Hygienic Practices of Bed Linens among University of Cape Coast Students in Ghana

Nicholette Vashti Hammond[1]
Patience Danquah Monnie[2]

[1]vashtiham@gmail.com
[2]patience.danquah@ucc.edu.gh

[1]https://orcid.org/0009-0004-0660-4435
[2]https://orcid.org/0000-0002-3733-7171

[1]Cape Coast Technical University, [2]University of Cape Coast, [1,2]Cape Coast, Ghana

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ABSTRACT

This paper examined the hygienic practices of University Students in relation to bed linens and determined the microbial content of mattresses and bed linens used by University of Cape Coast students. The study was conducted in two phases. Cross-sectional survey design was used for the first phase to describe the hygienic practices of the population in relation to bed linens. Laboratory tests were conducted in the second phase on mattresses and bed linens used by students to establish their microbial load. Total number of students used for the survey was 300. Thirty-two pieces of 100% cotton bed linens were used for the experiment. The population was grouped into two categories of gender (male, female). The statistical software employed for the analysis of the data collected was the Statistical Package and Service Solution (SPSS) for Windows version 26. The study revealed that no difference existed in relation to bed linen hygienic practices of male and female students; however, female students washed their bed linens frequently as compared to males. Mattresses and bed linens used by students had varying loads of microorganisms. The study concludes that lower contamination levels on mattresses, combined with higher levels on bed linens, underscore the importance of regular and thorough washing and drying methods for linens, regardless of gender. This study can be used as a basis to launch awareness campaigns that emphasize the importance of consistent hygiene routines and bed linen care for both males and females. It is recommended that students should be educated on hygiene and the role microorganisms play in affecting their health and academic work.

Keywords: Bacteria Contamination, Bed Linen Hygiene, Infection Prevention, Public Health, Students

I. INTRODUCTION

Proper hygiene is essential for preventing the spread of infections, especially in communal living environments like University residents. According to the World Health Organization (WHO, 2019), hygiene refers to the behaviors and surroundings that lessen the likelihood of disease transmission. Bed linens, which frequently contact the body, can easily become breeding grounds for bacteria, fungi and other pathogens if not washed regularly and correctly (Tierno, 2019). University students, often living independently for the first time, may not prioritize or understand the importance of these hygiene practices, potentially leading to increased health risks, including skin infections and respiratory issues (Scott et al, 2020). Numerous indoor fungus generate compounds that, when inhaled, can cause systemic or respiratory toxicity (Kuhn & Ghannoum, 2003; Lambrecht & Hammad, 2014). The primary advantages of maintaining good personal hygiene are a reduction in the spread of disease and an enhancement in overall health. Germs that can make you sick are removed when you wash your hands with soap and keeping yourself clean can also lessen the likelihood that you may infect others (Satish Kumar et al, 2020). Maintaining good personal and household hygiene can also serve as a preventative measure against impending diseases. Thus, maintaining good hygiene is essential to reducing the spread of infections in daily life.

All over the world, the profound effect of infectious diseases on health and prosperity has been recognized by health agencies with the need for investments which emphasizes on infection prevention strategies such as vaccines and hygiene (De Cock et al., 2013; Fonkwo, 2008; Bloomfield et al, 2011). Promoting the health of individuals and populations is an intricate attempt which is dependent upon individuals, families and communities, governments, health professionals, academics, administrators, development partners, businesses, the media, and others whose activities intersect or interlock. As the Center for Disease Control and Prevention [CDCP] (2019) and WHO (2018) stated, it is necessary for the infection control communities and public health agencies worldwide to make efforts toward emphasizing the necessity of basic hygiene practices, at both the individual and community levels for infection

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control. WHO (2018) indicated that preventing infection through hygiene in the home and everyday life has become progressively relevant.

The advantages of improved hygiene and sanitation are widely acknowledged and well-documented, serving as a highly effective approach to preventing infections and curbing the spread of pathogens (Aiello et al., 2008). The promotion of proper sanitation and hygiene practices has been highlighted in numerous international policy documents and global commitments (Kabir et al., 2021). The United Nations (UN), through Sustainable Development Goal (SDG) Target 6, for example, underscores the importance of access to improved sanitation and hygiene as essential for achieving sustainable economic growth and a brighter future (Mara et al., 2010). A recent study by Kabir et al. (2021) in Bangladesh indicated that despite having reasonable awareness and knowledge, the sanitation and hygiene practices of the university students studied were remarkably low. Locally, in Ghana, there is limited empirical data regarding the hygienic practices of university students, specifically related to bed linens. While some studies have assessed hygiene awareness in broader contexts, the specific habits and challenges faced by students at the University of Cape Coast (UCC) remain underexplored. Moreover, the tropical climate of Ghana increases the urgency of maintaining clean bed linens to mitigate the risk of infections.

1.1 Statement of the Problem

Taking care of your clothing by washing and changing them on a regular basis is an essential aspect of maintaining good personal hygiene, especially if a family member is ill (Smith, 2008). Using soap after using the toilet, washing hands regularly, covering your nose when you cough or sneeze, washing your hands after touching dogs and other animals, changing your clothes and washing them regularly and bathing the body twice a day are all examples of maintaining proper personal hygiene (WHO, 2019). On the other hand, poor personal hygiene results from a deliberate or inadvertent disregard for ones body's hygiene and health needs. When one ignores all the activities carried out for good personal hygiene, the general well-being is impacted, and the body starts to appear sick which encounters unwelcome health issues (Wilson, 2023). Bed linens play a critical role in maintaining personal hygiene and overall health, as they are in direct contact with the body during sleep. Poor personal and bed linen hygiene, potentially can lead to skin infections, allergies, and respiratory issues. Understanding the personal and bed linen hygienic practices among University students is essential to identify gaps and recommend healthier routines within this population.

1.2 Research Objectives

The objectives of the study were to:

i. Assess the hygienic practices related to bed linens among male and female students.
ii. Determine the microbial load on mattresses and bed linens used by students.

II. LITERATURE REVIEW

2.1 Empirical Review

2.1.1 Hygienic Practices of Humans

Personal cleanliness is a key defense against infectious diseases like the flu, COVID-19, and gastroenteritis (Nath, 2003). Hygiene involves practices that reduce disease transmission, enhancing overall health and reducing infection spread (WHO, 2019). Regular handwashing with soap removes germs and minimizes the risk of contaminating others (Satish Kumar et al., 2020). Since hands are frequently used in daily activities, they are primary sites for infection, making hand hygiene crucial (Aunger et al., 2016). Bathing with soap not only prevents body odor but also keeps the body free of harmful bacteria and lice (Campos et al., 2009). Proper hygiene extends to washing clothes regularly, especially if illness is present in the household (Smith, 2008). Ignoring these practices can lead to health problems and weakened well-being (Wilson, 2023).

2.1.2 Transmission of Microbes through Textiles

Textiles can harbour and transmit microbes. Historically, clothing was used in biological warfare, such as smallpox-contaminated blankets given to Native Americans (Freney & Renaud, 2012). Studies show that healthcare workers' clothing and bed linens can transmit pathogens like *Staphylococcus aureus* and *MRSA* (Bloomfield et al., 2011). Textiles, therefore, play a role in spreading infections (Olowomofe et al., 2020). The period of use significantly impacts microbial buildup, with longer use resulting in higher microbial loads (Wood et al., 2013). For instance, *Staphylococcus aureus* can survive on fabric for two weeks, while viruses like the flu can last up to 12 hours (The Conversation, 2021). Males tend to spread more bacteria due to higher sebum secretion compared to females (Ying et al., 2015; Smith et al., 2008).

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2.2. Theoretical Review

2.2.1 Diseases and Infections

Microorganisms are implicated in a range of infections. Bacteria cause illnesses like pneumonia, urinary tract infections, and meningitis (Smith, Venter & Glass, 2009). Fungi are linked to infections such as candidiasis and athlete's foot, while viruses lead to diseases like chickenpox, flu, and COVID-19 (Hyde, 2024). Textiles, including bed linens, can serve as reservoirs for microbial transmission, facilitating the spread of pathogens like *Staphylococcus aureus* and *Escherichia coli* (Abney et al., 2021).

2.2.2 Germ Theory of Disease

The germ theory, proposed by Louis Pasteur, asserts that microorganisms cause infectious diseases. It revolutionized health practices, introducing methods like sterilization, vaccination, and aseptic techniques (Berche, 2012). Advances in microbiology and molecular biology have enhanced infection control through techniques such as genetic sequencing (Maloy & Schaechter, 2006). Textiles play a role in disease transmission, emphasizing the importance of hygienic practices to mitigate risks (Scott et al., 2020).

III. METHODOLOGY

The study employed the quantitative research approach and was conducted in two phases. The cross-sectional survey design was used for the first phase of the study to describe the hygienic practices of the population in relation to bed linens. The second phase of the study employed the experimental study with the use of laboratory testing for the assessment of microbial load of mattresses and bed linens used by students. The study, included two categories of gender (male, female) and one fabric type (100% cotton).

3.1 Target Population

The target population of the study was all regular undergraduate students at the University of Cape Coast staying at the halls and diaspora. The total number of regular undergraduate students of the selected University at the time of research was 16,848 (University of Cape Coast, 2021).

3.1.1 Eligibility Criteria for Phase One

Respondents should be undergraduate regular students of the selected University and be residing in any of two gender-based halls of the University.

3.1.2 Eligibility Criteria for Phase Two

A volunteer for the study should be undergraduate student of the selected University and staying alone (single occupancy). In addition, should be someone who sleeps alone on his/her bed.

3.1.3 Sample and Sampling Procedure

The total number of sample size for the study was 332. Krejcie and Morgan's formula (1664) (as cited in Ahmad & Halim 2017) was used to select 332 participants/ volunteers out of a population of 16,848. For phase one, a sample size of 300 was selected from the total sample size of 332 for the study. The researchers selected 150 male participants and 150 female participants from the male and female halls respectively for the study.

The multi-stage sampling method was used in phase one to select participants for the study. Both simple random sampling and purposive sampling methods were used. The first stage of sampling used purposive sampling to select one male and one female hall since gender was a variable examined in the study. The simple random sampling procedure specifically the lottery method was employed to select rooms in the halls that formed part of the study. Since only 150 participants were needed from each hall, the researchers decided to select one person from each room to be part of the study. 150 rooms were selected from which one person each was selected from the rooms. Each room in the halls was numbered systematically starting from 1 and the numbers written on separate pieces of papers, these pieces of papers were mixed and put into a box then numbers drawn out in a random manner to select 150 rooms. Again, the lottery method was used in selecting individual participants from the 150 rooms. In the case where a room or participant that has already been selected for the study is selected during the process of the lottery, it was thrown back into the box and the process repeated.

For the second phase, a sample size of 32 volunteers (16 males and 16 females) was used for the study. Purposive sampling was used to select volunteers (16 males and 16 females) staying alone to reduce or eliminate any statistical mistakes that could alter the conclusions of the study's results. The volunteers were asked to ensure that they sleep on the bed linen alone throughout the study period.

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3.2 Materials

32 pieces of bed linens (bed sheets 55'' by 92'' and pillowcases 27'' by 18'') in 100% cotton were bought from the market. 32 mattresses were also employed. Nutrient agar (NA), Eosin Methylene Blue (EMB), Plate Count Agar (PCA) and Potato Dextrose agar (PDA) were used to cultivate and enumerate the microorganisms from sterilised swab sticks.

3.3 Data Collection Instruments

3.3.1 Phase One

The first phase of the study used questionnaire. This was administered to respondents from selected halls to collect information regarding their hygienic practices.

3.3.2 Phase Two

Test tube was used to store water for sterilization. Colony counter was used to estimate the liquid culture's density of microorganisms by counting individual colonies on the agar plate. Incubator was used to support the growth and maintain *microbiological* cultures or cell cultures. Petri dish was used to grow the microorganisms in the sample. Sterilized swab sticks with tubes were used to pick specimen from the bed linens samples for testing.

3.4 Data Collection Procedure

3.4.1 Phase One

The questionnaire was administered to the sampled respondents from the two gender-based halls of the University. The questionnaires were administered in person to respondents and taken immediately after completion which gave a 100% collection rate.

3.4.2 Phase Two

Labels were assigned to the bed linens, mattresses and the petri dishes for easy identification.

3.4.3 Media and Media Preparation

Nutrient Agar (NA)

11. 2g of dehydrated Nutrient Agar was suspended in 400mL of distilled water in a 500ml conical flask. The agar was melted in a microwave in order to dissolve in the solution. The conical flask was then corked tightly with cotton plug and wrapped with aluminium foil.

Eosin Methylene Blue (EMB) Agar

14.38g of dehydrated EMB Agar was weighed on a balance and suspended in 400ml of distilled water in a 500ml conical flask. The agar was melted in a microwave in order to dissolve in the solution. The conical flask was then corked tightly with cotton plug and wrapped with aluminum foil.

Plate Count Agar (PCA)

9.4 g of the Plate Count Agar was weighed and suspended in 400ml of distilled water in a 500 ml conical flask. The agar was melted in a microwave to dissolve completely in the Solution. The conical flask was then corked tightly with cotton plug and wrapped with aluminum foil.

Potato Dextrose Agar (PDA)

15.6g of the dehydrated PDA was weighed on a balance and suspended in 400ml of distilled water in a 500ml conical flask. The agar was melted in a microwave to dissolve in the solution. The conical flask was then corked tightly with cotton plug and wrapped with aluminum foil.

3.4.4 Specimen Collection and Testing Procedures (Phase two)

Isolation and Culturing (Bed linens/ Mattresses)

Sterile swab sticks moistened in normal saline were used to pick specimens from the mattresses and bed linens (Unused & used one week). The swab sticks were immediately transported in a refrigerated box to the laboratory for microbial analysis. The bed linens were swapped after a week usage.

The pour plate method was used for isolation and culturing of the specimens. One hundred and ninty-two (192) test tubes were filled with 9ml of distilled water each. The test tubes were then corked tightly with cotton plug and wrapped with aluminium foil. The media prepared, the 192 test tubes containing the distilled water and a pipette

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rack containing pipet tips were autoclaved in a YX- 24LM Eoral pressure steam autoclave for 15 minutes at 121°C. One sterile culturing swap stick was dipped in one of the sterile distilled water and swapped on the samples. The swab stick was dipped back into the sterile distilled water and swapped again. This process was repeated about 4 times on each sample (Swaps were taken from different portions of the samples). The Petri dishes were labelled with the names of the media and the labels on the samples. 1ml each of the specimen was pipetted into the various dishes according to the labels. The various media were soft melted and poured into the Petri dishes and swirled to mix properly with the specimen. After solidifying, the Petri plates were packed and incubated for 24 to 72 hours. After incubation, developed colonies on the plates were counted and recorded. Colonies were recorded as total bacteria count (CFU/ml). After specimen had been taken from the samples, those with microbes were disinfected with Clorox's hydrogen peroxide cleaner and disinfectant to ensure they were free from microbes before assigning treatment. The labelled samples were given to each volunteer in each group (male/ female) to be used for a period of one week.

3.5 Data Analysis

Responses were gathered on hygienic practices of respondents. Readings were recorded for microbial load found on the mattresses and bed linens. The statistical software that was used in the analysis of the data collected was the Statistical Package and Service Solution (SPSS) for Windows version 26. Descriptive statistics was employed in describing the hygienic practices of respondents. Means and standard deviations of microbial load of new and used bed linens were determined.

3.6 Ethical Considerations

Before commencing with this study, ethical approval was sought from the Institutional Review Board, University of Cape Coast (UCC, IRB). The researchers sought the consent of the participants; informed them about the nature and purpose of the study and guaranteed their confidentiality and anonymity of the information acquired. Participation in the research was, therefore, voluntary. Those who were purposively or randomly selected but were not willing to participate in the study were allowed to withdraw.

1V. FINDINGS & DISCUSSION

4.1 Personal Hygienic Practices of Students

Percentages and frequencies were employed for the analysis of the data gathered in the first phase to explore the hygienic practices of students in relation to bed linen. Personal and laundry hygienic practices were both measured using a five-point Likert scale with 1 representing not at all, 2 representing rarely, 3 representing moderately, 4 representing often and 5 representing very often. Tables 1, 2 and 3, present the results.

Table 1

Personal Hygienic Practices of Respondents

Personal Hygienic practices	Gender	Not at all Frequency (%)	Rarely Frequency (%)	Moderately Frequency (%)	Often Frequency (%)	Very often Frequency (%)
Bath twice a day (morning and evening)	Male Female	0 (0) 0 (0)	16 (10.7) 15 (10.0)	23 (22.0) 26 (17.3)	49 (32.7) 47 (31.3)	52 (34.7) 62 (41.3)
Bath with sponge, soap, and water in the morning	Male Female	0 (0) 0 (0)	0 (0.0) 1 (0.7)	16 (10.7) 12 (8.0)	41 (27.3) 36 (24.0)	93 (62.0) 101 (67.3)
Bath with just soap and water in the morning	Male Female	24 (16.0) 21 (14.0)	22 (14.7) 15 (10.5)	1 (0.7) 1 (0.7)	14 (9.3) 10 (6.7)	89 (59.3) 103 (68.7)
Bath with just water in the morning	Male Female	8 (5.3) 13 (8.7)	8 (5.3) 8 (5.3)	7 (4.7) 2 (1.3)	20 (13.3) 11 (7.3)	107 (71.3) 116 (77.3)
Bath with sponge, soap and water in the evening	Male Female	11 (7.3) 9 (6.6)	29 (19.3) 19 (12.7)	6 (4.0) 8 (5.3)	26 (17.3) 17 (11.3)	78 (52.0) 97 (64.7)
Bath with just soap and water in the evening	Male Female	77(51.3) 97 (64.7)	42 (28.0) 25 (16.7)	9 (6.0) 15 (10.0)	10 (6.7) 8 (5.3)	12 (8.0) 5 (3.3)
Bath with just water in the evening	Male Female	76 (50.7) 91 (60.7)	39 (26.0) 27 (18.0)	25 (16.7) 23 (15.3)	10 (6.7) 8 (5.3)	0 (0.0) 1 (0.7)
Eat on bed	Male Female	21(14.0) 20 (13.3)	37 (24.7) 34 (22.7)	29 (19.3) 32 (29.3)	37 (24.7) 32 (21.3)	26 (17.3) 32 (21.3)
Wash hair every day	Male Female	58 (38.7) 62 (41.3)	40 (26.7) 47 (31.3)	42 (28.0) 33 (22.0)	10 (6.7) 6 (4.0)	0 (0.0) 2 (1.3)
Wash hands frequently during the day with soap and water	Male Female	6 (4.0) 4 (2.7)	26 (17.3) 20 (13.3)	55 (36.7) 54 (36.0)	41 (27.3) 40 (26.7)	22 (14.7) 33 (21. 3)

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Cough/ sneeze into tissue and dispose	Male Female	1 (0.7) 0 (0.0)	16 (10.7) 19 (12.7)	16 (10.7) 24 (16.0)	74 (49.3) 65 (43.3)	43 (28.7) 42 (28.0)
Wash hands with soap and water after using tissue	Male Female	14 (9.3) 9 (6.0)	33 (22.0) 36 (24.0)	37 (24.7) 37 (24.7)	44 (29.3) 42 (28.0)	22 (14.7) 26 (17.3)
Wash hands with soap and water every time after using washroom	Male Female	6 (4.0) 4 (2.7)	18 (12.0) 13 (8.7)	11 (7.3) 13 (8.7)	45 (30.0) 42 (28.0)	70 (46.7) 78 (52.0)
Use hand sanitizer frequently	Male Female	7 (4.7) 4 (2.7)	24 (16.0) 26 (17.3)	53 (35.3) 51 (34.0)	27 (18.0) 31 (20.7)	39 (26.0) 38 (25.3)
Keep toes and fingernails are short	Male female	8 (5.3) 8 (5.3)	18 (12.0) 21 (14.0)	24 (16.0) 23 (15.3)	47 (31.3) 40 (26.7)	53 (35.3) 58 (38.7)

The results in Table 1 provide a gender-based breakdown of personal hygienic practices among respondents, highlighting variations in frequency across multiple behaviours. For Bathing Twice a Day (Morning and Evening), the results in Table 1 show that both males and females demonstrate relatively high frequencies of bathing twice a day, with over 60% reporting they do so "often" or "very often." However, females (41.3%) report bathing twice daily more frequently than males (34.7%). In relation to bathing with sponge, soap, and water in the morning, a large majority of both males (62.0%) and females (67.3%) report "very often" practicing this hygienic behaviour, suggesting a strong commitment to cleanliness in the morning routine for both genders. In addition, for bathing with just soap and water in the morning, while most respondents report using sponge, soap, and water, a significant portion also bathes with just soap and water. Females (68.7%) are slightly more likely to do this "very often" than males (59.3%).

With regard to bathing with just water in the morning, interestingly, a small but significant percentage (71.3% males, 77.3% females) reports bathing with just water. Females tend to engage in this practice slightly more often than males. While for bathing with sponge, soap, and water in the evening, similar trends are observed in the evening bathing habits, with the majority of respondents indicating they bathe with sponge, soap, and water, particularly females (64.7%) compared to males (52.0%). Again, for bathing with just soap and water in the evening, fewer respondents, particularly females, engage in this practice. Over 50% of males and 64.7% of females report rarely or never doing so. The practice of using only water in the evening is less frequent than in the morning, with over 50% of both genders (50.7% males, 60.7% females) rarely or never practicing it.

Respondents are divided on the practice of eating on bed. A relatively high percentage, around 20-30% of both males and females, report engaging in this behavior moderately or more often, suggesting a somewhat common but inconsistent habit. Daily hair washing is not widespread. While 41.3% of females and 38.7% of males report "not at all" or "rarely" washing their hair daily, around 22-28% of respondents wash their hair frequently. Hand hygiene is an important personal care routine. Over 60% of both males and females report "moderately" to "very often" practicing it, with slightly more females (21.3%) than males (14.7%) reporting doing so "very often." The majority of respondents exhibit responsible behavior when sneezing or coughing, with 49.3% of males and 43.3% of females practicing this hygienic habit "often."

Hand washing after using tissue is reported as "moderately" or "often" by over 50% of respondents, with males showing slightly higher adherence than females. The practice of washing hands after using the washroom is more consistently followed, with around 46.7% of males and 52.0% of females doing so "very often." Hand sanitizer use is less common than soap and water, with only about 25-26% of both males and females reporting frequent use. Good portions of respondents keep their nails short, with 35.3% of males and 38.7% of females reporting they do so "very often."

In relation to gender differences, females generally exhibit more frequent personal hygiene practices compared to males, particularly in bathing, washing hands, and nail care. Some practices, like hand washing after using the washroom and bathing twice daily, show high adherence, whereas others like daily hair washing and use of hand sanitizer are less common. The data reveals areas where hygienic habits could be improved, such as ensuring more respondents wash their hands frequently during the day and after coughing or sneezing.

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Table 2

Bed Linen Laundry Practices of Respondents

Laundry Hygienic practices	Gender Male/ female	Not at all Frequency (%)	Rarely Frequency (%)	Moderately Frequency (%)	Often Frequency (%)	Very often Frequency (%)
Use detergents in washing	Male female	9 (6.0) 10 (6.7)	29 (19.3) 32 (21.3)	22 (14.7) 29 (19.3)	36 (24.0) 34 (22.7)	54 (36.0) 45 (30.0)
Use bleach in washing	Male Female	50 (33.3) 53 (35.3)	33 (22.0) 34 (22.7)	44 (29.3) 39 (26.0)	14 (9.3) 17 (11.3)	9 (6.0) 7 (4.7)
Boil bed linens before washing	Male Female	71 (47.3) 59 (39.3)	42 (28.0) 41 (27.0)	7 (4.7) 17 (11.3)	20 (13.3) 22 (14.7)	10 (6.7) 11 (7.3)
Rinse bed linens two to three times after washing	Male Female	31 (20.7) 20 (13.3)	22 (14.7) 38 (25.3)	33 (22.0) 39 (26.0)	40 (26.7) 33 (22.0)	24 (16.0) 20 (13.5)
Air bed linen under sunlight two to three times in a week	Male Female	34 (22.7) 33 (22.0)	31 (22.0) 35 (23.3)	30 (22.7) 38 (25.3)	21 (14. 0) 15 (10.0)	34 (22.7) 29 (19.3)
Use warm water in washing bed linen	Male Female	38 (25.3) 29 (19.3)	56 (37.3) 51 (34.0)	13 (8.7) 22 (14.7)	12 (8.0) 17 (11.3)	31 (20.7) 31 (20.7)
Dry bed linen directly under sunlight after washing	Male Female	34 (22.7) 33 (22.0)	11 (7.3) 21 (14.0)	18 (12.0) 15 (10.0)	10 (6.7) 14 (9.3)	77 (51.7) 67 (44.7)
Dry bed linen under shade after washing	Male Female	87 (58.0) 74 (49.3)	35 (23.3) 32 (21.3)	14 (9.3) 20 (13.3)	4 (2.7) 14 (9.3)	10 (6.7) 10 (6.7)
Iron bed linen before usage on mattress	Male Female	19 (12.7) 19 (12.7)	46 (30.7) 48 (32.7)	25 (16.7) 40 (26.7)	38 (25.3) 31 (20.7)	22 (14.7) 12 (8.0)

The majority of respondents frequently use detergents, with 36.0% of males and 30.0% of females reporting they use detergents "very often"(Table 2). Only 6.0% of males and 6.7% of females do not use detergents at all, suggesting that detergent use is a common and regular part of laundry practices. Bleach use is less common, with 33.3% of males and 35.3% of females reporting that they "do not use bleach at all." Only a small percentage of respondents, 6.0% of males and 4.7% of females, use bleach "very often." The majority of respondents either rarely or moderately use bleach, indicating that bleach may not be a primary cleaning agent in their laundry routine. Boiling bed linens is not a widely adopted practice. Nearly half of the males (47.3%) and a significant portion of females (39.3%) never boil their bed linens. Only 6.7% of males and 7.3% of females do so "very often," indicating that boiling linens may be seen as an extra or less common hygienic measure.

A moderate number of respondents rinse their bed linens multiple times after washing. However, this practice is not overwhelmingly common, with 22.0% of males and 13.5% of females doing so "very often," and around 20-25% of respondents reporting they do not rinse their bed linens more than once. Significant portions of respondents air their bed linens under sunlight, though the frequency varies. Around 22-25% of both males and females report doing this "very often" or "moderately," while about the same percentage air their bed linens rarely or not at all. The majority of respondents rarely use warm water for washing bed linens, with 37.3% of males and 34.0% of females reporting they "rarely" do so. Around 20% of respondents use warm water "very often," indicating that warm water is not universally preferred for washing bed linens. A majority of respondents, 51.7% of males and 44.7% of females, dry their bed linens directly under sunlight "very often." This suggests a high level of adherence to natural drying methods that promote better hygiene through sunlight exposure.

However, the practice of drying bed linens in the shade is more common than expected, with 58.0% of males and 49.3% of females doing this "not at all." A smaller percentage of respondents, around 9-10%, dry bed linens under shade "very often," indicating sunlight is preferred for drying. Ironing bed linens before use is not a common practice, with 30.7% of males and 32.7% of females rarely ironing their bed linens. Only about 14.7% of males and 8.0% of females report ironing bed linens "very often," indicating that this hygienic practice is less prioritized.

The results in Table 2 reveal varied practices in maintaining hygienic bed linen laundry routines among respondents, with noticeable gender differences in certain areas. Overall, the use of detergents is widely practiced, indicating awareness of the importance of cleanliness. However, the use of bleach is less common, possibly due to concerns about fabric damage or the extra cost associated with bleach products. The infrequent use of boiling bed linens further suggests that time-intensive or energy-demanding practices are not favoured, even though they may offer additional hygiene benefits.

While most respondents adhere to rinsing bed linens multiple times, there is room for improvement, especially for females, who report lower rates of rinsing compared to males. Sunlight drying is a strong preference for a large portion of respondents, reflecting an awareness of its natural disinfecting properties. However, some still dry bed linens in the shade, which might not provide the same level of hygiene benefits. Interestingly, the relatively low frequency of ironing bed linens before use indicates that many respondents might not see this as essential to hygiene.

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This could be due to a lack of awareness of how ironing can eliminate lingering bacteria or simply a preference for less labour-intensive laundry practices.

4.2 Frequency of Bed Linen Washing Among Respondents

Table 3 presents the frequency of bed linen washing among respondents, categorized by gender. The results indicates that for male respondents, 7.3% wash bed linens every 3 days, 33.3% wash them every week, 22.0% wash them every two weeks and 37.3% wash them once a month. In relation to females, 6.7% wash bed linens every 3 days, 42.7% wash them every week, 23.3% wash them every two weeks and 27.3% wash them once a month.

Table 3

Number of Times Respondents Wash Bed Linens in Relation to Gender

Gender	Number of times for washing bedlinen			
	Every 3 days Frequency (%)	Every week Frequency (%)	Every two weeks Frequency (%)	Every month Frequency (%)
Male	11 (7.3)	50 (33.3)	33 (22.0)	56 (37.3)
Female	10 (6.7)	64 (42.7)	35 (23.3)	41 (27.3)

From Table 3, it is clear that the most common frequency for both genders is weekly, though a significantly higher percentage of females (42.7%) engage in this routine compared to males (33.3%). Conversely, men are more likely to wash bed linens monthly (37.3%) than women (27.3%). The result suggests a gender-based difference in the frequency of bed linen washing. A larger proportion of female respondents wash their linens weekly or bi-weekly, compared to male respondents, who tend to wash them less frequently, with the highest percentage (37.3%) washing them only once a month. Several factors could account for these differences. Societal expectations and traditional gender roles often place more emphasis on women maintaining household cleanliness, which may influence more regular washing habits. Women may also be more conscious of hygiene or have routines that align more closely with regular cleaning schedules.

On the other hand, men's higher tendency to wash bed linens monthly may reflect different priorities in personal hygiene routines or less concern about adhering to strict cleanliness standards. This could also be a reflection of lifestyle factors, such as living alone or with minimal household responsibilities, resulting in less frequent linen washing. The small percentage of respondents who wash their bed linens every three days is relatively similar across genders, indicating that this more frequent cleaning routine is less common, but followed by a minority in both groups.

4.3 Microbial Load of Mattresses, used and Unused Bed Linens with Gender Perspective

Table 4 shows that E. coli presence on mattresses from male respondents was low, with several samples (e.g., C1 and C2) showing minimal contamination. The highest observed load was 3.66 cfu/cm in sample C10 (S.D 6.35). For the female samples, E. coli was mostly absent on mattresses, with nearly all samples showing no microbial growth, indicating slightly better hygiene conditions compared to the male samples in this aspect. For Klebsiella A on Mattresses, both male and female mattresses had minimal contamination from *Klebsiella A*, with most samples showing a count of 0.01 cfu/cm or none at all. This suggests that mattresses, regardless of gender, had minimal exposure to this pathogen.

Table 4

Descriptive Statistics of Microbial Load of Mattresses, used and Unused Bed Linens

SAMPLE ID		Mattress				Unused bedlinen				Used bedlinen			
		E.coli		Klebsiella A		E.coli		Klebsiella A		E.coli		Klebsiella A	
		M(cfu/cm)	S.D	M(cfu/cm)	S.D	M(cfu/cm)	S.D	M(cfu/cm)	S.D	M(cfu/cm)	S.D	M(cfu/cm)	S.D
C1	Male Samples	0.33	0.58	0.00	0.00	0.67	1.15	11.00	19.05	73.67	38.79	53.67	2.30
C2		0.47	0.25	0.92	0.54	83.00	22.60	87.33	4.93	68.00	24.33	79.33	24.94
C3		0.26	0.44	0.00	0.00	0.00	0.00	0.00	0.00	61.66	84.21	30.33	43.08
C4		0.320.32	0.55	0.00	0.00	0.00	0.00	4.66	8.08	81.00	58.79	80.33	14.04
C5		0.26	0.44	0.00	0.00	0.00	0.00	0.00	0.00	61.66	84.21	30.33	43.08
C6		0.00	0.00	0.00	0.00	0.00	0.00	12.66	11.15	117.33	50.21	185.00	54.74
C7		0.00	0.00	0.01	0.01	145.33	137.71	6.00	7.00	184.66	138.01	143.00	198.46
C8		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	86.00	110.17	55.33	72.43

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C9		0.00	0.01	0.00	0.01	0.00	0.00	0.33	0.57	305.66	109.40	530.33	109.63
C10		3.66	6.35	0.01	0.02	0.00	0.00	0.33	0.57	94.33	130.48	198.66	135.88
C11		0.01	0.02	0.01	0.02	57.00	62.55	34.33	39.52	104.66	126.08	145.00	123.55
C12		0.33	0.57	0.00	0.00	1.33	2.30	0.00	0.00	30.66	42.82	47.33	61.49
C13		0.00	0.00	0.00	0.00	0.33	0.57	2.66	4.61	153.66	126.75	47.66	82.56
C14		0.00	0.00	0.01	0.02	2.33	4.04	16.66	1.15	208.66	75.00	296.66	5.77
C15		0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	105.66	140.50	59.33	58.82
C16		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	345.00	436.17	36.00	61.53
C17	Female	0.00	0.00	0.00	0.00	3.00	2.64	0.66	0.57	197.33	91.59	66.00	61.53
C18		0.00	0.00	0.03	0.05	0.00	0.00	0.66	1.15	72.66	98.19	133.33	109.57
C19		0.00	0.00	0.00	0.00	73.33	103.00	49.33	78.52	119.66	157.38	100.00	45.29
C20		0.00	0.00	0.00	0.00	1.00	1.73	53.33	73.21	105.66	140.69	28.66	24.84
C21		0.00	0.00	0.00	0.00	2.33	4.04	5.33	3.21	118.33	36.89	517.00	111.07
C22		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.33	11.95	19.66	29.77
C23		0.00	0.00	0.66	0.57	0.00	0.00	0.00	0.00	20.66	26.83	18.66	27.20
C24		0.00	0.00	0.00	0.00	292.00	88.27	426.66	68.06	180.66	52.50	212.00	367.19
C25		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	189.66	52.50	212.00	367.19
C26		0.00	0.00	0.00	0.00	0.33	0.57	0.00	0.00	23.00	23.89	48.66	69.06
C27		0.00	0.00	0.00	0.00	7.33	11.01	2.33	2.51	309.33	100.80	222.33	97.57
C28		0.00	0.00	0.00	0.00	0.00	0.00	2.33	4.04	151..66	99.32	31.00	53.69
C29		0.00	0.00	0.00	0.00	4.33	7.50	1.33	1.52	269.66	87.53	8.33	7.23
C30		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	248.00	61.02	322.33	77.42
C31		0.00	0.00	0.00	0.00	8.66	12.50	6.33	4.93	58.00	44.91	54.66	14.57
C32		0.00	0.00	0.01	0.02	586.33	185.07	740.00	189.19	732.66	102.96	553.66	170.93

The contamination levels of *E. coli* on unused bed linens varied considerably. Sample C2 had a high microbial load (83.00 cfu/cm, S.D 22.60), while several other male samples (e.g., C3) showed no contamination. Similar patterns were observed in female samples, with a significant spike in sample C32 (586.33 cfu/cm, S.D 185.07) (Table 4). This indicates that gender does not seem to play a major role in unused linen contamination, although high variance suggests differences in handling and storage conditions. However, the presence of *Klebsiella A* was substantial in certain male samples, with C2 showing a load of 87.33 cfu/cm (S.D 4.93). However, most samples, such as C3 and C4, had no contamination. However, female samples exhibited higher levels of *Klebsiella A* in general, with C32 being the highest (740.00 cfu/cm, S.D 189.19). This suggests that both male and female linens can harbour significant contamination, but female samples had a higher maximum load.

In addition, E. coli contamination was notably high in used bed linens for male respondents, with sample C16 showing 345.00 cfu/cm (S.D 436.17). The wide variance suggests significant differences in hygiene practices among male respondents. The female samples also showed high levels of contamination, particularly sample C24 (426.66 cfu/cm, S.D 68.06) (Table 4). This indicates that regardless of gender, used linens pose a significant risk for bacterial contamination. Also, Klebsiella A was consistently present in male samples, with a peak in C16 (553.66 cfu/cm, S.D 170.93). Several other male samples also showed high contamination levels, such as C9 and C10. The female samples were equally concerning, with sample C32 showing 553.66 cfu/cm (S.D 170.93). This suggests that *Klebsiella A* contamination is a major issue for both male and female used linens.

The analysis of microbial contamination on mattresses, unused, and used bed linens reveals several key gender-specific trends. Both male and female respondents had low microbial contamination on their mattresses, particularly for *E. coli* and *Klebsiella A*. However, mattresses from male respondents exhibited slightly higher variability in contamination levels, indicating possible differences in hygiene practices or mattress maintenance between genders. There were high variances in contamination levels on unused bed linens for both genders, suggesting that environmental factors, rather than gender, play a key role in introducing bacteria before use. Nevertheless, unused linens from female respondents exhibited higher peak values for both *E. coli* and *Klebsiella A*, which could imply differences in storage conditions or handling practices. Used bed linens posed the highest risk of contamination for both male and female respondents, particularly with *E. coli* and *Klebsiella A*. Both genders had samples with alarmingly high bacterial loads, which indicates that personal hygiene practices and laundering methods significantly influence microbial presence. Interestingly, male samples showed higher variance, suggesting more

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inconsistency in how male respondents manage bed linen hygiene compared to females. These results point to the importance of consistent laundering practices, proper handling, and environmental controls in maintaining hygiene in both male and female households. The high microbial loads, especially in used bed linens, highlight the necessity for regular cleaning with appropriate methods, such as using hot water, disinfectants, and ensuring proper drying conditions to reduce bacterial proliferation.

The findings are consistent with most studies as they confirm that textiles can serve as a habitant for microbes where they can even multiply (Bajpai et al., 2011; Hyde, 2024). Pathogen may be able to survive on textile surfaces for periods oscillating from a few minutes to several hours (Neely & Maley, 2001; Neely, 2000). Under an ideal condition which is 36–40 ″C, pH 5–9, some bacteria populations may double every 20 - 30 minutes (Zanoaga & Tanasa, 2014). This means that one single bacteria cell can increase to 1,048,576 cells in just 7 hours, and this is a confirmation of the findings of the study in the increase of microbial load after usage. The increase in microbial load after usage could also be attributed to operations like cooking and eating, being outside and working which can affect where the microbial flora present on the epidermis and in bodily excrements is distributed (Abney et al., 2021).

Again the results showed high load on the cotton bed linen used for the study. This result is consistent with studies that have shown that the properties of textiles, such as the fabric type, can also affect the presence of pathogens and bacteria that cause growth on textile surfaces (Abney et al., 2021). Natural fibres based on their high moisture retention qualities can give microbes nutrients and energy sources in the shape of proteins or carbohydrates (Gao & Cranston, 2008; Siracusa, 2019; Pathak, 2017). Various fibres' microbial attractions make fabric mixes made of natural and synthetic fibres more effective at reducing microbial adhesion (Siracusa, 2019; Szostak-Kotowa 2004; Pathak, 2017; Gupta & Bhaumik, 2007). A natural and synthetic fiber mix according to the researchers is less likely to promote microbial development than fabrics composed entirely of natural fibres.

The results reveals that there is a reason to be worried since majority of the load found on the used bedlinen contained more than 10^5 CFU/ml or 2.5 cfu/cm as indicated to be high and could cause health related issues (Mulvey et al., 2011; Situ Biosciences, 2023)

V. CONCLUSIONS & RECOMMENDATIONS

5.1 Conclusions

The study reveals a generally strong commitment to personal hygiene among respondents, with significant differences between males and females. Females tend to practice more frequent hygiene routines, especially in areas like bathing, hand washing, and nail care. However, some practices, such as using hand sanitizers and washing hands after sneezing or coughing, show room for improvement in preventing the spread of illness. The study also highlights a gender disparity in bed linen washing habits, with females more likely to wash linens weekly or every two weeks, while males tend to wash them monthly. This finding suggests that probably traditional gender roles and societal expectations influence these household tasks.

Microbial contamination, particularly from E. coli and Klebsiella A, was prevalent on used bed linens, highlighting the need for improved laundering practices. The lower contamination levels on mattresses, combined with the higher levels on bed linens, underscore the importance of regular and thorough washing and drying methods for linens, regardless of gender.

5.2 Recommendations

Hygiene education should be strengthened, particularly in areas like hand sanitizing and hand washing after coughing or sneezing, to help reduce the spread of illness. All genders are encouraged to wash bed linens more frequently, focusing on the importance of regular laundering to reduce bacterial contamination. This study can be used as a basis to launch awareness campaigns that emphasize the importance of consistent hygiene routines and bed linen care for both males and females. Students should be educated on hygiene and the role microorganisms play in affecting the health and academic work of students.

REFERENCES

Abney, S. E., Khalid Ijaz, A. M, McKinney, J. B. C., & Gerba, C. B. P. (2021). Laundry hygiene and odor control: state of the science. *Applied and Environmental Microbiology*, *87*(14), e0300220.

Aiello, A. E., Coulborn, R. M., Perez, V., & Larson, E. L. (2008). Effect of hand hygiene on infectious disease risk in the community setting A meta-analysis. *Am J Public Health*, *98*(8), 1372 – 81.

Ahmad, H. B. & Halim, H. B. (2017). Determining Sample Size for Research Activities: The Case of Organizational Research. *Selangor Business Review*, *2*(1), 20-34.

Aunger, R., Greenland, K., Ploubidis, G., Schmidt, W., Oxford, J., & Curtis, V. (2016). The determinants of reported personal and household hygiene behaviour: A multi-country study. *PLOS ONE*, *11*(8):e0159551.

Licensed Under Creative Commons Attribution (CC BY-NC)

Bajpai, V., Dey, A., Ghosh, S., Bajpai, S., & Jha, M. K. (2011). Quantification of bacterial adherence on different textile fabrics. *Indian Chemical Engineer*, *65*(8), 1169 - 1174.

Berche, P. (2012). Louis Pasteur, from crystals of life to vaccination. Clinical Microbiology and Infection, 18(5), 1-6.

Bloomfield, S. F., Exner, M., Nath, K. J., Scott, E. A., & Signorelli, C. (2011). The infection risks associated with clothing and household linens in home and everyday life settings, the role of laundry. *International Scientific Forum on Home Hygiene*, Somerset, United Kingdom.

Campos, A. K., Cardonha, A. M., Pinheiro, L .B., Ferreira, N. R., De Azevedo, P. R., & Stamford, T. L. (2009). Assessment of personal hygiene and practices of food handlers in municipal public schools of Natal, Brazil. *Food control*, *20*(9), 807-810.

Center for Disease Control and Prevention (CDCP). (2019). *Antibiotic resistance threats in the United States.* https://www.cdc.gov/drugresistance/biggest_threats.html.

De Cock, K. M., Simone, P. M., Davison, V., & Slutsker, L. (2013). The new global health. *Emerging infectious diseases*, *19*(8), 1192 - 1197.

Fonkwo, P. N. (2008). Pricing infectious disease. The economic and health implications of infectious diseases. *EMBO reports*, *9 Suppl 1*(Suppl 1), S13–S17. https://doi.org/10.1038/embor.2008.110

Freney, J., & Renaud, F. N. R. (2012). Textiles and Microbes. In P. Kiekens and S. Jayaraman (Eds.), *Intelligent Textiles and Clothing for Ballistic and NBC Protection*, pp 53-55. DOI: 10.1007/978-94-007-0576-0_3.

Gao, Y., & Cranston, R. (2008). Recent Advances in Antimicrobial Treatments of Textiles. *Textile Research Journal*, *78*(1), 60 - 72.

Gupta, D., & Bhaumik, S. (2007). Antimicrobial treatments for textiles. *Indian Journal of Fibre and Textile Research*, *32*(2), 254 - 263.

Hyde, M. (2024). *Bacteria in your Bed*. https://amerisleep.com/blog/bacteria-in-your-bed/

Kabir, A., Roy, S., Begum, K., Kabir, A. H., & Miah, M. S. (2021). Factors influencing sanitation and hygiene practices among students in a public university in Bangladesh. *PloS one*, *16*(9), e0257663. https://doi.org/10.1371/journal.pone.0257663.

Kuhn, D. M., & Ghannoum, M. A. (2003). Indoor mold, toxigenic fungi, and stachybotrys chartarum: Infectious disease perspective. *Clinical Microbiology Reviews*, *16*(1), 144 - 172.

Lambrecht, B. N., & Hammad, H. (2014). Allergens and the airway epithelium response: 780 gateway to allergic sensitization. *Journal of Allergy and Clinical Immunology*, *134*(3), 499 - 507.

Maloy, S., & Schaechter, M. (2006). The era of microbiology: a Golden Phoenix. International Microbiology, 9(1), 1-7.

Mara, D., Lane, J., Scott, B., & Trouba, D. (2010). Sanitation and health. PLoS Med, *7*(11), e1000363.

Mulvey, D., Redding, P., Robertson, C., Woodall, C., Kingsmore, P., Bedwell, D., & Dancer, S. (2011). Finding a benchmark for monitoring hospital cleanliness. *The Journal of hospital infection*, *77*(1), 25 - 30.

Nath, K. J. (2003). Home hygiene and environmental sanitation: a country situation analysis for India. *International Journal of Environmental Health Research*, *13*(1), 19 - 28.

Neely, A. N. (2000). A survey of gram-negative bacteria survival on hospital fabrics and plastics. *Journal of Burn Care & Rehabilitation*, *21*(6), 523 - 527.

Neely, A. N., & Maley, M. P. (2001). Survival of Enterococci and Staphylococci on hospital fabrics and plastic. *Journal of Clinical Microbiology*, *38*(2), 724 - 726.

Olowomofe, O. T., Oluyege, O. J, A., Ogunlade, O., & Makinde, O. T. (2020). Microbial assessment of bed Linens in Ekiti State University Students' Hostels. *Journal of Advances in Microbiology*, *20*(5), 43-52.

Pathak, V. M. N. (2017). Review on the current status of polymer degradation: a microbial approach. *Bioresource and Bioprocessing*, *4*(15), 1 – 31.

Satish Kumar, B. P., Meghana, A. R., Prolay, P., Lipika, D., Darshan, J. C., Berlin, P .K., Sayantan, G., & Ravindra, B. N. (2020). Importance of understanding the need of personal hygiene: A comprehensive review. *International Journal of Research in Pharmacy and Pharmaceutical Sciences*, *5*(6), 56 - 61.

Scott, E., Bruning, E., & Ijaz, M. K. (2020). Decontamination of environmental surfaces in everyday settings. In: McDonnell, Hansen, (Eds.), *Block's Disinfection, Sterilization, and Preservation.* (6th ed.) Philadelphia: Wolters Kluwerin press.

Situ Biosciences. (2023). *Assessment & Control of Microbial Contamination: A Guide to Microbial Testing: Microbial Control vs Microbial Elimination*. Assessment & Control of Microbial Contamination - Situ Biosciences.

Siracusa, V. (2019). Microbial degradation of synthetic biopolymers waste. *Polymers*, 11, 106.

Smith, H. O., Venter, J. C., & Glass, J. I. (2009). Creating bacterial strains from genomes that have been cloned and engineered in yeast. Science, (325), 1693–1696.

Smith, V. S. (2008). Clean: a history of personal hygiene and purity. Oxford University Press.

Licensed Under Creative Commons Attribution (CC BY-NC)

Szostak-Kotowa, J. (2004). Biodeterioration of textiles. *Intionational Biodeterioration & Biodegradable*, 53, 165 - 170.

The Conversation. (2012). *Your bed probably isn't as clean as you think – a microbiologist explains.* https://theconversation.com/your-bed-probably-isnt-as-clean-as-you-think-a-microbiologist-explains-163513

Tierno, P. M. (2019). *The secret life of germs: Observations and lessons from a microbe hunter*. New York, NY: Atria Books.

Wilson, D. R. (2023). *What does it mean to have bad hygiene*?. https://www.healthline.com/health/healthy-lifestyle/bad-hygiene

Wood, J. P., Choi, Y. W., Wendling, M. Q., Rogers, J. V., & Chappie, D. J. (2013). Environmental persistence of vaccinia virus on materials. *Lett Applied Microbiology, 57*(5), 399 - 404.

WHO. (2018). *Antimicrobial resistance*. https://www.who.int/health-topics/antimicrobial-resistance.

WHO. (2019). *Hygiene*. Hygiene. World Health Organization, Regional Office for Africa.

Ying, S.; Zeng, D., Chi, L., Tan, Y., Galzote, C., Cardona, C., Lax, S., Gilbert, J., & Quan, Z. (2015). *The Influence of Age and Gender on Skin-Associated Microbial Communities in Urban and Rural Human Populations. PLOS ONE, 10*(10), e0141842. doi:10.1371/journal.pone.0141842.

Zanoaga, M., & Tanasa, F. (2014). Antimicrobial reagents as functional finishing for textiles intended for biomedical applications. I. Synthetic organic compounds. *Chemistry Journal of Moldova*, 9, 14 - 32.

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