Predictors of Growth of *Escherichia Coli* on Lab Coats as Part of Hospital-Acquired Infection Transmission Through Healthcare Personnel Attire

Audai A. Hayajneh (✉ aahayajneh@just.edu.jo)
Jordan University of Science and Technology  https://orcid.org/0000-0002-8141-3530

Ziad W. Jaradat
Jordan University of Science and Technology

Eman S. Al-Satari
Jordan University of Science and Technology

Mohamad H. Abloom
Jordan University of Science and Technology

Research article

Keywords: Predictors, Bacterial Contamination, Lab Coats, Hospital-Acquired Infection, Healthcare Personnel Attire, Nurses

Posted Date: October 16th, 2020

DOI: https://doi.org/10.21203/rs.3.rs-52826/v1

License: ☑️  This work is licensed under a Creative Commons Attribution 4.0 International License. Read Full License

Version of Record: A version of this preprint was published at International Journal of Clinical Practice on September 16th, 2021. See the published version at https://doi.org/10.1111/ijcp.14815.
Abstract

**Background**: Healthcare personnel (HCP) attire could be potential vehicles for microbial transmission. This study aimed to explore the extent of bacterial contamination and hygiene and handling practices of healthcare personnel attire that could influence bacterial growth.

**Methods**: Descriptive, cross-sectional study was used in this study. Convenience sampling of the 188 healthcare personnel was recruited from a main holistic hospital in the northern part of Jordan. Three swab samples were collected from three different parts of lab coats used by each participant. ANOVA test and the generalized mixed linear model were used for the categorical variables of three or more levels and identify the predictors of positive growth of Escherichia Coli on healthcare personnel attire.

**Results**: *Enterococcus faecalis* was the most common species of bacteria found on lab coat. Despite of no statistically significant differences were found, the HCP attire coming from the critical care units and the emergency department were highlighted with slightly higher contamination compared to other departments. *Escherichia coli* ’s near-significant growth differences (p=0.057) were found based on different locations on lab coats compared to other types of bacteria. Factors associated with significant growth of *Escherichia coli* on healthcare personnel attire were age ≥36 years, a high income, bachelor marital status, working as a physician, lab coat use preferred over scrubs, and borrowing of lab coats.

**Conclusion**: Healthcare personnel should be cautious about the method of use and storage of lab coats they wear.

**Background**

Healthcare-associated infection, also known as nosocomial infection, is a major challenge in healthcare systems particularly in intensive care units and for patients and families visiting hospitals.\(^1\) Intensive care units have immunocompromised patients who are at higher risk of getting infected with opportunistic pathogens present in hospitals.\(^2\) The World Health Organization (WHO) defines healthcare-associated infection as the infection that usually becomes evident after 48 h of patient admission to a hospital; the infection is not present at the time of the admission or immediately after discharge.\(^3\) Healthcare-associated infection cause increased morbidity, mortality, and healthcare burden.\(^4,5\) It is estimated that 7 and 10% of hospitalized patients in developed and developing countries, respectively, will acquire at least one healthcare-associated infection at any given time.\(^6\)

Clinical settings, mainly hospitals, are environments where patients are at high risk of getting infections from healthcare personnel. Of these settings, intensive care units are highly susceptible to nosocomial pathogens due to poor sanitation,\(^7,8\) invasive monitoring procedures, and immunocompromised patients.\(^9\) Therefore, intensive care units should be sterile and free of microorganisms as much as possible; those transported by healthcare personnel predisposes patients to healthcare-associated infection.
Recent evidence indicate that healthcare personnel’s hands are the main vehicle and source of cross-contamination to patients.\textsuperscript{5,10} However, the transmission of microbes from healthcare personnel and clinical devices to patients has also been reported.\textsuperscript{11,12} These infections could be transmitted to hospitalized patients through textiles, such as lab coats, and mobile and medical devices used by healthcare personnel. Evidence supporting this hypothesis has never been reported in Jordan.

White coats have a long traditional history of being a symbol of hope, healing, and identification for medical professionals. However, there has been a concern that white coats may play a potential role in the transmission of pathogenic microorganisms within and outside hospital settings.\textsuperscript{13,14} The material used in lab coats plays a salient role in microbial adhesion, in which fabric blended with cotton is more likely to catch microbes more than fabric made completely from polyester.\textsuperscript{15} Healthcare personnel, such as nurses and doctors, who wear white coats over their uniforms are at a higher risk for transmitting microbes through lab coats to their patients.

After admission to a hospital, a condition known as dysbiosis, which is the loss of “health-promoting” bacteria in human body, makes the body vulnerable to any pathogens in the hospital environment, especially to nosocomial infections.\textsuperscript{16} The most common among dangerous bacteria that are transmitted and cause severe illnesses and deaths in hospitalized patients, are clustered in what is known as the ESKAPE group (\textit{Enterococcus faecium}, \textit{Staphylococcus aureus}, \textit{Klebsiella pneumoniae}, \textit{Acinetobacter baumannii}, \textit{Pseudomonas aeruginosa}, and \textit{Enterobacter} species). The hazard of this group is due to their multidrug resistance.\textsuperscript{17} The species in the ESKAPE group that were found to be transmitted through lab coats include a methicillin-resistant \textit{Staphylococcus} spp., \textit{Pseudomonas} spp., \textit{Klebsiella} spp., \textit{Escherichia coli} (\textit{E. coli}), and vancomycin-resistant \textit{Enterococci} spp.\textsuperscript{15}

The prolonged use of a lab coat and the greater number of coats used by a healthcare personnel are associated with higher number of isolates on the sleeve of the coat compared to other parts.\textsuperscript{18} The white coat used by Jordanian healthcare personnel has long sleeves and two pockets at waist level, reaches the mid-thigh, and is made from a blend of polyester and cotton fabrics.

The hand hygiene of healthcare personnel plays an important role in microbial transmission. Touching items during or after the physical examination of patients without hand washing can act as a vehicle for the transmission of healthcare-associated infection to patients and objects.\textsuperscript{19} Therefore, the aim of this study was to identify, describe, and explore the extent of bacterial contamination and the species of bacteria, particularly \textit{Escherichia coli} (\textit{E. coli}), on healthcare personnel attire. It also aimed to identify the hand hygiene practices of healthcare personnel that might reduce and control bacterial growth.

\section*{Methods}

\subsection*{Design and setting}
A descriptive, cross-sectional design was used in the current study. Cross-sectional study is useful to assess and describe the health status of communities\textsuperscript{20} in a relatively short period during data collection and less cost. Convenience sampling of 188 healthcare personnel, including physicians, nurses, and allied health (medicine, nursing and pharmacy) students, was used in our study. The current study was conducted in one of the main hospitals located in the northern part of Jordan.

**Data and Sample Collection**

Approval (Rf#20180170) from Jordan University of Science and Technology (JUST) was obtained to conduct this study. Each participant completed an anonymous, self-administered, and structured research questionnaire (socio-demographic data). Three swab samples were collected from three different locations (collar, mid-sleeve, and waist) on the lab coat or scrub used by the participants. Three milliliters of phosphate buffered saline was added to sterile cotton swabs before sample collection. An area of 10 by 10 cm of each three locations of the lab coat or scrub was swabbed. Then, the swabs were examined.

**Total Plate Count and Sample Storage**

Each swab sample was vortexed in a solution for 10 sec to release the bacteria into the solution. Serial dilution was performed and 100 µl from two dilutions were inoculated onto two nutrient agar plates to estimate the colony forming units for each sample. Colonies were counted after overnight incubation at 37°C. For stock keeping, 5 ml Tryptone soya broth (Oxoid, UK: CM0129) was added to each swab and incubated at 37°C for 48 h, followed by mixing 1 ml of the culture with 666 µl of 50% glycerol and storage at -80°C. Colonies were cultured on four different differential media to identify major bacterial pathogens as follows: *Staphylococcus aureus* was grown on Baird-Parker agar; *Klebsiella pneumoniae* and *Escherichia coli* were grown on MacConkey agar; *Pseudomonas aeruginosa* was grown on cetrimide agar; and *Enterococcus faecalis* was grown on bile esculin agar.

**Statistical Analysis**

The mean and standard deviation were used to describe continuous variables, whereas the frequencies and percentages were used for categorical variables. The multiple response analysis was used to describe the prevalence of the grown species across the three different lab coat locations (collar, mid-sleeve and waist), accounting for the dependency between those measured bacterial species. Cochran's Q chi-squared test was used to assess the correlation between the growth of specific bacterial species across the locations, assuming that the three locations were repeated-measures for the same participant. The factor analysis for categorical variables was used to assess age, marital state, monthly income, number of family members that the healthcare personnel live with, and specialization. ANOVA test was used for the categorical variables of three or more levels. The generalized mixed linear model was used to identify the predictors of bacterial growth on healthcare personnel attire.

**Results**
One hundred eighty-eight healthcare personnel and allied health students participated in the current study. The mean age of the participants was 28.10 (SD = 5.67) y, ranging from 19 to 43 y old. The distribution of the age groups of healthcare personnel was as follows: 52.7% were aged between 19 and 27 y; 37.2%, between 28 and 35 y, and 10.1%, between 36 and 43 y. More than half of the participants were women (57.4%). In addition, about 53.2% of the participants were never married. Of the participants, allied health students accounted for 31.4%; nurses, 36.7%; and physicians, 31.9%. The department-wise distribution of participants was as follows: surgical floors, 21.8%; medical floors, 33.5%; critical care units, 17.6%; outpatient clinics and auxiliary departments, 12.8%; and emergency department, 14.4% (Table 1).

With respect to clinical experience, 29.8% of participants had less than 1 y experience; 29.8%, between 2 and 5 y; and 40.4%, >5 y. As for economic status, 31.4% of the participants had household monthly income of less than 400 JOD. The mean household size or number of family members was 4.15 (SD = 2.3) members. Majority of the participants lived with their spouses and children (28.7%).

Table 2 displays the handling behaviors and the hygiene and washing practices of uniforms or lab coats used by the healthcare personnel. Around half (50.5%) of the personnel preferred to wear white lab coats over scrubs for their daily work. The average number of uniforms or lab coats owned by the healthcare personnel was 2.1 (SD = 0.82). The mean number of washing times of healthcare personnel attire per month was 7.42 (SD = 6.86). Most of the participants (55.3%) washed their uniforms between 1 and 4 times per month and 41.5% of the participants washed their uniforms or lab coats once every three days. Of the participants, 29.8% owned only one uniform or lab coat. The majority of the participants (53.2%) kept their uniforms or lab coats inside hospital lockers, whereas 46.8% kept theirs at home.

Around half (54.3%) of the participants owned the same uniform or lab coat for less than 1 y, while 45.7% owned theirs for more than 1 y. Only 13.3% of the healthcare personnel borrowed their uniforms or lab coats from their work peers; 36.7% were assigned or had contact to ten patients or fewer every day; 27.7% had contact to 10 to 15 patients every day; and most of the participants (35.6%) had contact to or cared for more than 15 patients every day. The majority (83%) mentioned that they wear uniforms or lab coats to comply with professional attire or dress code. In addition, 96.3% of the participants agreed that uniforms and white lab coats can be potential vehicles of pathogens to their patients (Table. 2).

Table 3 displays the bacterial growth findings yielded from screening healthcare personnel attire using surveillance swabs of three locations of each attire. Regardless of the location, presumptive growth types of bacteria were as follows: 77.7% of the healthcare personnel attire had *E. faecalis*; 31.2%, *S. aureus*; 28%, *E. coli*; and 5.1%, *P. aeruginosa*. The mean of number of colony forming units in the inoculated petri dishes was 9.81 (SD = 4.46). Pertaining to certain locations on healthcare personnel attire, the distribution of positive bacterial growth was as follows: the collar had mean colony forming units 3.22 (SD = 1.69), mid-sleeve had 3.32 colony forming units (SD = 1.879), and waist had 3.27 colony forming units (SD = 1.88) (Figure 1).

The proportions of the species of bacteria across three different locations of healthcare personnel attire were compared using the Cochran’s Q chi-squared test for significant differences. The analysis findings
showed that none of the four species (*Enterococcus faecalis* \(p = 0.224\), *Staphylococcus aureus* \(p = 0.711\), *Escherichia coli* \(p = 0.057\) and *Pseudomonas aeruginosa* \(p = 0.197\)) differed significantly between the collar, mid-sleeve, and waist (Table 4).

Moreover, the one-way ANOVA revealed no statistically significant mean differences in the number of recovered organism CFU across healthcare workers from various hospital units \(p=0.080\). However, the HCP attire from critical care units and emergency rooms showed a slightly higher mean recovered CFU (Figure 2).

The generalized mixed linear model (Table 5) showed that the attire of healthcare personnel aged between 28 and 35 y exhibited significantly lower mean colony forming units compared to those of personnel aged \(\geq 36\) y \(p = 0.021\). The same model revealed that attire worn by male healthcare personnel exhibited significantly lower mean colony forming units compared to those worn by female personnel, accounting for other predictors in the analysis \(\beta = -0.112, p = 0.007\). The participants with household monthly income less than 400 JOD exhibited significantly lower mean colony forming units compared to those with monthly income more than 800 JOD \(p = 0.011\), accounting for the other predictors. Allied health students’ attire exhibited significantly lower mean colony forming units compared to physicians \(p < 0.001\). The attire of healthcare personnel who work in critical care units, showed significantly higher mean colony forming units than the attire of those who work in the emergency department \(\beta = 0.283, p < 0.001\), accounting for other predictors in the model.

The same analysis model revealed that healthcare personnel who live alone measured significantly higher mean attire colony forming units compared to those who live in shared residence \(\beta = 0.225, p < 0.001\). Healthcare personnel living with spouse, children, and parents showed significantly greater mean attire colony forming units compared to those living with friends/others \(\beta = 0.119, p = 0.020\). The healthcare personnel who used white coats exhibited significantly lower mean attire colony forming units compared to Scrubs \(\beta = -0.124, p = 0.014\). The attire of healthcare personnel who owned only one uniform had significantly lower mean attire colony forming units compared to those of personnel who owned three uniforms \(\beta = -0.174, p < 0.001\).

In addition, the analysis model showed that the personnel who did not borrow their uniforms from their peers exhibited slightly lower mean attire colony forming units compared to those who borrowed their uniforms from other work peer \(\beta = -0.092, p = 0.068\). The attire of personnel who prefer to carry their uniforms covered by anything other than bag had significantly higher mean attire colony forming units than those of personnel who carry their uniforms by hand without cover \(\beta = 0.121, p = 0.006\). Moreover, the attire of personnel who carried their uniforms in a bag exhibited significantly lower mean attire colony forming units compared to those of personnel who carried their uniforms by hand and without cover or bag \(\beta = -0.100, p = 0.022\).

Because of the nearly significant growth differences of *Escherichia coli* \(p=0.057\) at different locations on lab coats from other types of bacteria (Table 4), we performed a bivariate analysis for the occurrence of
*Escherichia coli* in association with the HCPs' sociodemographic, professional, and attire hygiene practice levels (Table 6).

In the chi-square test, positive *E. coli* growth on HCP attire was associated with the female sex (p=0.032; Table 6) and old age (mean: 29.10 ± 4.35 vs. 27.92 ± 5.82 years; p=0.046). Furthermore, in the chi-square test for analysing the association of the likelihood of positive *E. coli* growth across HCWs of different age groups, those aged between 28 and 38 years showed significantly more growth of *E. coli* (p=0.035) compared to HCWs of other age groups.

The marital state of HCP did not correlate significantly with their likelihood of having positive *E. coli* growth on their attire (p=0.066; Table 6). However, the ever-married people were slightly more inclined to have positive *E. coli* growths on their attire. The chi-square test showed that students were significantly less likely to have positive *E. coli* growth compared to nurses and physicians (p<0.001). Interestingly, the HCP working in critical care had significantly less positive *E. coli* growth on their attire compared to those working in other departments (p=0.002). HCP working in surgical floors showed less positive *E. coli* growths, but those working in the emergency room or treating outpatients showed more positive *E. coli* growth on their attire.

In Figure 3, the odds of having *E. coli* growth on the attire has been depicted on the y-axis, and HCPs' working/training area has been depicted on the y-axis. It is clear that people working in emergency rooms and outpatient areas are the most susceptible, followed by those in medical and surgical floors and then those in critical care.

Moreover, the duration of experience of HCP correlated significantly with the probability of having positive *E. coli* growth on their attire (p=0.022). The chi-squared test showed that those with an experience of 2 to 5 years were more likely to have *E. coli* growth on their attire. The monthly income of HCP's households correlated significantly with their likelihood of having *E. coli* growth on their attire (p<0.001). People with an income of 600–800 JOD were significantly more inclined to have positive *E. coli* growth swabs (p<0.001) than the other HCP with different monthly income levels of the households. Nonetheless, a standardized socioeconomic index score was computed using the factor analysis procedure comprising the HCP's income, age, marital status, and living conditions. The mean socioeconomic index score differed significantly between people with and without *E. coli* growth on their attire. Those who had the growth showed a higher socioeconomic index score compared to those who did not (p=0.004; Table 6).

Moreover, HCP with family size of 4 to 6 members were significantly more likely to have *E. coli* growth on their hospital attire (p=0.012), according to the chi-squared test. However, the analysis results suggested that the residence type of HCP did not correlate significantly with their probability of positive *E. coli* growth on their hospital attire (p=0.406). HCP living in houses shared with their spouse, kids, and parents were slightly more likely to have positive *E. coli* samples on their hospital attires (Table 6).

Table 6 shows the bivariate analysis results for the association between HCP's attire characteristics and hygienic practices with the likelihood of having *E. coli*-positive samples on various attire sites. The
analysis outcomes suggested that the HCP using various types of uniforms did not differ with respect to their attire growing *E. coli* (p=0.550). Moreover, their rate of washing the attire did not correlate significantly with their likelihood of having positive *E. coli* samples on their attire sites (p=0.957). Furthermore, HCP’s hygiene and attire characteristics and practices (namely the number of lab coats, washing frequency of lab coats, age of lab coats, borrowing lab coats from other workers, reasons of wearing lab coats, and the way they handle them besides the laundry service used for their attire) correlated with their likelihood of having *E. coli* samples on their attire (p>0.050 each). However, the chi-squared test suggested that the HCP who store their attire in the hospital were significantly more inclined to show positive *E. coli* samples on various attire sites compared to those who stored their attire at home (p=0.002). Moreover, the analysis suggested that HCP who cared for 10 to 15 patients per day were significantly more likely to have positive *E. coli* samples compared to other HCP who deliver care to <10 patients per day or those who care for >15 patients per day (p<0.001). Storing the lab coat at the hospital correlated significantly with a higher incidence of positive *E. coli* samples on the attire (p=0.039). Likewise, the HCP who wore their uniforms outside hospital settings were found to be significantly more likely to have positive *E. coli* samples on their attire (p=0.005). Those who disagreed with the ability of hospital attire to transmit pathogens were slightly more likely to have positive *E. coli* samples on their attire (p=0.081), according to the chi-squared test of independence.

**Discussion**

In our study, *Enterococcus faecalis* was the most common species of bacteria found on healthcare personnel attire. Notwithstanding, *Enterococcus* usually does not cause health problems in healthy people, unless it has spread to other areas of the body which might cause life-threatening infections, such as endocarditis, sepsis, urinary tract infections (UTIs), and meningitis. *E. faecalis* is found in a wide variety of environments, including soil, water, and human and animal gastrointestinal tract. In our study, the source of *E. faecalis* contamination in healthcare personnel attire might be due to poor hospital surface disinfection, personal hygiene, or both. Moreover, *E. faecalis* is able to survive on dry surfaces for nearly a week to four months, depending on the strain as stated by Wendt and colleagues. Whereas, *Staphylococcus aureus* was the most common contamination agent on lab coats in studies conducted in Moshi, Tanzania and Mansoura, Egypt, which contradict the results obtained in the current study. In our study, the presence of *E. coli* varied based on the location on the lab coat. In the literature, it has been associated with numerous diseases, such as inflammatory bowel disease, Crohn’s disease, UTIs, and pediatric acute diarrhea.

In the current study, the distribution of bacterial growth was highest on the mid-sleeve area healthcare personnel attire, in which mid-sleeves are close to the sides of uniforms. This is in concordance with what was found in the study conducted by Banu and colleagues. They reported that the sides of the coats were the most highly contaminated areas compared to the collar and pockets. The mid-sleeves might be contaminated when resting arms on nurse stations or reception desks while documenting activities. Mid-
sleeve areas are the prominent parts of the body that might touch surrounding environment while moving and ambulating. *E. coli* was found to be the highest in the collar area of the lab coat in the current study. This might be due to transmission from the perineal area to the collar because of a bad washing habit and changing of lab coats in bathrooms.

To the best of our knowledge, the current study only reveals the correlation between the age of healthcare personnel and the bacterial contamination on their attire. This study indicated that healthcare personnel aged ≥ 36 y had higher bacterial contamination in their attire compared to those in other age groups. Younger healthcare personnel possibly tend to change and clean their attire more frequently. In contrast, *E. coli* was found to be the highest in the attire of HCP aged between 28 and 36 years, which might be due to the frequent use of bathrooms among younger HCWs.

The attire of female healthcare personnel had higher bacterial contamination than those of male personnel, which is different from what was reported by Akanbi and colleagues. Their study revealed that lab coats of male resident doctors were more contaminated compared to female resident doctors. The justification of the results in our study is that most of allied health students, including female allied health students, have only one place, which is bathrooms, to change their dresses due to the lack of specialized dressing rooms. This was supported by what was observed during the data collection stage as reported by Dir and colleagues. In their study, they observed that many people attended the bathroom while wearing their lab coats. Similarly, female HCP attires were highly contaminated with *E. coli* compared to their male counterparts in this study. UTIs caused by *E. coli* is more common in women, which raises concerns about female HCP being prone to UTI from their attires.

Allied health students’ uniforms, in our study, had lower contamination compared to those of physicians, which could be due to the higher adherence to university official code of tidy and clean lab coats/scrubs by the students than by the physicians. This result might be unanticipated compared to what was reported by Muhadi and colleagues, who demonstrated higher contamination in allied health students’ attire and that allied health students use lab coats outside the hospital premises, resulting in the higher contamination levels of their lab coats, particularly *E. coli* growth on nurses’ attires and those working on medical floors. The type of HCP working department in our study also showed a significant role in causing higher contamination of the attire among HCP working in critical care units compared to the emergency department. In concordance with the role of the department in bacterial contamination, the surgery department was found to predispose its HCP to the highest degree of contamination, as reported by Akanbi and colleagues.

In the current study, white lab coats were more contaminated compared to scrubs, which in turn, raised questions about the importance of wearing white lab coats in settings where patients received healthcare. This was also recommended by Qaday and colleagues, in which lab coats should not be recommended to use anymore. Although Banu and colleagues reported that the possession of two or more white lab coats reduced contamination compared to the possession of only one, our study results showed the opposite—that those who possess two lab coats were more contaminated. This might be due to failure to
keep track of which lab coat needs to be cleaning. This result could be also justified that HCP might clean their only one lab coat frequently compared to who possess several lab coats. Hygienic practices of lab coats/scrubs might be considered more important than the number of uniforms that HCP possess in terms of bacterial contamination on uniforms.

Borrowed lab coats/scrubs from others in the current study had high contamination, which necessitates the compulsory policy of possession at least two coat/scrub for each HCP as well as yearly purchase of lab coats/scrubs and banning the borrowing lab coats from each other as this item is strictly personal.\textsuperscript{34} In addition, due to the borrowing of these attire, the owners of lab coats/scrubs cannot keep track of where these labs coats were used and when they should be washed. Despite the recommendation that lab coats/scrubs should be stored within hospital premises\textsuperscript{35} and washed regularly because of continuous bacterial contaminations within a few hours of usage, the current study revealed that \textit{E. coli} grew on attires stored in hospital lockers more than those sored at homes. A washing facility on the hospital premises is a must to keep the lab coats clean and cut the chain of contamination of nosocomial pathogens, even after newly laundered uniforms.\textsuperscript{36} It was shocking that the positive growth of \textit{E. coli} on attires were associated with the number of cared/examined patients per day (more than ten patients) by HCP in our study. Such contamination of \textit{E. coli} predisposes patients to \textit{E. coli} bacteremia, which in turn leads to adverse health outcomes, such as increased length of stay and cost of those patients\textsuperscript{37} as well as advanced colorectal neoplasia\textsuperscript{38}. As a result, infection control starting with combating contamination with \textit{E. coli} and its strains should be structured and adhered to by HCP as part of their efforts in eradicating nosocomial infections\textsuperscript{39–41}. Subsequently, further steps should be antimicrobial susceptibility testing to contribute significantly in the treatment of nosocomial infections for patients in the healthcare departments\textsuperscript{42}.

**Conclusions**

The use of white lab coats develops more concerns pertinent to its role in transmission healthcare-associated infection compared to use of scrubs. HCP are in urgent need to recognize the risk factors and behaviors that contribute to healthcare-associated infection through use of lab coats, not merely hygienic handling of lab coats, but awareness of places or hospital premises where lab coats should be used. HCP, including physicians, nurses, and allied health students, should be cautious on how and where lab coats should be brought and worn.

**Abbreviations**

\textit{E. coli}: Escherichia coli

HCP: Healthcare personnel

**Declarations**
Ethics approval and consent to participate

The Institutional Review Boards of Jordan University of Science and Technology (IRB #.20180170) and Consenting participants signed a written consent form.

Consent for publication

Not Applicable

Availability of data and material

Not applicable

Competing interests

All authors have no financial and non-financial competing interests

Funding

This work was funded by the Jordan University of Science and Technology. [Grant number 20180170].

Authors' contributions

We hereby confirm that all listed authors meet the authorship criteria and that all authors are in agreement with the content of the manuscript.

Study conception & design: AH; data collection and analysis: AH, ZJ, EA, MA; data interpretation: AH, ZJ; and manuscript preparation: AH, ZJ; final approval of the manuscript version to be published: AH.

Acknowledgments

The authors would like to thank Jordan University of Science and Technology for funding this study.

Conflict of Interest

All authors declare that they have no conflict of interest.

Funding

This work was funded by the Jordan University of Science and Technology. [Grant number 20180170].

Authorship Statement

We hereby confirm that all listed authors meet the authorship criteria and that all authors are in agreement with the content of the manuscript.
Study conception & design: AH; data collection and analysis: AH, ZJ, EA, MA; data interpretation: AH, ZJ; and manuscript preparation: AH, ZJ; final approval of the manuscript version to be published: AH.

References

1. Agency for Healthcare Research and Quality. Patient safety primers: health care–associated infections. Updated October 2012. Accessed July 22, 2013.

2. Young, Lowell S. Nosocomial infections in the immunocompromised adult. *The American journal of medicine* 70.2 (1981): 398-404.

3. World Health Organization. Prevention of Hospital-Acquired Infections: a Practical Guide 2nd Edition. Geneva: World Health Organization; 2002

4. Pittet, D. Infection Control and Quality Health Care in the New Nillenium. *American Journal of Infection Control*; 2005: 33(5): 258–67.

5. Pittet, D., Dharan, S., Touveneau, S., Sauvan, V., & Perneger, T. V. Bacterial contamination of the hands of hospital staff during routine patient care. *Archives of internal medicine,* 1999;159(8), 821-826.

6. World Health Organization. WHO Report on the burden of endemic health care-associated infection worldwide. 2011: [http://www.who.int/iris/itstream/10665/80135/1/9789241501507_eng.pdf](http://www.who.int/iris/itstream/10665/80135/1/9789241501507_eng.pdf)

7. McDermid, R. C., Stelfox, H. T., & Bagshaw, S. M. Frailty in the critically ill: a novel concept. *Critical Care,* 2011:15(1), 301. Chernow B. Variables affecting outcome in critically ill patients. Chest. 1999;115(5 suppl):71S-76S.

8. Robati, Reza, et al. Effect of white coats on spread of nosocomial infection. *European Journal of Experimental Biology* 3.3 (2013): 156-159.

9. World Health Organization, Special Programme for Research, Training in Tropical Diseases, World Health Organization. Department of Control of Neglected Tropical Diseases, World Health Organization. Epidemic, & Pandemic Alert. Dengue: guidelines for diagnosis, treatment, prevention and control. World Health Organization; 2009

10. Salgado, C. D., Sepkowitz, K. A., John, J. F. *et al.* Copper surfaces reduce the rate of healthcare-acquired infections in the intensive care unit. *Infection Control & Hospital Epidemiology,* 2013:34(5), 479-486.

11. Passaretti, C. L., Otter, J. A., Reich, N. G. *et al.* An evaluation of environmental decontamination with hydrogen peroxide vapor for reducing the risk of patient acquisition of multidrug-resistant organisms. *Clinical infectious diseases,* 2012:56(1), 27-35.

12. Loh, W., Ng, V. V., & Holton, J. Bacterial flora on the white coats of medical students. *Journal of Hospital Infection,* 2000:45(1), 65-68.

13. ANZIC Influenza Investigators. Critical care services and 2009 H1N1 influenza in Australia and New Zealand. *New England Journal of Medicine,* 2009:361(20), 1925-1934.

14. Gupta, P, Bairagi, N., Priyadarshini, R., Singh, a., Chauhan, D., & Gupta, D. Bacterial contamination of nurses’ white coats made from polyester and polyester cotton blend fabrics. Journal of Hospital
15. Akanbi, A. A. A., Kareem, T., Adedoja, A. et al. Bacterial contamination of medical doctors’ white coats as contributing factor to hospital acquired infections. *International Journal of Biological and Chemical Sciences*;2017:11(1), 185. http://doi.org/10.4314/ijbcs.v11i1.15

16. McDonald, Daniel, *et al.* Extreme dysbiosis of the microbiome in critical illness. *Msphere* 1.4 2016: e00199-16.

17. Sirijan, S. & Indrawattana, N. Mechanisms of antimicrobial resistance in ESKAPE pathogens. *BioMed research international*; 2016.

18. Chawla, K., Mukhopadhyay, C., Gurung, B., Bhat, P., &airy, I. Bacterial ‘cell’Phones: Do cell phones carry potential pathogens?. *Online Journal of Health and Allied Sciences*;2009:8(1).

19. Grimes, D. A., & Schulz, K. F. Descriptive studies: what they can and cannot do. *The Lancet*, 2002;359(9301), 145-149.

20. CLSI. Performance standards for Antimicrobial Susceptibility testing; Twenty First Informational Supplement. CLSI document M100-S21. Wayne, PA: Clinical and Laboratory Standards Institute; 2011.

21. Leonard, J. What’s to know about Enterococcus faecalis?. *Medical News Today*.2017 Retrieved from: https://www.medicalnewstoday.com/articles/318337

22. Murray, Barbara E. The life and times of the Enterococcus. *Clinical microbiology reviews*,3.1 (1990): 46-65.

23. Wendt, Constanze, *et al.* Survival of vancomycin-resistant and vancomycin-susceptible enterococci on dry surfaces. *Journal of clinical microbiology* 36.12 (1998): 3734-3736.

24. Qaday J, Sariko M, Mwakyoma A, et al. Bacterial Contamination of Medical Doctors and Students White Coats at Kilimanjaro Christian Medical Centre, Moshi, Tanzania. *International journal of bacteriology*. 2015;507890. doi:10.1155/2015/507890.

25. Gouda1 NS, Sultan AM, Eldega1 H & Seliem WA. Bacterial contamination of white coats and hands of healthcare workers at Mansoura university children's hospital, Mansoura, Egypt. *Afr. J. Cln. Exper. Microbiol*. 2018;19 (1): 18-23

26. Mirsepasi-Lauridsen HC, Vallance BA, Krogfelt KA, Petersen AM. 2019. *Escherichia coli* pathobionts associated with inflammatory bowel disease. Clin Microbiol Rev 32:e00060-18. https://doi.org/10.1128/CMR.00060-18.

27. Costa, R.F.A., Ferrari, M.L.A., Bringer, M. *et al.* Characterization of mucosa-associated *Escherichia coli* strains isolated from Crohn's disease patients in Brazil. *BMC Microbiol* 20, 178 (2020). https://doi.org/10.1186/s12866-020-01856-x

28. Butcher, C.R., Rubin, J., Mussio, K. *et al.* Risk Factors Associated with Community-Acquired Urinary Tract Infections Caused by Extended-Spectrum β-Lactamase-Producing *Escherichia coli*: a Systematic Review. *Curr Epidemiol Rep*, 300–309 (2019). https://doi.org/10.1007/s40471-019-00206-4
29. Zhou, Y., Zhu, X., Hou, H. et al. Characteristics of diarrheagenic Escherichia coli among children under 5 years of age with acute diarrhea: a hospital based study. *BMC Infect Dis* 18, 63 (2018). https://doi.org/10.1186/s12879-017-2936-1

30. Banu A, Anand M, Nagi N. White coats as a vehicle for bacterial dissemination. *J Clin Diagn Res.* 2012;6(8):1381–1384. doi:10.7860/JCDR/2012/4286.2364

31. Dir LZ, Paulino WB, Trarbach LS, Martins JDL, Arpini CM. White Coat as a contamination Agent. *J Pathogen Res.* 2018;1 (1:2)

32. Abou Heidar NF, Degheili JA, Yacoubian AA, Khauli RB. Management of urinary tract infection in women: A practical approach for everyday practice. *Urol Ann.* 2019;11(4):339-346. doi:10.4103/UA.UA_104_19

33. Muhadi SA, Aznamshah NA, Jahanfar S. A cross sectional study on the microbial contamination of the medical student’s white coats. *Malaysian Journal of Microbiology.* 2007;3(1):35–38

34. Namazi N, Khosti S, Magdum D, Jadhav S, Varekar A & Golgire S. Microbial flora on white coat. *International Journal of Current Medical And Pharmaceutical Research.* 2017;3:2 (1300-1303).

35. Mwamungule S, Chimana HM, Malama S, Mainda G, Kwenda G, Muma JB. Contamination of health care workers’ coats at the University Teaching Hospital in Lusaka, Zambia: the nosocomial risk. *Journal of Occupational Medicine & Toxicology.* 2015;10(1):1-6. doi:10.1186/s12995-015-0077-2.

36. Burden M, Cervantes L, Weed D, Keniston A, Price CS, Albert RK, Bacterial Contamination of Work Wear. *J. Hosp. Med* 2011;4;177-182. doi:10.1002/jhm.864

37. Naylor, N. R., Pouwels, K. B., Hope, R., Green, N., Henderson, K. L., Knight, G. M., Atun, R., Robotham, J. V., & Deeny, S. R. (2019). The health and cost burden of antibiotic resistant and susceptible Escherichia coli bacteraemia in the English hospital setting: A national retrospective cohort study. *PloS one*, 14(9), e0221944. https://doi.org/10.1371/journal.pone.0221944

38. Kohoutova, D., Smajs, D., Moravkova, P. *et al.* Escherichia coli strains of phylogenetic group B2 and D and bacteriocin production are associated with advanced colorectal neoplasia. *BMC Infect Dis* 14, 733 (2014). https://doi.org/10.1186/s12879-014-0733-7

39. Godoy, P., Torner, N., Soldevila, N. *et al.* Hospital-acquired influenza infections detected by a surveillance system over six seasons, from 2010/2011 to 2015/2016. *BMC Infect Dis* 20, 80 (2020). https://doi.org/10.1186/s12879-020-4792-7

40. Kim, Y.A., Lee, K. & Chung, J.E. Risk factors and molecular features of sequence type (ST) 131 extended-Spectrum-β-lactamase-producing *Escherichia coli* in community-onset female genital tract infections. *BMC Infect Dis* 18, 250 (2018). https://doi.org/10.1186/s12879-018-3168-8

41. Lindstedt, B., Finton, M.D., Porcellato, D. *et al.* High frequency of hybrid *Escherichia coli* strains with combined Intestinal Pathogenic *Escherichia coli* (IPEC) and Extraintestinal Pathogenic *Escherichia coli* (ExPEC) virulence factors isolated from human faecal samples. *BMC Infect Dis* 18, 544 (2018). https://doi.org/10.1186/s12879-018-3449-2
42. Motbainor, H., Bereded, F. & Mulu, W. Multi-drug resistance of blood stream, urinary tract and surgical site nosocomial infections of *Acinetobacter baumannii* and *Pseudomonas aeruginosa* among patients hospitalized at Felegehiwot referral hospital, Northwest Ethiopia: a cross-sectional study. *BMC Infect Dis* 20, 92 (2020). https://doi.org/10.1186/s12879-020-4811-8

**Tables**

**Table 1**: Descriptive analysis of the healthcare personnel sociodemographic and professional characteristics (*N*=188).
| Parameter                              | N (%)  | Mean (SD) |
|----------------------------------------|--------|-----------|
| Age (years)                            |        | 28.07 (5.67) |
| Gender                                 |        |           |
| Male                                   | 80 (42.6) |           |
| Female                                 | 108 (57.4) |           |
| Age groups                             |        |           |
| 19-27 years                            | 99 (52.7) |           |
| 28-35 years                            | 70 (37.2) |           |
| 36-43 years                            | 19 (10.1) |           |
| Marital state                          |        |           |
| Never married                          | 100 (53.2) |           |
| Ever married                           | 88 (46.8) |           |
| Profession                             |        |           |
| Medical Students                       | 59 (31.4) |           |
| Nurses                                 | 69 (36.7) |           |
| Physicians                             | 60 (31.9) |           |
| Department                             |        |           |
| Surgical floor                         | 41 (21.8) |           |
| Medical Floor                          | 63 (33.5) |           |
| Critical Care Unit                     | 33 (17.6) |           |
| Outpatient clinics and auxiliary departments | 24 (12.8) |           |
| Emergency Department                   | 27 (14.4) |           |
| Experience years                       |        |           |
| ≤ 1 years                              | 56 (29.8) |           |
| 2-5 years                              | 56 (29.8) |           |
| >5 years                               | 76 (40.4) |           |
| Households income/month (JOD)          |        |           |
| < 400 JOD                              | 59 (31.4) |           |
| 400_600 JOD                            | 50 (26.6) |           |
| Income Level | Count (Percentage) |
|--------------|-------------------|
| 600_800 JOD  | 57 (30.3)         |
| >800 JOD     | 22 (11.7)         |

**Households size (Family members)**

| Number of Members | Count (Percentage) |
|-------------------|--------------------|
| 1-3 members       | 81 (43.1)         |
| 4-6 members       | 75 (39.9)         |
| ≥7 members        | 32 (17)           |

**Living / rooming with**

| Living Situation              | Count (Percentage) |
|-------------------------------|--------------------|
| Alone                         | 18 (9.6)           |
| Spouse Only                   | 25 (13.3)          |
| Spouse and sons/daughters     | 54 (28.7)          |
| Spouse, sons/daughters & Parents | 51 (27.1)    |
| Others                        | 40 (21.3)          |

*Note: Medical students are medicine, nursing and pharmacy students.*

**Table 2: Descriptive analysis of the handling behaviors and washing practices of uniforms/ lab coats (N=188).**
| Type of uniform used   | N (%)   | Mean (SD) |
|------------------------|---------|-----------|
| lab coat               | 95 (50.5) |           |
| Scrub                  | 93 (49.5) |           |

**Number of owned uniforms/Lab coats**  
2.10 (0.82)

**How often do you wash/launder your used uniforms (times/months)**  
7.42 (6.86)

| How often do you wash/launder your used uniforms (times/months) | N (%)   | Mean (SD) |
|------------------------------------------------------------------|---------|-----------|
| 1-4 times/Months                                                 | 104 (55.3) |           |
| 5-10 times/Months                                                | 41 (21.8) |           |
| 11-16 times/Months                                               | 30 (16) |           |
| ≥17 times/Months                                                 | 13 (6.9) |           |

**How many uniforms/lab coats do you have**

| How many uniforms/lab coats do you have | N (%)   | Mean (SD) |
|----------------------------------------|---------|-----------|
| One                                    | 56 (29.8) |           |
| Two                                    | 62 (33) |           |
| Three                                  | 70 (37.2) |           |

**How often do you wash your uniform/lab coat**

| How often do you wash your uniform/lab coat                         | N (%)   | Mean (SD) |
|---------------------------------------------------------------------|---------|-----------|
| Once/ 3 days                                                        | 78 (41.5) |           |
| Once/week                                                           | 78 (41.5) |           |
| Every two weeks                                                     | 27 (14.4) |           |
| Once per month or more                                             | 5 (2.7) |           |

**Where you store your uniform/lab coat.**

| Where you store your uniform/lab coat.                             | N (%)   | Mean (SD) |
|--------------------------------------------------------------------|---------|-----------|
| Hospital locker                                                    | 100 (53.2) |           |
| Home                                                               | 88 (46.8) |           |

**How many years have you been using the same uniforms/lab coats**

| How many years have you been using the same uniforms/lab coats      | N (%)   | Mean (SD) |
|---------------------------------------------------------------------|---------|-----------|
| < 1 year                                                            | 102 (54.3) |           |
| 1-2 years or more                                                  | 86 (45.7) |           |

**Do you borrow uniforms/lab coats from work peers sometimes**

| Do you borrow uniforms/lab coats from work peers sometimes          | N (%)   | Mean (SD) |
|---------------------------------------------------------------------|---------|-----------|
| No                                                                  | 163 (86.7) |           |
| Yes                                                                 | 25 (13.3) |           |

**Number of cared/examined patients per day**

| Number of cared/examined patients per day                         | N (%)   | Mean (SD) |
|--------------------------------------------------------------------|---------|-----------|
| <10 patients | 69 (36.7) |
| 10-15 patients | 52 (27.7) |
| >15 patients | 67 (35.6) |

**Reasons for wearing your uniform/lab coat**

| Reason                                                      | Count (% of total) |
|-------------------------------------------------------------|-------------------|
| To cover clothes/keep warm                                  | 21 (11.1)         |
| For professional attire/code of dress                       | 156 (83)          |
| Other reasons                                               | 11 (5.9)          |

**How you carry your uniform/lab coat once you finish your clinical day**

| How you carry          | Count (% of total) |
|------------------------|--------------------|
| Covered                | 31 (16.5)          |
| In a bag               | 58 (30.9)          |
| In hands               | 99 (52.7)          |

**Where do you wash your uniforms/lab coat**

| Where you wash        | Count (% of total) |
|-----------------------|--------------------|
| laundry               | 33 (17.6)          |
| Home                  | 153 (81.4)         |
| Both                  | 2 (1.1)            |

**Where do you store/keep your used uniform/lab coat**

| Where you store/keep  | Count (% of total) |
|-----------------------|--------------------|
| Hospital              | 88 (46.8)          |
| Home/hostel           | 100 (53.2)         |

**Do you believe that white coats can be a potential transmitting agent for pathogens**

| Do you believe        | Count (% of total) |
|-----------------------|--------------------|
| No                    | 7 (3.7)            |
| Yes                   | 181 (96.3)         |

**Do you wear a uniform/lab coat outside hospital/clinical areas**

| Do you wear           | Count (% of total) |
|-----------------------|--------------------|
| No                    | 151 (80.3)         |
| Yes                   | 37 (19.7)          |

**Table.3**: Descriptive analysis of the types of bacteria on the HCPs’ uniforms/lab coats (N=188).
Enterococcus faecalis 122 (77.7)
Staphylococcus aureus 49 (31.2)
Escherichia coli 44 (28)
Pseudomonas aeruginosa 8 (5.1)

Total number of positive grown CFUs 9.81 (4.46)
Total number of non-identified bacterial types 2.42 (1.08)

Bacterial CFU counts per location
Location-A CFU's= Collar 3.22 (1.69)
Location-B CFU's= Mid-sleeve 3.32 (1.79)
Location-C CFU's= Waist 3.27 (1.77)

Note: CFU: Colony Forming Units

Table 4: Descriptive analysis of the isolated positive growth bacterial types from three attire locations (N=188).

|                | Total N (%) | Collar N (%) | Mid-Sleeve N (%) | Waist N (%) | test statistic | p-value |
|----------------|-------------|--------------|------------------|-------------|----------------|---------|
| Enterococcus fecalis | 203         | 64 (65.3)    | 63 (66.3)        | 76 (73.1)   | $\chi^2(2)=2.99$ | 0.224   |
| Staphylococcus aureus | 68          | 24 (24.5)    | 20 (21.1)        | 24 (23.1)   | $\chi^2(2)=0.681$ | 0.711   |
| Escherichia coli    | 74          | 30 (30.6%)   | 18 (18.9)        | 26 (25)     | $\chi^2(2)=5.74$ | 0.057   |
| Pseudomonas aeruginosa | 11         | 2 (2%)       | 6 (6.3)          | 3 (2.9)     | $\chi^2(2)=3.25$ | 0.197   |

Note: Cochran Q-Chi squared test for related samples

Table 5: Multivariate generalized linear “mixed effects gamma” regression analysis of attire hygiene characteristics of their measured total colony forming unit counts measured from three attire locations (N=564).
| Parameter                     | 95% C.I Beta coefficient | Std. Err. | t-value | Lower  | Upper  | p-value  |
|-------------------------------|--------------------------|-----------|---------|--------|--------|----------|
| **Intercept**                 |                          |           |         |        |        | <0.001   |
| **Age groups**                |                          |           |         |        |        |          |
| 19-27 years old              | 0.056                    | 0.064     | 0.877   | -0.069 | 0.181  | 0.381    |
| 28-35 years old              | -0.137                   | 0.059     | -2.31   | -0.254 | -0.021 | 0.021    |
| 36-43 years reference        | 0                        |           |         |        |        |          |
| **Gender**                   |                          |           |         |        |        |          |
| Male                         | -0.112                   | 0.041     | -2.412  | -0.197 | -0.031 | 0.007    |
| Female reference             |                          |           |         |        |        |          |
| **Monthly income**           |                          |           |         |        |        |          |
| < 400 JOD                    | -0.154                   | 0.064     | -2.56   | -0.272 | -0.036 | 0.011    |
| 400-600 JOD                  | -0.058                   | 0.06      | -0.969  | -0.175 | 0.06   | 0.333    |
| 600-800 JOD                  | -0.023                   | 0.054     | -0.4129 | -0.13  | 0.084  | 0.675    |
| >800 JOD reference           | 0                        |           |         |        |        |          |
| **Occupation**               |                          |           |         |        |        |          |
| Medical students             | -0.181                   | 0.045     | -4.001  | -0.27  | -0.092 | <0.001   |
| Nurses                       | 0.066                    | 0.052     | 1.255   | -0.037 | 0.168  | 0.168    |
| Physicians reference         | 0                        |           |         |        |        |          |
| **Department**               |                          |           |         |        |        |          |
| Surgical ward                | -0.007                   | 0.06      | -0.118  | -0.125 | 0.111  | 0.906    |
| Medical ward                 | -0.018                   | 0.055     | -0.322  | 0.127  | 0.091  | 0.747    |
| Critical care units          | 0.283                    | 0.06      | 4.678   | 0.164  | 0.401  | <0.001   |
| auxiliary clinics            | -0.014                   | 0.057     | -0.254  | -0.126 | 0.097  | 0.8      |
| Outpatient and auxiliary     |                          |           |         |        |        |          |
| emergency department reference|                          |           |         |        |        |          |
| **Living with**              |                          |           |         |        |        |          |
| Alone                        | 0.225                    | 0.064     | 3.531   | 0.1    | 0.351  | <0.001   |
| Spouse only                  | 0.128                    | 0.072     | 1.781   | -0.013 | 0.269  | 0.076    |
| Spouse & sons/daughters      | 0.119                    | 0.051     | 2.331   | 0.019  | 0.22   | 0.020    |
| Spouse & sons/daughters & parents | 0.064 | 0.052 | 1.24 | -0.037 | 0.165 | 0.215 |
| Others reference             | 0                        |           |         |        |        |          |
Table 6: Bivariate Analysis of the association between E. coli positive growth with the HCW’s sociodemographic factors, uniform and lab coat using and handling behaviors (N=564).

| Uniform type | lab coat | -0.124 | 0.05 | -2.474 | -0.222 | -0.025 | 0.014 |
|--------------|----------|--------|------|--------|--------|--------|------|
| Scrub reference | | 0 | |

| Num. of uniforms | One | -0.174 | 0.044 | -3.989 | -0.259 | -0.088 | <0.001 |
| Two | -0.027 | 0.037 | -0.731 | -0.099 | 0.045 | 0.465 |
| Three reference | | 0 | |

| Borrows uniform | No | -0.092 | 0.05 | -1.829 | -0.191 | 0.007 | 0.068 |
| Yes reference | | 0 | |

| Carrying method | Covered | 0.121 | 0.044 | 2.762 | 0.035 | 0.207 | 0.006 |
| In a bag | -0.1 | 0.044 | 2.294 | -0.186 | -0.014 | 0.022 |
| By hand reference | | 0 | |

Note: Link function: Log under Gamma distribution; Model Information Criteria: Akaike's; AIC=608.44; Bayesian BIC=616.99; p<0.001; Random effect= Subject ID X site of the sample.
| Attire Escherichia coli positive | No Mean (SD)/N (%) | Yes Mean (SD)/N (%) | tests statistic | p-value |
|---------------------------------|-------------------|---------------------|----------------|---------|
| | **Gender** | | | | |
| | Male | 217 (44.3) | 23 (31.1) | $\chi^2 (1) = 4.59$ | 0.032 |
| | Female reference | 273 (55.7) | 51 (68.9) | | |
| | **Age (years)** | 27.920 (5.82) | 29.10 (4.35) | t(116.60) = 2.01 | 0.046 |
| | **Age groups** | | | | |
| | 19-27 years | 268 (54.7) | 29 (39.2) | $\chi^2 (2) = 6.71$ | 0.035 |
| | 28-35 years | 173 (35.3) | 37 (50) | | |
| | 36-43 years | 49 (10) | 8 (10.8) | | |
| | **Marital state** | | | | |
| | Never married | 268 (54.7) | 32 (43.2) | $\chi^2 (1) = 3.39$ | 0.066 |
| | Ever married | 222 (45.3) | 42 (56.8) | | |
| | **Profession/occupation** | | | | |
| | Medical Students | 171 (34.9) | 6 (8.1) | $\chi^2 (2) = 21.44$ | <0.001 |
| | Nurses | 171 (34.9) | 36 (48.6) | | |
| | Physicians reference | 148 (30.2) | 32 (43.2) | | |
| | **Department** | | | | |
| | Surgical floor | 109 (22.2) | 14 (18.9) | $\chi^2 (4) = 17.33$ | 0.002 |
| | Medical Floor | 164 (33.5) | 25 (33.8) | | |
| | Critical Care Unit | 95 (19.6) | 3 (4.1) | | |
|                                | Count | Percentage |
|--------------------------------|-------|------------|
| **Outpatient clinics and auxiliary departments** | 57 (11.6) | 15 (20.3) |
| Emergency department **reference** | 64 (13.1) | 17 (23) |

| **Experience years** | Count | Percentage |
|----------------------|-------|------------|
| <=1 years            | 155 (31.6) | 13 (17.6) | \( \chi^2 (2) = 7.62 \) 0.022 |
| 2-5 years            | 138 (28.2) | 30 (40.5) |
| >5 years             | 197 (40.2) | 31 (41.9) |

| **Monthly income** | Count | Percentage |
|-------------------|-------|------------|
| < 400 JOD         | 165 (33.7) | 12 (16.2) | \( \chi^2 (2) = 21.66 \) <0.001 |
| 400-600 JOD       | 135 (27.6) | 15 (20.3) |
| 600-800 JOD       | 132 (26.9) | 39 (52.7) |
| >800 JOD **reference** | 58 (11.8) | 8 (10.8) |

| **Households size (members)** | Count | Percentage |
|-------------------------------|-------|------------|
| 1-3 members                   | 215 (43.9) | 28 (37.8) | \( \chi^2 (2) = 8.8 \) 0.012 |
| 4-6 member                    | 185 (37.8) | 40 (54.1) |
| >=7 members                   | 90 (18.4) | 6 (8.1) |

| **Socioeconomic index score** | Count | Percentage |
|-------------------------------|-------|------------|
| -0.047 (1.01)                 | 0.311 (0.89) | t (562) = 2.89 0.004 |

| **Living with** | Count | Percentage |
|-----------------|-------|------------|
| Alone           | 50 (10.2) | 4 (5.4) | \( \chi^2 (4) = 4 \) 0.406 |
| Spouse only     | 68 (13.9) | 7 (9.5) |
| Spouse & sons/daughters | 141 (28.8) | 21 (28.4) |
| Spouse & sons/daughters & parents | 128 (26.1) | 25 (33.8) |
| Others **reference** | 103 (21) | 17 (23) |

| **Uniform type** | Count | Percentage |
|------------------|-------|------------|
|                         | Lab coat | Scrub | $\chi^2$ | p-value |
|-------------------------|----------|-------|----------|---------|
|                         | 250 (51) | 35 (47.3) | 0.36 | 0.550 |
|                         | 240 (49) | 39 (42.7) |       |        |

**Washing/laundry times**

| Frequency/Number of Times | Lab coat | Scrub  | $\chi^2$ | p-value |
|---------------------------|----------|--------|----------|---------|
| 1-4 times/Months          | 270 (55.1) | 42 (56.8) | 0.320 | 0.957 |
| 5-10 times/Months         | 107 (21.8) | 16 (21.6) |       |        |
| 11-16 times/Months        | 78 (15.9) | 12 (16.2) |       |        |
| >=17 times/Months         | 35 (7.1) | 4 (5.4) |       |        |

**Num. of uniforms**

| Number of Uniforms | Lab coat | Scrub  | $\chi^2$ | p-value |
|-------------------|----------|--------|----------|---------|
| One               | 141 (28.8) | 27 (36.5) | 2.67 | 0.263 |
| Two               | 167 (34.1) | 19 (25.7) |       |        |
| Three             | 182 (37.1) | 28 (37.8) |       |        |

**Frequency of lab coat washing**

| Frequency         | Lab coat | Scrub  | $\chi^2$ | p-value |
|-------------------|----------|--------|----------|---------|
| Once/ 3 days      | 202 (41.2) | 32 (43.2) | 0.13 | 0.989 |
| Once/week         | 204 (41.6) | 30 (40.5) |       |        |
| Every two weeks   | 71 (14.5) | 10 (13.5) |       |        |
| Once per month or more | 13 (2.7) | 2 (2.7) |       |        |

**Storing lab coats**

| Storage Location   | Lab coat | Scrub  | $\chi^2$ | p-value |
|-------------------|----------|--------|----------|---------|
| Hospital locker   | 248 (50.6) | 52 (70.2) | 9.98 | 0.002 |
| Home              | 242 (49.4) | 22 (29.7) |       |        |

**Borrows uniform**

| Whether Borrows Uniform | Lab coat | Scrub  | $\chi^2$ | p-value |
|-------------------------|----------|--------|----------|---------|
| No                      | 424 (86.5) | 65 (87.8) | 0.10 | 0.758 |
| Yes                     | 66 (13.5) | 9 (12.2) |       |        |

**Number of cared/examined patients per day**

| Number of Patients | Lab coat | Scrub  | $\chi^2$ | p-value |
|-------------------|----------|--------|----------|---------|
| <10 patients      | 199 (40.6) | 8 (10.8) | 31.23 | <0.001 |
| 10_15 patients | 119 (24.3) | 37 (50) |
|----------------|------------|--------|
| >15 patients   | 172 (35.1) | 29 (39.2) |

**How long have you been using the same lab coats**

| <1 year | 270 (55.1) | 36 (48.6) | $\chi^2 (1) =1.08$ | 0.299 |
|---------|------------|-----------|---------------------|-------|
| 1-2 years or more | 220 (44.9) | 38 (51.4) |         |       |

**Reasons for wearing lab coats**

| To cover clothes/wearing | 56 (11.4) | 7 (9.5) | $\chi^2 (2) =3.57$ | 0.168 |
|--------------------------|------------|--------|---------------------|-------|
| For professional attire/dress code | 402 (82) | 66 (89.2) |         |       |
| Other reasons            | 32 (6.5) | 1 (1.4) |         |       |

**Carrying method**

| Covered | 83 (16.9) | 10 (13.5) | $\chi^2 (2) =4.10$ | 0.130 |
|---------|------------|-----------|---------------------|-------|
| In a bag | 157 (32) | 17 (23) |         |       |
| By hand | 250 (51) | 47 (63.5) |         |       |

**Place of laundering/washing**

| Hospital laundry | 88 (18) | 11 (14.9) | $\chi^2 (2) =2.20$ | 0.333 |
|--------------------------------|--------|-----------|---------------------|-------|
| Home                        | 396 (80.8) | 63 (85.1) | LR                   |       |
| Both                        | 6 (1.2) | 0         |         |       |

**Place of storing**

| Hospital          | 221 (45.1) | 43 (58.1) | $\chi^2 (1) =4.37$ | 0.037 |
|-------------------|------------|-----------|---------------------|-------|
| Home/hostel       | 269 (54.9) | 31 (41.9) |         |       |

**Do you believe that white coats can be a potential transmitting agent for pathogens**

| No               | 21 (4.3) | 0 | $\chi^2 (1) =2.21$ | 0.137 |
|------------------|----------|---|---------------------|-------|
| Yes              | 469 (95.7) | 74 (100) | YATES |       |

**Wearing a lab coat outside clinical areas.**
| No | 388 (79.2) | 65 (87.8) | $\chi^2 (1) = 3.10$ | 0.081 |
| Yes | 102 (20.8) | 9 (12.2) |

**Figures**

**Figure 1**

The mean of bacterial growth CFUs measured from three bodily sites of the HCPs' attire

**Figure 2**

The association between HCP working unit and their attire total recovered Mean-Log(CFU) counts
Figure 3

The odds of measuring a positive E. coli from the attire of HCP coming from various working units.