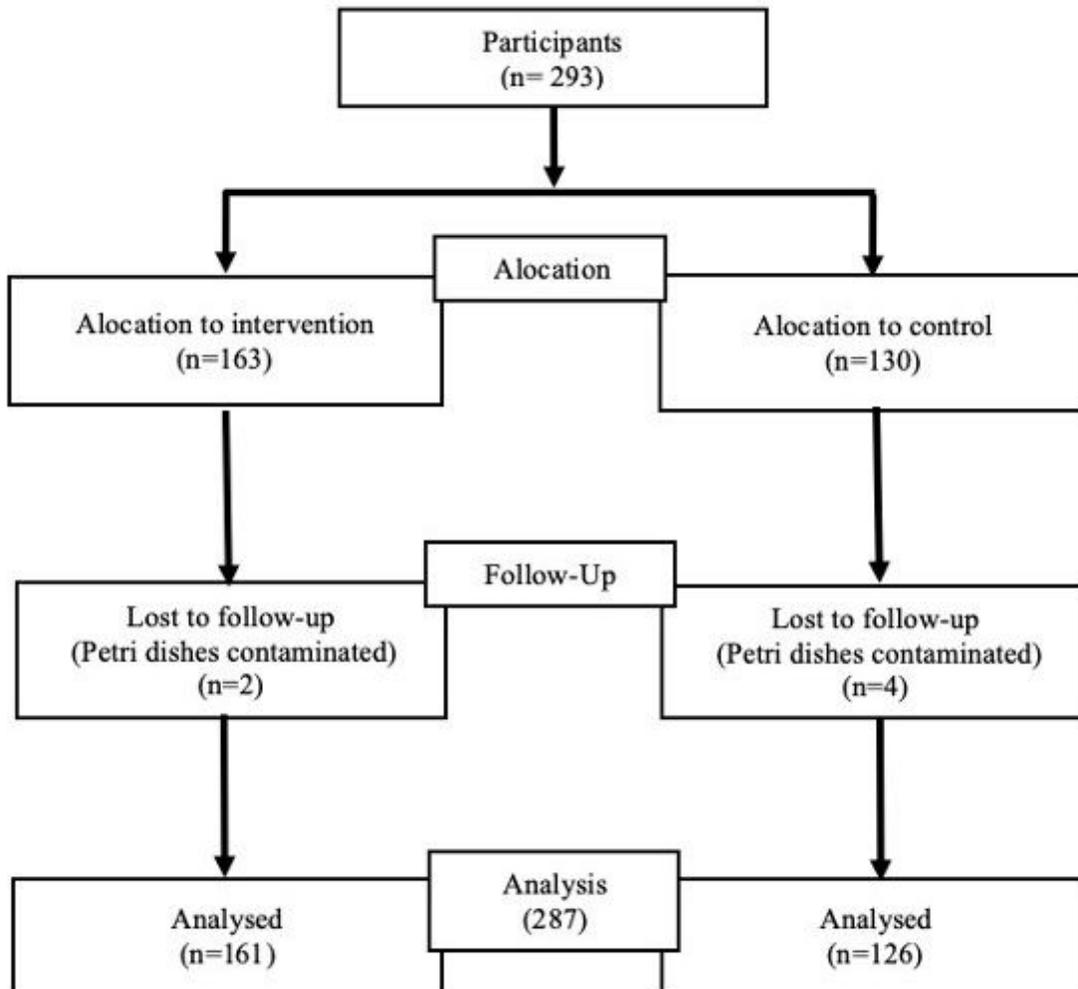


Figure 1

The group selection process

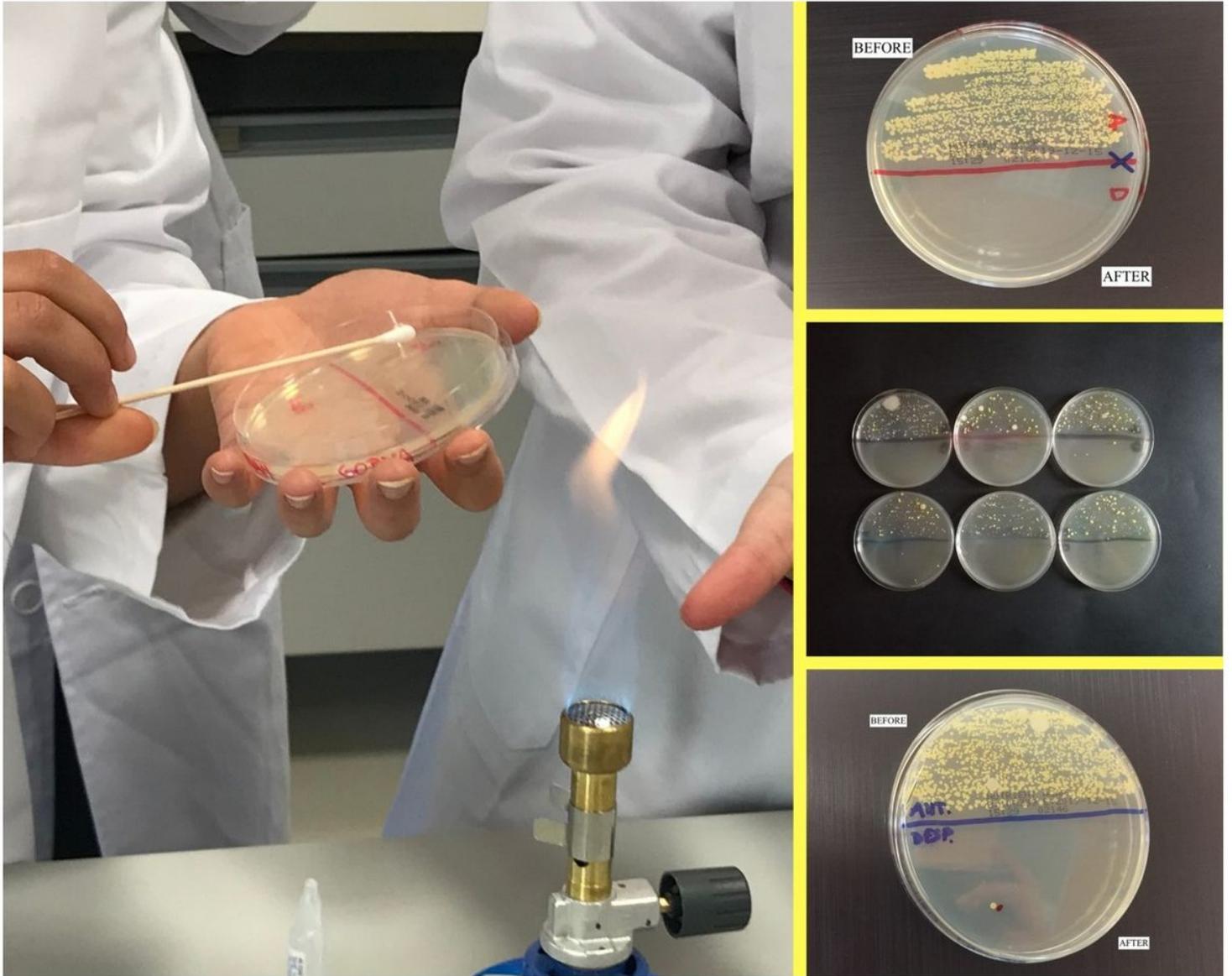


Figure 2

description of the intervention and data collection.