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# Can We Influence Habit and Motivation for Proper Hand Disinfection Technique Through Education? An Experimental Pilot Study

## Možemo li edukacijom utjecati na naviku i motivaciju za pravilnom tehnikom dezinfekcije ruku? Eksperimentalno pilot-istraživanje

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**Abstract. Aim:** Hand hygiene is critical for the prevention of healthcare-associated infections, yet it is poorly practiced by healthcare workers. The aim of this study is to examine the effects of various incentives on the correctness of hand disinfection technique and motivation to use the technique correctly. **Participants and Methods:** The experiment was performed on three different days with 36 healthcare students. The procedure on the first and third day was the same and equal for all four groups (feedback alone). On the second day, the groups received different incentives (1: feedback + demonstration + creative teamwork; 2: feedback + demonstration + lecture; 3: feedback + demonstration; 4: feedback alone). Correctness (gel coverage percentage) and motivation were measured and compared between the three measurements. **Results:** Initially, only 25% of participants achieved at least 95% coverage, and only 55.56% tried at least "quite a bit" to use the technique correctly. Coverage increased after the incentive in groups 1 ( $\chi^2_{(2)} = 6.000$ ;  $P = 0.050$ ), 2 ( $\chi^2_{(2)} = 7.750$ ;  $p = 0.021$ ), and 3 ( $\chi^2_{(2)} = 15.273$ ;  $P = 0.001$ ). Motivation increased in groups 1 ( $\chi^2_{(2)} = 10.571$ ;  $P = 0.005$ ) and 3 ( $\chi^2_{(2)} = 7.515$ ;  $P = 0.023$ ). Dorsum coverage was significantly smaller than palm coverage in both hands. **Conclusion:** Demonstration of hand disinfection technique, creative teamwork, and lecture were effective in adopting the habit of hand disinfection and reinforcing motivation to do so, but scanner feedback alone wasn't effective in this way. Future studies should examine longer follow-up period and testing these results in clinical settings.

**Keywords:** Education; Habits; Hand Disinfection; Health Occupations; Motivation; Students

**Sažetak. Cilj:** Higijena ruku ključna je za prevenciju infekcija povezanih sa zdravstvenom skrbi, ali zdravstveni djelatnici je često nepravilno prakticiraju. Cilj je ovog istraživanja ispitati učinke različitih poticaja na ispravnost tehnike dezinfekcije ruku i motivaciju za pravilno korištenje te tehnike. **Ispitanici i metode:** Eksperiment je proveden tijekom tri različita dana s 36 studenata zdravstvenih studija, podijeljenih u četiri skupine. Postupak je bio isti za sve četiri skupine (sa slučajno izabranim sudionicima) prvog i trećeg dana (samo povratna informacija). Drugog dana, skupine su dobile različite poticaje (1. skupina: povratna informacija + demonstracija + kreativni timski rad; 2. skupina: povratna informacija + demonstracija + predavanje; 3. skupina: povratna informacija + demonstracija; 4. skupina: samo povratna informacija). Ispravnost (postotak pokrivenosti dezinfekcijskog gela) i motivacija izmjereni su i uspoređivani između triju mjerenja. **Rezultati:** Na početku je samo 25 % sudionika postiglo pokrivenost od barem 95 %, a samo 55,56 % se potrudilo da "prilično" pravilno koristi tehniku. Pokrivenost je porasla nakon pruženog poticaja u skupinama: 1. ( $\chi^2_{(2)} = 6,0$ ;  $P = 0,050$ ), 2. ( $\chi^2_{(2)} = 7,750$ ;  $P = 0,021$ ) i 3. ( $\chi^2_{(2)} = 15,273$ ;  $P = 0,001$ ). Motivacija se povećala u skupinama 1. ( $\chi^2_{(2)} = 10,571$ ;  $P = 0,005$ ) i 3. ( $\chi^2_{(2)} = 7,515$ ;  $P = 0,023$ ). Pokrivenost dorzuma bila je značajno manja od pokrivenosti dlana objiju ruku. **Zaključak:** Demonstracija tehnike dezinfekcije ruku, kreativan timski rad i predavanje bili su učinkoviti u usvajanju navike dezinfekcije ruku i jačanju motivacije za dezinfekciju, ali povratna informacija skenera sama po sebi nije bila učinkovita na taj način. Buduća istraživanja

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trebala bi obuhvatiti dulje razdoblje praćenja i ove rezultate testirati u kliničkim okruženjima.

**Ključne riječi:** dezinfekcija ruku; motivacija; navike; obrazovanje; studenti; zdravstvena profesija

There is a need to explore different approaches to teaching hand disinfection techniques, as the application among healthcare workers is not satisfactory.

## INTRODUCTION

In 1847, Ignaz Philipp Semmelweis found that disinfecting the hands of medical personnel with chlorinated lime solution between performing autopsies and providing maternal care in the maternity ward reduced puerperal fever from 16% to 3%<sup>1</sup>. According to the World Health Organization (WHO), healthcare-associated infections are considered the most common adverse event in hospitals and represent a major financial problem<sup>2</sup>. Hand hygiene, whether hand washing or hand disinfection, remains the most important measure to prevent healthcare-associated infections. For a long time, healthcare professionals were not sufficiently aware of the importance of this simple procedure<sup>3,4</sup>. Recognizing ignorance as a patient safety issue, the WHO launched a project in late 2005 called First Global Patient Safety Challenge: "Clean Care is Safer Care," with the goal of reducing the incidence of healthcare-associated infections. Handwashing practices have achieved positive results on a global scale<sup>5</sup>. Infection control as a quality standard in health care is prescribed in Croatia by the "Regulation on Quality Standards in Health Care and the Way of Their Application" (Official Gazette 79/2011), and an essential part of the regulation is hand, skin and mucous membrane hygiene. Data on inadequate Hand Hygiene are published by the Agency for Quality and Accreditation in Healthcare<sup>6</sup>. The guidelines for hand disinfection in the hospital settings in Croatia emphasize the importance of effective training for healthcare workers in adopting the habit of correct and proper hand disinfection and recommend regular monitoring and feedback on hand hygiene procedures, taking into account factors such as behavior change

and education about hand contamination and hand hygiene<sup>5</sup>. Active learning techniques such as group work, active information seeking, or problem solving have been shown to be effective in nursing education, as they promote critical thinking, self-confidence, and practical skills<sup>7-9</sup>. On the other hand, some research shows that students negatively evaluate active learning and that they prefer lectures that deliver well-organized information, which they find reliable and helpful during exams<sup>10,11</sup>.

## BACKGROUND

Compliance with hand hygiene instructions is often unsatisfactory for healthcare professionals<sup>12</sup>. Therefore, healthcare students, as future healthcare providers, play the greatest role in preventing healthcare-associated infections, but research indicates low levels of hand hygiene among health profession students<sup>13,14</sup>. There are personal and organizational factors that influence hand hygiene compliance among nurses, such as personal beliefs and knowledge about the impact of hand hygiene on reducing infections, availability of hand hygiene supplies, continuous health education, and supportive organizational management<sup>15</sup>. While there is extensive research on Hand Hygiene knowledge, beliefs, and adherence among nursing and medical students, few studies have been conducted with other healthcare students. In addition, little research has been conducted to determine if professional differences are evident in hand hygiene at the undergraduate level<sup>13</sup>. While nurses are well aware of the basic rules of hand hygiene and are willing to put them into practice, the correct technique is performed by only 52%<sup>16</sup>. Some studies have shown that the worst disinfected part of the hand is the dorsum<sup>17</sup>. Therefore, training strategies and the level of compliance of nurses with hand hygiene guidelines is required<sup>18</sup>. Education of healthcare professionals has been shown to be the most commonly used intervention to improve hand hygiene, even though not always effective and not necessarily leading to change<sup>19,20</sup>. Several teaching models have been developed that aim to improve hand hygiene among healthcare professionals<sup>20,21</sup>. However, to adopt a behavior, in-

dividuals must be motivated, as motivation is a key factor in habit adoption and development of interventions that lead to improvement of hand hygiene performance<sup>20</sup>. In addition, building of self-confidence and receiving of feedback information is required for a proper training of health-care professionals<sup>21</sup>. Perceived self-efficacy is also necessary for the formation of the belief in one's ability to perform a desired action and it correlates with the number of health behaviors, including hand hygiene<sup>22, 23</sup>. Many studies have documented the key role of intervention planning in the acceptance and maintenance of a variety of health behaviors such as hand hygiene<sup>24, 25</sup>.

### OBJECTIVES

The aim of this study is to compare different teaching methods for adopting the habit of correct hand disinfection technique in healthcare students, measured by the correctness of the technique and the motivation to use the technique correctly (we call them correctness and motivation).

Since we are measuring the effect on the correctness and on the motivation, we use the term incentive instead of the term teaching method.

First specific objective is to determine the initial correctness, measured by the percentage of coverage of hands by the disinfection gel, and the initial motivation.

Second specific objective is to investigate the effects of timing (day 1, day 2, and day 3) and the effects of type of incentive (groups 1, 2, 3, and 4) on the correctness and on the motivation.

The third specific objective is to measure the correlation between the correctness and the motivation.

The fourth specific objective is to analyze whether there is a difference in correctness depending on the part of the hand in the initial and final measurements.

### HYPOTHESES

The first hypothesis (H1) is that fewer than 50% of participants will initially apply hand disinfection technique correctly and that fewer than 50% of participants will have strong motivation ("quite a

bit" or "a lot" of effort to apply the technique correctly, i.e., responses 4 or 5 on the scale of 1 to 5). The second hypothesis (H2) is that there will be significant differences in the correctness and in the motivation depending on the day (1, 2, or 3) and the type of incentive (1, 2, 3, and 4). The highest values are expected on day 3 compared to day 1 and 2 and in groups 1 and 2 compared to groups 3 and 4.

The third hypothesis (H3) states that there is a positive correlation between the correctness and the motivation.

The fourth hypothesis (H4) is that there is a significant difference in the correctness, depending on the part of the hand, in the initial and final measurements, with the dorsum performing worse compared to the palm.

### PARTICIPANTS AND METHODS

The experiment was conducted in October 2021 in faculty lecture halls on three separate days: day 1 – baseline, day 2 – the next day, and day 3 – after 9 days.

There was one control group and three experimental groups that differed in the type of incentives. The procedure was identical for all four groups on day 1 and day 3 and different for all groups on day 2 (described in detail in Methods). To prevent participants from different groups from sharing information about the experiment on day 2, the temporal and spatial order of the groups was carefully planned.

The experimental design was accordingly, based on 3 days period involving 4 groups. Each group participants were in the lecture hall at the same time during the experimental procedure and could observe and talk to each other. Four experimenters performed the experiment.

Uniformity of performance was ensured by a research protocol, joint preparation prior to performance, and work in pairs in each group so that one of the experimenters monitored whether the process was performed according to the protocol. Prior to the experiment start, four independent evaluators assessed the two experimenters' consistency performance of hand disinfection technique demonstration, so this was also refined in advance.

## Participants

80 participants were randomly selected from the list of full-time students, considering the quota of all majors, randomly divided into 4 groups using MS Excel and invited to participate by e-mail. Due to insufficient response, participants were invited in person and randomly divided into four groups. The planned number of participants per group was a maximum of 20 because of epidemiological measures in vigor at the time, and the final response rate was 48.75%. Participants were informed that they would participate in one of the 4 experimental groups, but not in which one. Part-time students were excluded as it was assumed they are already familiar with the hand disinfection technique in their clinical work experience. Exclusion criteria: hypersensitivity to alcohol.

39 participants attended day 1. On day 2, one participant from group 2 and one from group 3 didn't participate, and on day 3 one more participant from group 4 didn't participate. These 3 participants were excluded from the analysis because they were missing at random (loss of 7.69%). The total number of participants included in the analysis is 36 (N group 1 = 9, N group 2 = 8, N group 3 = 11, and N group 4 = 8). Demographic data are shown in Table 1.

**Table 1.** Demographic characteristics of participants (N=36)

Characteristic	Data
Sex	Female 33
	Male 3
Age (year)	18 – 22 (Median 19,5, Q=0,5)
Year of study	1 <sup>st</sup> 26
	2 <sup>nd</sup> 3
	3 <sup>rd</sup> 7

## Instruments

1. Sociodemographic questionnaire: gender, age, study and year of study.
2. Motivation questionnaire: "To what extent have you tried to disinfect your hands properly as much as possible?" scale from 1 – "not at all" to 5 – "a lot".
3. Semmelweis Scanner (Hungary): The scanner reads the surface of the hand on which the disin-

fectant training gel was applied. The percentage of hand coverage is considered a measure of correctness. Participants received three feedback information on the scanner. Pictorial information shows the coverage of the four parts of the hand (left and right palm, left and right dorsum). The covered areas are marked in green and the uncovered in red. Numerical information indicates the percentage of coverage of the most poorly covered part of the hand. If the coverage is below 95%, the rating is "fail", if it's above 95%, the rating is "pass". Narrative information indicates which part of the hand to pay special attention to when applying the gel. Based on the research of Nagy et al. (2017), in which the proposed pass/fail criteria were 90%, 95%, and 97% coverage, we decided to use a pass threshold of 95%<sup>26</sup>.

## Procedure

### Day 1.

All four groups underwent the same procedure. Participants were informed about the study and signed the informed consent form. They completed the sociodemographic questionnaire and the form with the codes for each participant, in case the participant forgot the code until the next measurement (days 2 and 3). The form with the codes was sealed in an envelope in front of the participants. The experimenter instructed each participant to disinfect hands with gel and to read the feedback on the scanner. He gave each participant the same instructions for using the scanner and reading the pictorial, numerical, and narrative feedback, without giving any other feedback himself.

At the end, participants completed the motivation questionnaire.

### Day 2.

All four groups were subjected to different procedures.

**Group 1.** Participants were divided into two subgroups and each group was tasked with creating a poster on the importance of proper hand hygiene. Subgroup 1's task was to address questions: Why is hand disinfection important? Who do healthcare professionals protect when they practice hand hygiene? How do healthcare workers protect themselves by practicing hand hy-

giene? How do healthcare workers protect their colleagues by practicing hand hygiene? and to make recommendations on how best to teach and motivate healthcare workers to adopt and maintain the habit of hand hygiene. The task of Subgroup 2 was to address the following questions: What is hand disinfection? Who do healthcare workers protect when they perform hand hygiene? How does a healthcare worker protect patients by performing hand hygiene? How do healthcare workers protect their household through hand hygiene? and to make recommendations on how best to teach and motivate healthcare workers to adopt and maintain the habit of hand hygiene. They were allowed to share ideas with each other and research the literature. At the end, they briefly presented their poster. After the poster presentation, the experimenter demonstrated the proper hand disinfection technique. After the demonstration, participants were instructed, as on day 1, to disinfect their hands with gel, read the feedback on the scanner and complete the motivation questionnaire.

**Group 2.** Participants listened to the experimenter's lecture on the importance of proper hand disinfection. The content of the lecture corresponded to the content of the poster questions in Group 1: hand hygiene; Why should a healthcare professional perform hand hygiene? Hand hygiene as a protection for patients/self/colleagues/household members; adopting a habit. Participants listened to the lecture without actively participating. After the lecture, the experimenter demonstrated the proper hand disinfection technique. After the demonstration, participants were instructed, as on day 1, to disinfect their hands with gel, read the feedback on the scanner and complete the motivation questionnaire.

**Group 3.** The experimenter demonstrated the proper hand disinfection technique. After the demonstration, participants were instructed, as in day 1, to disinfect their hands with gel, read the feedback on the scanner and complete the motivation questionnaire.

**Group 4 (control group).** As on day 1, participants were instructed to disinfect their hands with gel, read the feedback on the scanner and complete the motivation questionnaire.

In all four groups, the experimenter himself did not provide participants any feedback on hand disinfection technique.

### Day 3.

All four groups underwent the same procedure as on day 1. Participants were instructed to disinfect their hands with gel, read the feedback on the scanner and complete the motivation questionnaire, without giving any other feedback himself.

The combination of hand disinfection technique demonstration, creative teamwork, lecture, and feedback on advanced technologies was effective in adopting the habit of proper hand disinfection and reinforcing motivation to do so. Continuous teaching and feedback are recommended to maintain the habit and motivation.

### Statistical analysis

Differences in motivation and correctness between four groups were tested with Kruskal-Wallis ANOVA, as was the difference in the correctness between four parts of the hand. Differences in motivation and correctness between three measures were tested with Friedman test. Correlation between motivation and correctness was tested with Spearman correlation test. The results of all tests were considered statistically significant if p-value was less than 0.05. Statistical analysis was performed in Statistica 14.0.0.15 (TIBCO Software Inc.).

### Ethical aspects

Participation in the study was voluntary, and participants gave written informed consent. The intervention followed ethical principles for research with human participants. Approval was obtained from the faculty ethics committee before the study was performed.

## RESULTS

H1. At the first measurement on day 1, 9 of 36 participants (25%) applied the hand disinfection technique correctly, and 20 of 36 participants (55.56%) reported that they tried "quite a bit" or

**Table 2.** Coverage of hands with hand disinfection gel and motivation for correct use of the technique in three measures and in four groups.

		Coverage Average rank	Friedman test $\chi^2_{(df), p}$	Motivation Average rank	Friedman test $\chi^2_{(df), p}$
Group 1	Day 1	1.333	$\chi^2_{(2)} = 6.000$ $p = 0.050^a$	1.222	$\chi^2_{(2)} = 10.571$ $p = 0.005$
	Day 2	2.333		2.444	
	Day 3	2.333		2.333	
Group 2	Day 1	1.375	$\chi^2_{(2)} = 7.750$ $p = 0.021$	1.625	$\chi^2_{(2)} = 4.769$ $p = 0.092$
	Day 2	1.875		2.313	
	Day 3	2.750		2.063	
Group 3	Day 1	1.091	$\chi^2_{(2)} = 15.273$ $p = 0.001$	1.455	$\chi^2_{(2)} = 7.515$ $p = 0.023$
	Day 2	2.182		2.091	
	Day 3	2.727		2.455	
Group 4	Day 1	1.375	$\chi^2_{(2)} = 4.750$ $p = 0.093$	1.750	$\chi^2_{(2)} = 4.667$ $p = 0.097$
	Day 2	2.375		1.938	
	Day 3	2.250		2.313	

<sup>a</sup> Original p-value  $p = 0.04979$  rounded to three decimal places here

“a lot” to use the hand disinfection technique correctly. Therefore, the first hypothesis is partially rejected.

H2. Before analyzing the effects of timing and type of incentive on correctness and motivation, baseline scores were compared between the four groups on day 1. The Kolmogorov-Smirnov test indicated that the data were not normally distributed, so nonparametric tests were used. Kruskal-Wallis ANOVA showed that there was no statistical difference in correctness ( $\chi^2_{(3)} = 5.773$ ,  $p = 0.123$ ) or motivation ( $\chi^2_{(3)} = 4.909$ ,  $p = 0.179$ ). The Friedman test was used to test hypothesis 2. In groups 1 and 3, there is a significant difference in the correctness (group 1  $\chi^2_{(2)} = 6.000$ ,  $p = 0.050$ ; group 3  $\chi^2_{(2)} = 15.273$ ,  $p = 0.001$ ) and in motivation

(group 1  $\chi^2_{(2)} = 10.571$ ,  $p = 0.005$ ; group 3  $\chi^2_{(2)} = 7.515$ ,  $p = 0.023$ ) between the three measures and no differences were found in groups 2 and 4 (see other values in table 2). In group 1, correctness increased significantly on both day 2 and 3 compared to day 1. Similarly, in group 3, correctness increased significantly on day 2 compared with day 1, and it was nearly significant on day 3 compared with day 1. In group 1, motivation increased significantly on day 2 and 3 compared to day 1. In group 3, motivation increased significantly on day 3 compared to day 1. Otherwise, there were no significant differences. Overall correctness increased from initial 25% to 58.33% on the day 2 and 66.67% on the day 3 and motivation increased from initial 55.55% to 83.33% both on days 2 and 3. Hypothesis 2 is therefore partially rejected.

H3. Hypothesis 3 is confirmed as there is a significant positive correlation between correctness and motivation (Spearman  $\rho = 0.268$ ,  $p < 0.05$ ).

H4. The Kruskal-Wallis test was used to test hypothesis 4. There is a significant difference in correctness depending on the part of the hand at the initial measurement on day 1 ( $\chi^2_{(3,144)} = 53.759$ ,  $p < 0.001$ ) and at the final measurement on day 3 ( $\chi^2_{(3,144)} = 21.199$ ,  $p < 0.001$ ) (table 3). Therefore, the hypothesis is accepted. In the first measurements, the correctness of the left dorsum is significantly smaller than the correctness of the left

**Table 3.** Coverage of hands with hand disinfection gel depending on the hand area in the initial and final measures.

		Coverage Average rank	Kruskal-Wallis test $H_{(df, N), p}$
Day 1	Left palm	90.806	$H_{(3, 144)} = 53.759$ , $p < 0.001$
	Right palm	103.375	
	Left dorsum	55.000	
	Right dorsum	40.819	
Day 3	Left palm	85.722	$H_{(3, 144)} = 21.199$ , $p < 0.001$
	Right palm	89.889	
	Left dorsum	63.347	
	Right dorsum	51.042	

and right palms, and the correctness of the right dorsum is significantly smaller than the correctness of the left and right palms. The results of the final measurement are the same, except that the correctness of the left dorsum and the left palm are not significantly different.

## DISCUSSION

Only 25% of the participants reached the threshold of 95% coverage in initial measurements, suggesting improper hand disinfection technique. Herein obtained result is significant and points to the need for a more serious approach to hand disinfection by healthcare students. Some other studies came to similar results<sup>14–17</sup>. A high failure rate in performance found in the study with clinical staff supports our conclusion<sup>27</sup>. We considered the possibility that the reason is a weaker motivation, which worsens the use of the technique itself. But more than 55% of our participants reported that they were at least moderately motivated to do so. It is possible that motivation in a real hospital setting would be even higher, as would be the correctness, in contrast to the experimental conditions. However, motivation has been found to be weak in hospital environments<sup>26</sup>. Furthermore, Bánsághi et al. (2020) suggest that performance in a real clinical setting should be worse not only because of less attention paid to the protocol of correct hand hygiene technique, but also because the amount of disinfectant used is often insufficient<sup>28</sup>. We found a weak but significant positive correlation between motivation and the correctness, so motivation is not the right explanation for the poor performance, at least not the only reason. Therefore, it is possible that the reason is a lack of knowledge about hand disinfection technique. As these are healthcare students, our result can be considered worrying, considering the importance of hand hygiene for their health, as well as for the health of their patients and others around them. In addition, the research was conducted in the midst of the Covid 19 pandemic, in which health professionals were required to raise awareness of proper and mandatory hand hygiene for disease prevention which also suggests a poor outcome. In our study correctness in-

creased significantly in all groups except for group 4, and motivation increased significantly in groups 1 and 3. This suggests that the type of incentive plays a role. As expected, correctness and motivation increased in group 1, in which the specific incentive included demonstration plus teamwork, active information seeking, poster making, and presentation. Therefore, participants in this group were exposed to several factors, all of which promote learning: active learning, peer learning, repetition, creativity, and having fun<sup>7, 29–32</sup>. There was increase in correctness but not in motivation in group 2. A specific incentive in this group was demonstration plus lecture as the most common form of teaching. Lecture is preferred by students and leads to better learning outcomes compared to problem-based learning, but weaker learning outcomes compared to peer learning<sup>9, 11</sup>. We expected weaker outcomes in group 3 compared to groups 1 and 2 because here the specific incentive involved only demonstration and therefore fewer possible learning styles<sup>33</sup>. But we found increase in the outcomes in this group. It is possible that lecture plus demonstration was equally effective as demonstration alone because the lecture itself was not interactive and therefore less effective per se. Part of the explanation may lie in the fact that our research protocol called for refinement of the demonstration procedure before the experiment within two different demonstrators. As we expected, there was no improvement in results in group 4, which received only the scanner feedback.

Feedback is necessary for learning, but not sufficient. The habit is thought to be much better adopted and retained when a device with feedback is used and the action is repeated, but some research does not confirm this<sup>34, 35</sup>. In our study, all four groups had the same incentives in the form of pictorial, numerical, and verbal feedback from the scanner, and it appears that feedback itself is not sufficient, as there was no increase in group 4, which had only scanner feedback. However, our participants received accurate feedback from the scanner, and because the experiment was conducted in groups, it is possible that motivation was influenced by individual participants' desire to make a good



impression. However, it is also possible that they wanted to compete with themselves, which could indicate the importance of individual feedback for individual motivation<sup>36</sup>. Lhaxhang et al. (2015) found that the self-regulation module, which focused on self-efficacy and planning, was more effective than the motivation module, which focused on the importance of proper hand hygiene and the negative aspects of improper hand hygiene<sup>37</sup>.

Increased scores on day 2 in groups 1, 2, and 3 indicate a learning effect. The fact that correctness and motivation remained the same on day 3 as on day 2 suggests retention of knowledge about the hand disinfection technique, so we can speak of adoption of the habit after 9 days. The information provided in the classroom may lead to a better understanding and appreciation of the need for hand washing during professional practice, and the implementation of regular hand hygiene training early during study is suggested as one of the first steps to improve the quality of patient care by reducing healthcare-associated infections<sup>13</sup>.

The most poorly disinfected part of the hand was the right dorsum, followed by the left dorsum. This may be related to the dominance of the right hand in most people, but in this study, we did not ask participants about their dominant hand, similarly with some other studies where researchers also did not specify hand dominance<sup>17, 27</sup>.

A limitation of this study is the small sample size, and the impossibility of a longer follow-up period due to epidemiological measures in the context of the Covid 19 pandemic.

The results on the effectiveness of combined techniques in hand hygiene education could be useful in interventions to acquire the habit of correct hand disinfection in students and health professionals, during studies and in daily clinical practice.

## CONCLUSION

Feedback or repetition alone is not sufficient to make the correct hand disinfection technique a habit neither to strength motivation. Demonstration, alone or in combination with creative teamwork or with lecture could be however, effective.

Future studies should therefore, examine the effects of individual versus group learning and include control groups that would receive no feedback at all. Also, hand dominance should be controlled. Habit persistence should be checked after more than 9 days. Due to the time frame of the research in Covid 19 pandemic when the importance of hand hygiene was emphasized, post-pandemic comparison is recommended. This research protocol should be tested in real clinical settings as well.

**Conflicts of Interest:** Authors declare no conflicts of interest.

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