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Healthcare workers' hand hygiene knowledge and compliance evaluation, in a Greek university hospital

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Abstract. – OBJECTIVE: Healthcare associated infections affect both patients and employees, in terms of morbidity, mortality, and financial costs. Routine hand hygiene is the most important factor against this pestilence. Hand hygiene knowledge and compliance of healthcare workers are considered poor worldwide. Herein, we aimed to measure knowledge and compliance with hand hygiene of the healthcare workers at a university hospital.

MATERIALS AND METHODS: The "WHO hand hygiene knowledge questionnaire for healthcare workers" was translated in the Greek language, and was validated linguistically, culturally, and psychometrically. Reliability, content, construct, and convergent validity were measured. A survey on hand hygiene knowledge, and compliance, based on this questionnaire, was conducted on 439 employees.

RESULTS: The translated questionnaire presented good reliability, with Guttman's Lambda-6 evaluation (0.7). Content Validity Ratio was 84.6%. Confirmatory and exploratory factor analysis showed moderate construct validity. Convergent validity showed low correlation between the questionnaire items. Regarding the answers received, it was found that only 55.3% of the respondents received formal training on hand hygiene during the last three years prior to the study. Furthermore, 74.0% of them used alcohol-based solutions routinely. Only 54.3% of the participants presented an acceptable level of hand hygiene knowledge.

CONCLUSIONS: The translation and validation of the WHO questionnaire resulted in an acceptable, reliable, and valid instrument. The survey showed that hand hygiene is rather a matter of habit, than of knowledge, and that there is great need of more organized training.

Key Words:
Hand hygiene, Compliance, Knowledge, Healthcare workers, Healthcare acquired infections.

Introduction

Healthcare associated infections are defined as those which occur in healthcare facilities. They are not present, or incubating, at the time of admission. Infections acquired in healthcare facilities, with clinical expression after hospital discharge, and occupational infections among personnel, are also included in this definition[1,2].

They are the most common infectious disease, at least until the recent outbreak of the COVID-19 pandemic, with an estimated annual number of approximately 250,000 deaths in Europe and the United States of America, and a cost of 30 billion dollars[3]. The prevalence of patients with at least one incident of healthcare infection in a recent European survey[2] was estimated in 5.9% (4.4% in primary care hospitals, 7.1% in tertiary care hospitals, and 19.2% in intensive care units). It has been estimated that they affect 90,000 patients per day in European acute care hospitals, resulting in 4.5 million cases each year[2].

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The role of healthcare workers' hands in the dissemination of microorganisms within the healthcare environment is well documented. Hand hygiene is considered as the core procedure for the prevention of healthcare associated infections, and the reduction of their rate, and antimicrobial resistance[4,5]. Furthermore, it is a quite simple and not time-consuming procedure; twenty seconds are considered enough to clean hands with an alcohol-based hand rub[6]. However, adherence rates to hand hygiene among healthcare workers have been considered poor[3]. Lack of time during patient care, inconvenient access to hand rub, fear of skin irritation, and low quality of information and training on why, when, and how to apply routine hand hygiene, have been blamed as causes of negligence[6].

Direct observation of healthcare workers during their routine activity by qualified observers has been considered as the gold standard method to obtain improved compliance[7]. Sophisticated methods and equipment have also been recruited[3,8,9]. Microbiological analysis of smears obtained from hands and garments of hospital personnel has been implemented[10]. Nevertheless, direct observational surveys present limitations, such as time and money cost, discontinuous monitoring, and small sampling availability[3]. The Hawthorne effect, regarding a modified personnel behavior in response to awareness of observation, has occasionally been noticed[11].

Researchers have attempted to evaluate the level of hand hygiene training in various healthcare facilities and medical faculties[12-20]. Herein, we aimed to record knowledge and compliance levels in the University Hospital of Patras in Greece, with the WHO "hand hygiene compliance and knowledge of healthcare workers" questionnaire. The final scope was to trigger reassessment of knowledge and improvement of compliance, aiming to a future reduction of the healthcare associated infections rate.

Materials and Methods

Study Population and Inclusion Criteria

A total of 1,435 healthcare workers were employed at the 800-bed University Hospital of Patras, where the survey was performed, just before the outbreak of the coronavirus SARS-CoV-2 pandemic. We defined as healthcare workers in the study, those with a permanent occupational status. For example, personnel such as part-time nurses or visiting doctors were excluded. The participants were classified into four categories according to their activity: medical doctors, nurses, administrative personnel, and others, i.e., an inclusive term for a heterogeneous group of pharmacists, dentists, laboratory technicians, dieticians, paramedics, midwives, social workers, physio-, ergo- and speech-therapists.

The Questionnaire

The instrument used for the survey was the translated in the Greek language and validated World Health Organization (WHO) hand hygiene questionnaire for healthcare workers[21]. The instrument included 21 main questions. The first 11 (q1-q11) regarded demographic information such as date, age, gender, profession, specialty, and department. Question q12 regarded training during the last three years, and question q13 regarded compliance with the routine use of an alcohol-based solution. The last eight questions (q14-q21 with their subunits, in total 26 items) assessed the level of knowledge on hand hygiene (Table I). An item about the use of neckties was added in q21, in the translated edition. The final version of the questionnaire consisted of 39 items, including all questions with their subunits.

The questionnaire was distributed in person to the participants and was recollected in a sealed anonymous envelope. The ideal sample was estimated to 335 participants, with an error of estimation e=0.35, and confidence interval 95%. As it was not possible to calculate the responsiveness rate accurately, 500 questionnaires were distributed.

Questionnaire Validation

Translation, Linguistic and Cultural Validation

Three bilingual native Greek speakers independently translated the questionnaire from English to Greek. Conceptional definition research meeting resulted in a forward translation. Synthesis, refinement, and backward translation were performed by a bilingual native English-speaking independent contributor. Synthesis by the complete research team ensured equivalence of meaning between the two languages.

This preliminary version was initially distributed to 13 independent employees of random occupations, to assess whether the original content was well culturally adapted. Personal interviews

Table I. Questions q14-q21 on hand hygiene knowledge with their respective correct answers shown in italics (Translated version).

Item	Questions (Correct answers are shown in italics)	n_{co}	per_{co}	n_{in}	n_{nr}
q14	Which of the following is the main route of cross-transmission of potentially harmful germs between patients in a healthcare facility? Tick one answer only. *Answer: Healthcare workers' hands when not cleaned*	339	77.22	98	2
q15	What is the most frequent source of germs responsible for healthcare associated infections? Tick one answer only. *Answer: Germs already present on or within the patient*	67	15.26	371	1
q16	Which of the following hand hygiene actions prevents transmission of germs to the patient?				
q16a	Before touching the patient. *Answer: Yes*	429	97.72	5	5
q16b	Immediately after a risk of body fluid exposure (i.e., blood, urine). *Answer: No*	13	2.96	415	11
q16c	After exposure to the immediate surroundings of a patient (i.e., bed, stool, table, chair, etc.). *Answer: No*	57	12.98	368	14
q16d	Immediately before a clean/aseptic procedure. *Answer: Yes*	386	87.93	40	13
q17	Which of the following hand hygiene actions prevents transmission of germs to the healthcare worker?				
q17a	After touching the patient. *Answer: Yes*	433	98.63	2	4
q17b	Immediately after a risk of body fluid exposure. *Answer: Yes*	424	96.58	5	10
q17c	Immediately before a clean/aseptic procedure. *Answer: No*	84	19.13	337	18
q17d	After exposure to the immediate surroundings of a patient (i.e., bed, stool, table, chair, etc.). *Answer: Yes*	401	91.34	28	10
q18	Which of the following statements on alcohol-based handrub and handwashing with soap and water are true?				
q18a	Handrubbing is more rapid for hand cleansing than handwashing. *Answer: True*	247	56.26	174	18
q18b	Handrubbing causes skin dryness more than handwashing. *Answer: False*	182	41.46	240	17
q18c	Handrubbing is more effective against germs than handwashing. *Answer: True*	132	30.07	288	19
q18d	Handwashing and handrubbing are recommended to be performed in sequence. Answer: *False*	56	12.76	381	2
q19	What is the minimal time needed for alcohol-based handrub? *Answer: 20 seconds*	177	40.32	251	11
q20	Which type of hand hygiene method is required in the following situations?				
q20a	Before palpation of the abdomen. *Answer: Antiseptic use*	214	48.75	221	4
q20b	Before giving an injection. *Answer: Antiseptic use*	265	60.36	164	10
q20c	After emptying a bedpan. *Answer: Antiseptic use*	66	15.03	365	8
q20d	After removing examination gloves. *Answer: Antiseptic use*	73	16.63	361	5
q20e	After making a patient's bed. *Answer: Antiseptic use*	162	36.90	270	7
q20f	After visible exposure to blood. *Answer: Washing*	183	41.69	254	2
q21	Which of the following should be avoided, as associated with increased likelihood of colonization of hands with harmful germs?				
q21a	Wearing jewelry. *Answer: Yes*	397	90.43	40	2
q21b	Damaged skin. *Answer: Yes*	413	94.08	20	6
q21c	Artificial fingernails. *Answer: Yes*	407	92.71	25	7

Abbreviations: n_{co}: correct responses, per_{co}: percentage (%) of correct responses, n_{in}: incorrect responses, n_{nr}: non-responded.

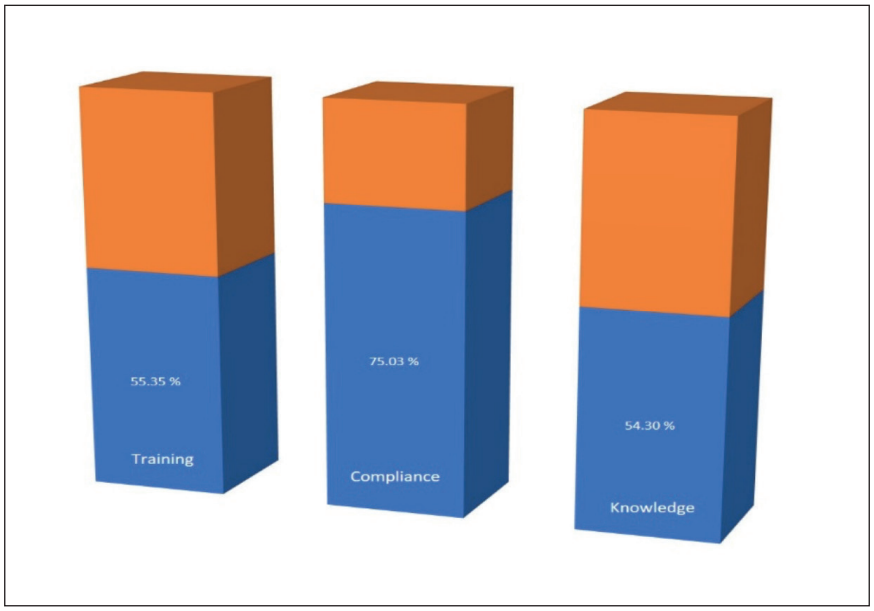

Figure 1. Outcomes of training (left), compliance (middle), and knowledge (right) regarding hand hygiene in the sample population of the participants in the survey.

were also performed. Based on this cognitive debriefing, some questions underwent adjustment. The time consumed to complete the task of the instrument was estimated to 4-5 minutes. The final version was distributed to 65 participants for an ultimate pilot survey.

Psychometric Validation

For the psychometric validation of the questionnaire, the properties measured were reliability, content, structural, and convergent validity:

Reliability

Cronbach's alpha (Cronbach's α) was used to measure internal consistency. As Cronbach's α is sample-dependent, Guttman's Lambda 6 (L6) limit of reliability was also measured, because the correlations between the items of the sample were small.

Content validity

Content validity was evaluated during the process of translation into the Greek language, and the linguistic and cultural validation. To obtain quantification of this parameter, we used the content validity ratio, which correlated the number of the participants of the pilot study to the number of those needed to consider the instrument valuable.

Construct validity

Construct validity was measured with factor analysis. Confirmatory factor analysis evaluated if the size of the instrument was sufficient to explain the interdependences between the 26 items, regarding the knowledge of the participants. Exploratory factor analysis was used to measure the dimensions required to explain the variability of the answers. The reliability evaluation of factor analysis was performed with the root mean square error of approximation.

Convergent validity

Convergent validity was measured with Pearson's correlation coefficient (r_p).

Statistical Analysis

Standard descriptive statistics were used to describe the variables of the questionnaire outcomes. Chi square and Fisher's exact tests were used for categorical data. Analysis was performed with the R-Project for Statistical Computing, Version 3.3.0., Vienna, Austria. The threshold for statistical significance was defined as $p < 0.05$.

Results

We obtained 439 fulfilled questionnaires from 121 male (27.5%), and 317 female (72.5%) participants (age range 25-65 years, mean 44.9, standard deviation 7.7 years). The participants were medical doctors (n= 122, 27.79%), nurses (n= 253, 57.63%), administration personnel (n=49, 11.16%), and other specialties (n=15, 3.42%).

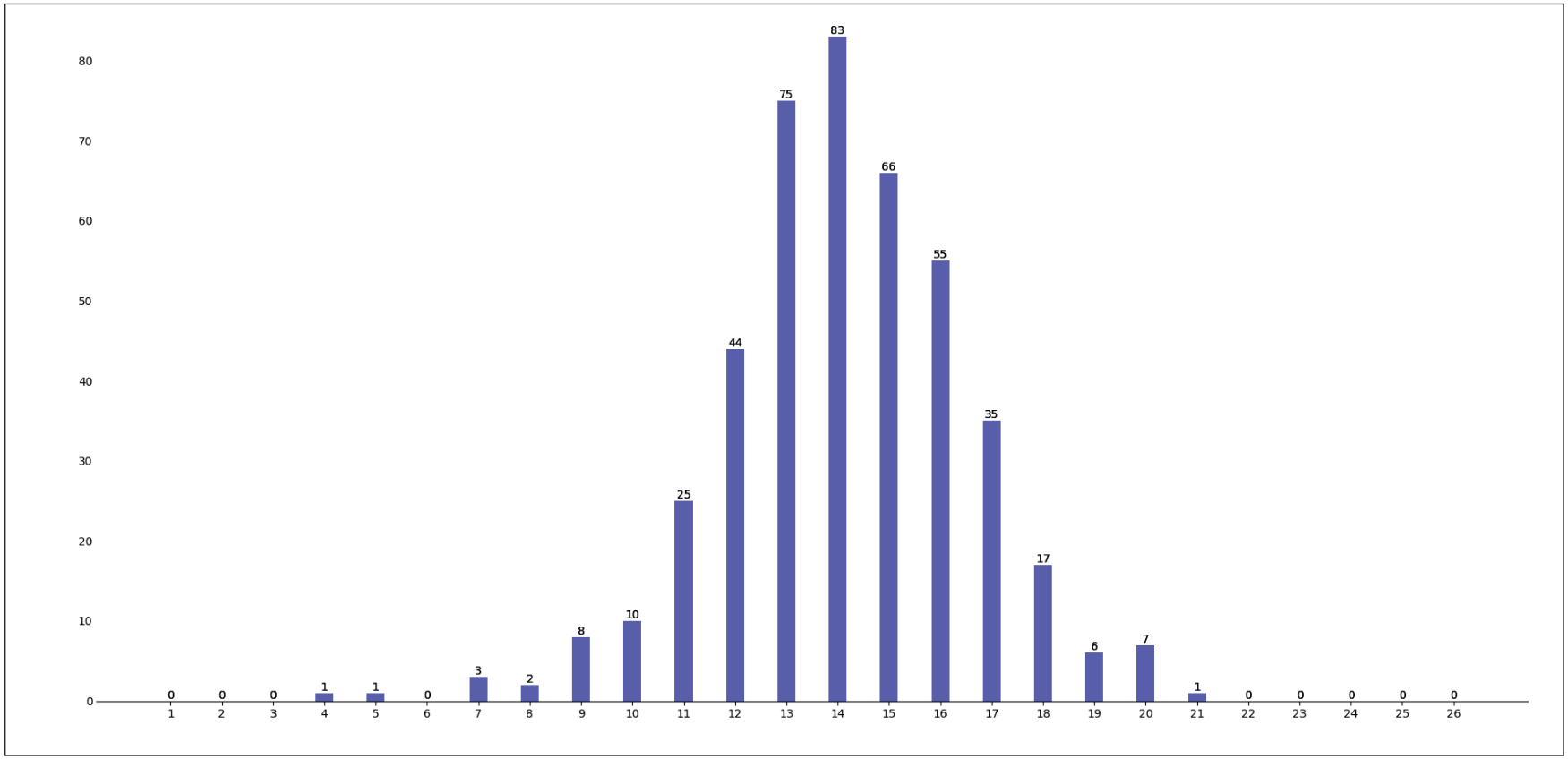

Figure 2. Correct responses for questions q14-q21 (26 items) for each participant. The columns correspond to the numbers of participants who correctly responded to each corresponding question.

Approximately half (n=243, 55.35%) of the participants had received formal training in hand hygiene, during the last three years prior to the conduction of the survey. A total of 325 participants (74.03%) showed compliance with the use of alcohol-based solutions for hand hygiene routinely. The level of knowledge about the most common source of hospital infections was poor, with a 15.26% rate of correct responses (Figure 1). Compliance and knowledge levels of the study population presented statistical significance ($p<0.001$), compared to each other.

There were no significant differences between correct responses from participants of different gender, age, activity, or departments. Age groups of 35-40 and 60-65 years presented a higher mean value of correct responses. The first peak (35-40 years) is probably compatible with the more recent training. The second peak (60-65 years) is probably in accordance with the acquired experience.

The responses to the 26 items of the questions q14-q21 are shown in detail in Table I. Each item's correct response was rated with one point, with a maximum total obtainable score of 26. The score of correct responses in this section for each participant, resulted in a mean of 54.30% (range: 4-21 correct responses per participant, median: 14) (Figure 2).

The score means of correct answers to q14-q21 according to gender were equal (males 14.0, females 14.10). According to occupation, the scores did not present noteworthy variations (physicians 14.2, nurses 14.10, administrative 13.60, other 14.60). According to department, the top three higher scores were found in health-visitors (18.50), orofacial surgery (17.00), infectious diseases unit (16.00), while the top three lower, in the pharmacy (10.33), nursing administration (11.00), and neurological clinic (11.50).

Questionnaire psychometric validation outcome

Reliability

Cronbach's alpha value was 0.5, according to the hypothesis of one factor model. This outcome indicated a poor internal consistency. However, the value of the Guttman's Lambda 6 (L6) was 0.7, rendering the questionnaire reliable.

Validity

Content validity

During the evaluation of content validity of the instrument, with the pilot interview procedure, the content validity ratio was estimated at 84.6%.

Construct validity

The Kaiser-Meyer-Olkin testing for sampling adequacy for the 34 items was 0.6, a result regarded as acceptable. Shapiro-Wilk test and Q-Q plots, for a statistically significant p-value $p<0.05$ for each of the 34 items, and for the total score as well, rejected the null hypothesis that the sample originated from a population with a normal distribution. Correlation between the 34 variables was found small for most items.

The statistically significant factors were 16, indicating a multidimensional questionnaire. The same outcome was obtained with p-value testing in a significance level $\alpha=0.05$. For the data of the 16 factors, the root mean square error of approximation was calculated to be 0.1. Scree plot graphic analysis was performed. It showed that at least 11 factors were required for this task.

Convergent validity

Pearson's correlation coefficient r_p for the items q12-q14 showed that some measures did not present statistically significant results. Correlation values were smaller than ±0.4 in the significant results. The outcome was weak correlation, therefore low convergent validity.

Discussion

A survey with the "WHO hand hygiene knowledge questionnaire for healthcare workers" was performed for the evaluation of hand hygiene compliance and knowledge. The participants showed willingness to fulfill the questionnaire. They also reported that they considered it valuable for their self-evaluation and improvement. The results of the survey showed that while approximately half of them had received formal training on hand hygiene, it was about three quarters of them who routinely used an alcohol solution for hand hygiene. This outcome revealed difference between training and practice. Regarding the evaluation of knowledge, the mean of correct responses per participant was approximately higher than half of them.

Studies which used questionnaires for the evaluation of hand hygiene of healthcare workers present a rather heterogeneous group[12-20,22-25]. Inclusion of different types of institutions (i.e., general hospitals, hospital departments, intensive

care units, pediatric hospitals, neonatal intensive care units, academic institutions, or groups of community hospitals) resulted in variability of study populations. However, there are certain issues to be noted, as they were common on all occasions: i. a better attitude of nurses compared to doctors, both in knowledge and compliance of hand hygiene, ii. healthcare workers who recently attended courses on prevention of infection performed better, and iii. experience seemed to play a role in compliance with guidelines. Most studies reported about 60-90% levels of hand hygiene knowledge and compliance[12-15,17-19,22,25]. We would classify our performance among those with lower knowledge scores, and with a moderate level of compliance[16,23,24]. Incidence of healthcare associated infections was found lower (average prevalence 2.9%) compared to other institutions of the region, and to the respective total value (9.3%) of the country[26]. A possible explanation for the difference between compliance and knowledge observed in our study population, could be the routine overuse of antiseptic solutions independently from training. The common use of alcohol-based solutions was rather habitual. Nevertheless, increased hand hygiene training should be a priority.

We have currently experienced the outbreak of the recent coronavirus pandemic with a great impact in our way of life. It definitively affected hand hygiene routine, as this practice has been included in the main measures for the virus transmission. Healthcare workers are intensively advised to follow local policies and keep up to date with best practice guidelines. They are encouraged to access warm water for washing hands using soap, or alternatively use alcohol-based hand gel[27]. Concerns have been aroused as nurses were reported to focus on intensive clinical activities forgetting to decontaminate their hands[27]. Furthermore, skin damage after continuous hand cleansing has been incriminated as a possible route of entry for the virus, setting the need of more specific skincare measures after handwashing[28].

Limitations

The study presented limitations: it involved personnel during working hours, under different circumstances in terms of availability and time constraints. The completion of the questionnaire by each person also introduced a self-report bias. Furthermore, comparing the results of the study with those from analogous research is biased, as data in literature present variability in study populations, institutional specialization, and methodology. Finally, as the coronavirus pandemic changed hand hygiene habits in a cataclysmic manner, we believe that the results of our survey, which was conducted just before the pandemic outbreak, would today be quite different, at least regarding compliance.

Conclusions

The knowledge of health professionals regarding hand hygiene is considered insufficient. The difference between compliance and knowledge showed that hand hygiene was performed rather as routine than as documented practice.

Ignaz Philip Semmelweis (1818-1865), whose contribution was a milestone in the war against infection, especially in the field of hand hygiene, faced rejection from his contemporary peers and resulted in insane asylum detention[29]. In a way, the community of healthcare workers is "guilty" of his destiny. As hand hygiene is still an underestimated practice in terms of compliance and knowledge worldwide, though coronavirus someway affected this recently, an allegorical liberation of Semmelweis from the asylum of ignorance and negligence would be redemptive.

It is important to emphasize the importance of undergraduate education of health professionals and the continuous training of workers in health care facilities. Increased hand hygiene training should become a priority in healthcare institutions. To achieve this, enhanced frequency of periodical educational courses within the healthcare institutions, combined with increased and sophisticated monitoring of compliance is essential. We presume that the coronavirus pandemic, which aggressively changes every single day our habits, might be an optimal opportunity.

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Conflict of Interest

The authors declare that they have no conflict of interests.

Informed Consent

The participants did not provide informed consent. They provided information within a sealed anonymous envelope.

Ethics Approval

The study protocol was approved by the Bioethics Committee of the institution where the survey was performed

(71.041516 Bioethics Committee decision). Approval by the WHO was obtained for the translation of the hand hygiene knowledge questionnaire for healthcare workers in the Greek language (178089 questionnaire translation). The planning conduct and reporting of human research are in accordance with the Declaration of Helsinki.

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