Microbial Presence on Artificial vs. Natural Nails

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OXON HILL HIGH SCHOOL

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- OHHS Instrumental Music Boosters Association (2016-2020)

Advice to Class of 2021:

Apply for plenty of scholarships as soon as possible! You can find them on websites such as niche.com, fastweb.com, and scholarshipowl.com.

Acknowledgements

I would first like to thank my mother for providing me with the opportunity to have an internship and amazing mentors, Dr. Xinbin Gu and Dr. Hashmi Rahat. These two individuals guided me throughout the entire duration of my project, as well as allowed me to use their facility to conduct my study. Secondly, I would like to thank my friends for encouraging me to apply for an internship in the first place. I especially would like to thank my friend and classmate, Makayla McKnight, for encouraging me to look into outside internships when it was not a guarantee that I would receive an internship through the school. Last of all, I would like to acknowledge and thank the 4 staff members at the Howard University College of Dentistry who acted as participants in my study.

Abstract

In this study, 4 different sets of both artificial and natural nails were swabbed in order to determine if the type of nail made a difference in the presence of microflora. Using 20 cotton swabs for each nail type, both unwashed and washed, each participant's nails were swabbed with a cotton swab containing Dulbecco's Phosphate-Buffered Saline (DPBS), cultivated with nutrient agar in 8 separate Petri dishes, and placed into the incubator. After the Petri dishes were taken out of the incubator, the microbial colonies were visible and could be counted. The results showed that on average, artificial nails had at least 100 microbial colonies more than natural nails. Based on the data collected, the hypothesis that artificial nails would yield more microflora because they conceal the natural nail was disproved.

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Finger	Sample 1	Sample 2	Sample 3	Sample 4
Thumb	67	550	78	500
Index	51	37	550	25
Middle	67	56	500	400
Ring	50	750	500	7
Pinky	8	41	450	20

Table 1. Approximate amount of microbial colonies on artificial nails, unwashed.

Table 2

Finger	Sample 1	Sample 2	Sample 3	Sample 4
Thumb	150	90	150	27
Index	400	500	8	13
Middle	400	300	200	2
Ring	500	350	70	60
Pinky	150	15	32	0

Table 2. Approximate amount of microbial colonies on artificial nails, washed.

Table 3

Finger	Sample 1	Sample 2	Sample 3	Sample 4
Thumb	50	16	300	12
Index	50	1	50	12
Middle	100	16	45	4
Ring	150	1	55	1
Pinky	250	0	1	7

Table 3. Approximate amount of microbial colonies present on natural nails, unwashed.

Table 4

Finger	Sample 1	Sample 2	Sample 3	Sample 4
Thumb	200	13	60	0
Index	300	0	4	13
Middle	40	0	7	10
Ring	28	0	0	2
Pinky	2	0	0	130

Table 4. Approximate amount of microbial colonies present on natural nails, washed.

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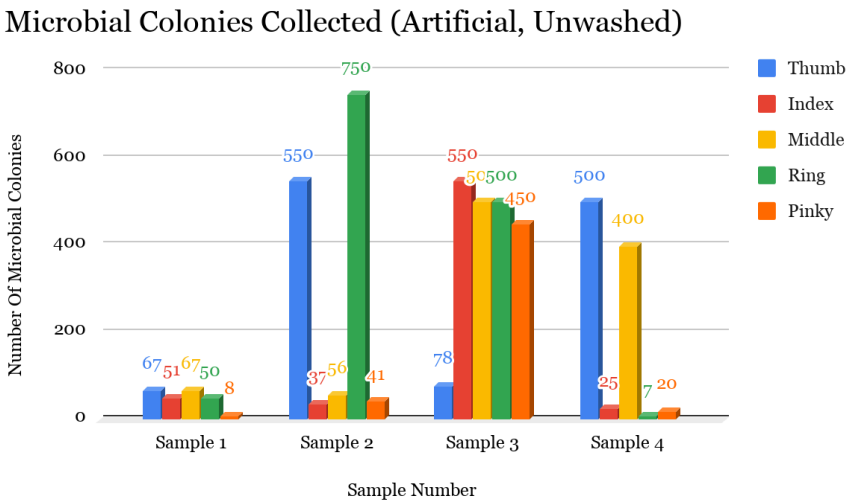
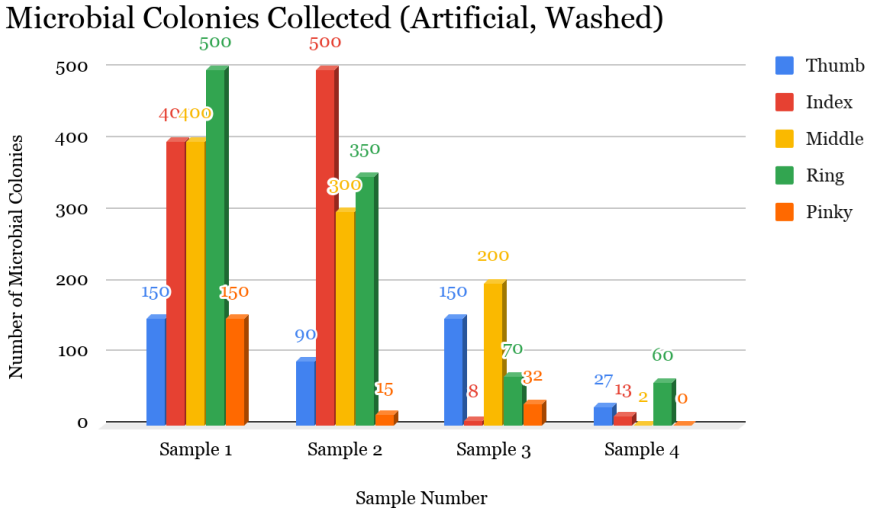


Figure 1. Visual representation of microbial colonies on artificial nails, unwashed.

Figure 2



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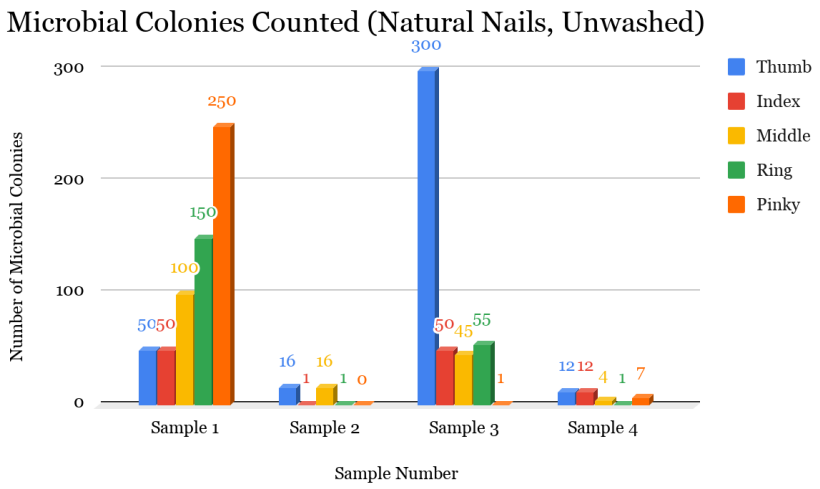

Figure 3. Visual representation of microbial colonies on natural nails, unwashed.

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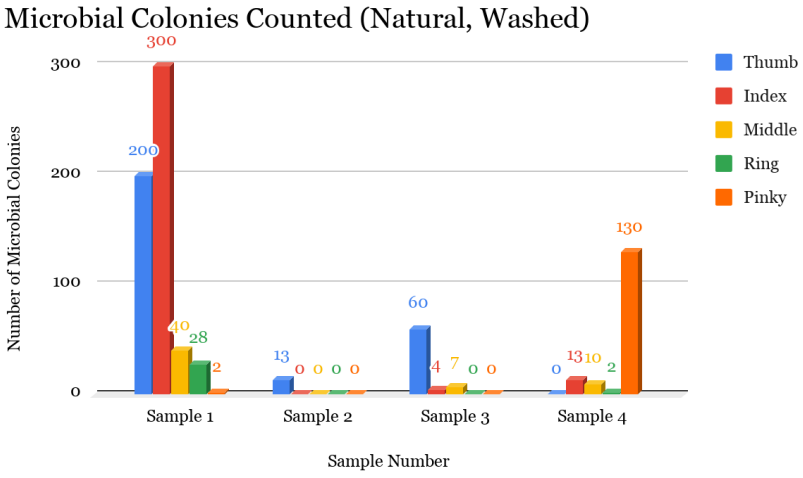


Figure 4. Visual representation of microbial colonies on natural nails, washed.

Chapter One

The Problem and its Setting

In healthcare settings, the most important focus to healthcare workers when treating patients, is eliminating the spread of bacteria as much as possible. This is done by taking extra precautionary measures, such as always reminding employees to wash their hands properly, using gloves when dealing with patients, constantly disinfecting environmental surfaces, as well as many others. However, a major concern is being brought to the attention of hospitals: staff members wearing artificial nails. The two types of artificial nails, gel and acrylic, are essentially used for nail beautification, and are also primarily used to protect nails that are damaged and brittle. As these artificial nails cover a person's natural nails, there is a higher risk for the spread of infection between healthcare workers (Klotter 2019).

Statement of the Problem

The main focus of hospitals, besides treating patients, are making any environment that people come in contact with as sterile as possible. Because of the increased opportunity of microflora to spread due to the length of artificial nails, they are strongly discouraged in healthcare environments. This study will compare the growth of microflora on both natural and artificial nails, washed and unwashed, to determine if artificial nails make a significant difference in the presence of bacteria. If artificial nails are proven to carry more microflora than natural nails, then that would urge every healthcare agency in the nation to prohibit healthcare workers from wearing artificial nails, ultimately protecting the safety of everyone. The testable factor in this project is the comparison of microflora growth on natural nails. To summarize, which yields the highest amount of microflora: natural nails or artificial nails?

Hypothesis

A hypothesis that can be made is that if natural nails are concealed by the artificial nails, then artificial nails will yield the highest amount of microflora. This hypothesis is based on common knowledge, as well as a study supporting that bacteria can only be killed through proper hand washing (Schroeter 1998). If this does not happen, or if the bacteria is not exposed to direct air, the bacteria already present on a person's nails will multiply itself. Because of this, it is likely that artificial nails will have the highest microflora count compared to natural nails alone, due to the fact that the bacteria is trapped under the artificial nail, and the bacteria from the artificial nail is transferred to the natural nail.

Variables and Specifications

The independent variable is the two different types of nail samples. These samples, which are natural nails and artificial nails, will be swabbed for microflora. Each of the samples will also be either washed with antibacterial soap, or unwashed. The same swab will then be transferred to the petri dish containing nutrient agar. The control group in this study are the natural nails that have been washed with antibacterial soap, since hospitals prefer natural nails over artificial ones. This will be used as a baseline to determine how much bacteria on a person's nails is "normal", compared to if the amount of microflora on artificial nails significantly differs. The dependent variable is the amount of microflora on all of the nail samples. This will be measured through a colony counter machine after being swabbed on the petri dishes, and placed in the incubator. The control variables include the amount of nutrient agar in each petri dish, the same size petri dish, the time and temperature at which the nutrient agar is sterilized, and the amount of time that the cultures are kept in the incubator to allow the bacteria to grow. There will be sixteen different

samples used: eight natural nail samples--four samples washed and four unwashed--and eight artificial nail samples--four also being washed and the other four being unwashed. To summarize, 8 trials will be conducted for each sample, totaling 32 trials altogether.

Assumptions and Limitations

Assumptions

1. Each nail sample has different amounts of microflora.
2. The ingredients used in the artificial nails are the same.
3. The artificial nails have been on each subject's nails for the same amount of time.

Limitations

1. The washed samples will not all be equally clean.
2. The swab will not collect the exact same amount of microflora for each nail sample.

Statistical Analysis

The statistical analysis used to determine which type of nail yields the higher amount of microflora will be determined using quantitative methods. The quantitative data is significant because it is what the statistical test will use to lead to the acceptance or rejection of the hypothesis.

Summary

Artificial nails are one of the many methods of nail beautification. However, its length and the way it traps bacteria is a major concern in the healthcare field. Testing natural nail samples in comparison to artificial nail samples can determine which type of nail yields the highest amount of microflora. This could make healthcare institutions, such as hospitals, aware of what measures need to be taken in order to keep bacteria from spreading from employees to

patients. Each bacteria culture found will be precisely counted using a colony counter machine, and mean and standard deviation will be calculated to get statistical analysis. The assumptions that come with this study regard amounts of microflora collected, some of which may not be the same, possible difference in the ingredients used for artificial nails, and the amount of time each subject had artificial nails on. Mean and standard deviation can be calculated based on the amount of bacteria colonies, and the amount of colonies can be compared to draw a conclusion.

Definitions of Terms and Abbreviations

1. Microflora-microscopic organisms, found only in certain environments
2. Nutrient agar-used to cultivate various types of bacteria and fungi using detrimental ingredients for growth

Chapter Two

The Review of the Related Literature

Artificial nails are worn in order to protect natural nails, as well as a method for nail beautification. In healthcare settings, however, these are prohibited due to the increased presence of microbial cultures on artificial nails (Schroeter, 1998). Their increased microbial presence stems from two factors—its increased surface area and the presence of nail polish. Since artificial nails are usually longer and thicker than natural nails, this gives bacteria and yeast the opportunity to multiply. Chipped nail polish results in an increased rough surface, leading to more bacterial multiplication.

Due to the increased presence of bacteria, there is a greater chance of cross-contamination between employees and patients. They can lift from the nail bed, giving the opportunity for bacteria to spread. Artificial nails are also more likely to puncture gloves, making them extremely dangerous for patients to come in contact with. Also, healthcare workers failing to adhere to specific handwashing procedures could result in the spread of infection. A solution to this problem would be a study of testing which type of nail—artificial or natural—carried more bacteria, and how this could be eliminated within the healthcare field. If healthcare institutions around the world were aware of these specific precautions and followed them, healthcare institutions could be better equipped to eliminate the spread of bacteria and infection.

History of Nails

The artificial nails and nail polish have been used for centuries. Nail coloring goes back to ancient time periods where people such as Egyptians used wax, for example, to color their nails. Modern-day nail polish includes film-forming agents, resins, plasticizers, solvents, thixotropic agents, pigments, and natural agents. Artificial nails, both acrylic, and gel were developed in order to protect natural nails that may be brittle and damaged (Tuupo, 2006). The ingredients needed to make acrylic nail powder are ethyl methacrylate and powdered poly-methacrylate. Benzyl peroxide, located in the powder, acts as a catalyst to speed up the drying and setting process, and may sometimes include titanium dioxide. Lastly, they can be removed with acetone. Gel nails, on the other hand, use powder and liquid to make the polish gel light and utilize UV light to harden the polish. Since long nails trap bacteria, do not effectively clean after using an antimicrobial soap, and can puncture gloves, healthcare advisors advise workers to steer clear of artificial nails (Madnani et al., 2012). The most recent advances of nail coloring in artificial nails include increased variations of liquid formulas. New nail polishes have been created that have different pigments, special effects, such as nail polish that changes according to your mood, and polishes with faster setting times (Burciaga, 2018). Being aware of the increased amount of bacteria that spreads with artificial nails can, furthermore, put both employees and patients at lower risk for infection.

Hand Hygiene

Hand washing is the number one way in preventing infections in healthcare institutions, or more specifically, healthcare-associated infections (HAIs). The precedent of washing your hands with an antiseptic agent was around since the early 19th century, but specific regulations on handwashing did not exist until the mid-1900s. The CDC stated that before and after patient contact with patients not at high risk for the spread of infection, employees should wash their hands with non-antimicrobial soap. With patients that are at high risk for spreading infections, as well as dealing with patients in invasive procedures, employees should wash their hands with antimicrobial soap. A non-antimicrobial soap does not necessarily kill bacteria, but efficiently removes them from the hands altogether (Canham, 2016). On the other hand, antimicrobial soap is harsher and kills bacteria. However, this method of hand-washing severely dries out the skin. The final method of hand cleansing is using an alcohol-based hand rub, which is being used among many healthcare facilities. When workers start to create their own standards on cleaning their hands instead of adhering to the explicit instructions the manufacturer gives, the spread of infection becomes a major concern. AORN recommends using actual soap and water over a waterless, hand-rub product because this is the most effective in killing bacteria, especially before surgical procedures (Ogg, 2007).

After cleaning hands with soaps and scrubs, it is vital that staff moisturize their hands with a compatible lotion immediately after hand washing. The purpose of this is to prevent skin from cracking due to excessive dryness, where bacteria can also thrive. Another factor that makes handwashing so harmful is the type of soap that is used: various dyes and detergents used in soaps are too harsh for frequent use on the skin. This is because your skin has natural oils and moisture that keep its pH balanced. In nursing, the most common skin problem is dermatitis,

which is skin inflammation. When skin is damaged, it is more likely to carry bacteria, such as Staphylococcus aureus. This factor, combined with the latex in gloves, can promote a great amount of bacterial infection (Metules, 2000). If healthcare workers worldwide are aware of this, they can be more knowledgeable about minimizing the spread of bacteria.

Types of Bacteria

The two different types of bacteria are transient flora and resident flora (Bush, 2019). Transient flora is also known as surface bacteria, and it is easier to remove than resident flora. This type of bacteria can be removed using non-antibacterial soap. Resident flora, or deep bacteria, live beyond the surface and can only be removed using antimicrobial soap. In other words, resident flora occupies a particular body site permanently, while transient flora does not. Gram-negative bacteria, which cause infection, are the primary cause of the spread of bacteria in healthcare settings. For example, fecal and oral pathogens can contaminate multiple environments due to its microbial presence on hands. This occurs, mostly in young children, due to the fact that they constantly encounter microbial bacteria from areas that contain a high count of bacteria, such as the soil. Given the fact that children constantly use their hands for eating, as well as playing, pathogens from these environments have the chance of being consumed (Parez., et al 2019). Researchers found that mobile children (5-14 months) had a higher count of E.coli on their hands and fingernails than immobile children (1-4 months). In the context of the healthcare field, this study further makes readers aware that children carry large amounts of bacteria on their hands, which can be harmful to healthcare facilities—sterile environments. Connecting this to the bacteria that exists under nails, both natural and artificial, if healthcare workers are exposed to this high count of bacteria since they work with children as well,

artificial nails could be an easier way for microbial bacteria to spread. In addition to gram-negative bacteria being spread through children, acrylic nails have been found to have a great number of gram-negative bacteria under the nail itself (Parry et al., 2001). If healthcare environments are aware of this, they will be more likely to prohibit the use of artificial nails due to its ability to harbor more bacteria, as well as take extra precautionary measures on employees washing their hands and using gloves when dealing with patients.

Hospital-Acquired Infections

Hospital-acquired infections (HAI) are bacteria, often gram-negative bacteria (GNB), that spreads to patients during their stay at a hospital. HAI caused by antimicrobial resistance (AMRs) are more difficult to treat, raising the risk of patient deaths (Peters et al., 2019). Even though HAI with ABR bacteria is less likely to be spread through communities, or people in general, AMR is the cause of approximately 300,000 deaths. Newborns and infants are also susceptible to infection more easily because of their weak immune systems, and 40% of baby deaths are related to this type of spread of bacteria (Klotter, 2019). This relates to the problem of artificial nails in the healthcare field because once again, they carry more bacteria than natural nails do. A study conducted from AORN Journal showed that artificial nails contained higher counts of cultures of bacteria than natural nails and that more effective measures need to be taken in healthcare fields in order to prevent the possible spread of bacteria to patients. The relevance of this study can help healthcare workers understand the major influences of microbial flora on humans when artificial nails come in contact with sterile fields (Zhang., et al 2019).

Hand Washing Procedures

Hands, as well as forearms, should be pre-washed to remove any debris. Next, healthcare workers should use a nail brush to clean all parts of the hands while they are under running water. Hands and forearms should be dried thoroughly with a paper towel, ensuring that no moisture remains on the hands. Lastly, the proper amount of hand rub should be applied to the hands and forearms, repeating if necessary. Once hands are completely dry, workers should then proceed to gown and gloves. Other key takeaways when it comes to handwashing are to wash your hands for no more than 30 seconds, with the exception of surgical scrubbing, which takes 2-5 minutes, use lotion afterward, and avoid things that harbor additional microbes, such as long nails and jewelry. Relating this study to microbial growth and fingernails, avoiding the use of artificial nails and scrubbing under fingernails could ensure that all parts of the hands are getting thoroughly cleaned. Making healthcare workers more aware of all of these key factors of hand cleanliness will ultimately minimize the spread of microflora bacteria.

Additional Health Precautions. Nurses' nails should be kept at a short length to make the handwashing process more effective. All healthcare staff and anyone else who enters a healthcare setting is encouraged to keep their hands clean as well, using both soap and water and hand sanitizer. It is stressed that artificial nails are not permitted in health care settings, and natural nails should be kept at a length of less than 1/4 inch. If nails are too long, this can make them more likely to puncture gloves, putting the health of patients, as well as the personnel, at-risk (Wilfinger, 2004). In addition to the length of nails, nails that are rough or brittle can cause damage to the nail bed, overall damaging the entire nail and making it more prone to infection. In order to prevent this bacteria from spreading to patients, nails should be smooth with a white hue at the base. Most importantly, they should be light, even color (Malkin, 2009).

Artificial nails should be avoided at all costs in order to ensure the best patient care possible. Natural nails should be cut short and even and they should be clean at all times. With hand washing, it is important to be as thorough as possible because of the constant and close contact with other people—especially people who are at high risk for the spread of infection. If healthcare institutions reinforce proper handwashing with soap and water on the hands, fingernails, wrists, and forearms, the presence of bacteria will be reduced significantly.

Summary

Artificial nails have been used as a method of nail beautification for years, and have been posed as a threat in healthcare settings. However, some healthcare workers within these institutions disregard these health precautions, putting others at risk for the spread of infection. This study provides a solution to the problem by determining whether having artificial nails makes a significant difference in the microbial presence, and how this bacteria can be prevented altogether. The most efficient way to eliminate the spread of bacteria is to wash your hands with soap and water. When washing, healthcare workers should pay attention to their hands, wrists, forearms, and fingernails. For workers that have direct contact with patients, they should wash their hands for 2-5 minutes. Surgeons should scrub their hands for no less than 5 minutes. All healthcare workers should use a moisturizing agent immediately following handwashing in order to prevent skin irritation or dryness. Artificial nails or long nails should not be worn, in addition to rings. Lastly, latex gloves should be worn during every interaction with a patient and changed after every patient. If artificial nails are eliminated completely and these healthcare procedures are followed by every healthcare facility in the nation, HAIs, and HCAIs, as well as the spread of bacteria, in general, could decrease significantly.

Chapter Three

The Research Methodology

Artificial nails are popular for their versatility in the sense of the various lengths, designs, colors, and types that you can wear. However, its larger surface area allows the opportunity for the greater presence of microflora. This is a significant problem in healthcare settings, especially, since healthcare workers would not be only putting their co-workers at risk for infection, but the patients they interact with as well. The spread of infection can be regulated through rigid hand-washing procedures and precautions. According to "The first step in infection control is hand hygiene: clean hands are more than a matter of soap and water." (Canham, 2016) artificial nails harbor more bacteria than natural nails, and so these handwashing procedures ensure that healthcare workers do not put their fellow healthcare professional peers, as well as their patients, at risk.

The hypothesis is that since artificial nails conceal natural nails, the combined surface areas will result in artificial nails harboring the most microflora. In order to test this, both artificial nails and natural nails were swabbed while they are in their unwashed and washed states. The cotton swabs used to collect the nail bacteria were submerged in Dulbecco's Phosphate-Buffered Saline (DPBS). This allowed for the bacteria to easily be collected on the swab and tested using nutrient agar so that the bacteria colonies collected from the nail samples

could be seen with the naked eye. With this study, healthcare institutions across the nation can become aware of the importance of hand hygiene altogether, and enforce these procedures.

Methods

Materials

1. 7 g Difco LB Agar, Lennox
2. 16 Corning Cell Culture Dishes 100 mm x 20 mm Style Treated Polystyrene
3. Incubator
4. Autoclave
5. 80 cotton swabs
6. Dulbecco's Phosphate-Buffered Saline (DPBS)
7. Latex gloves
8. Sharpie
9. 80 test tubes
10. Dial Complete Liquid Antibacterial Hand Soap
11. Pipette

Procedures

These procedures are adapted from an ongoing independent study conducted by an intern under the mentorship of professor and associate dean, Dr. Xibin Gu. This study was conducted at Howard University Interdisciplinary Research Building. A current limitation of this study is time. Since increasing my sample size would require board approval, which could take many months, the study was limited to four nail participants for both artificial and natural nails.

1. Label 20 test tubes each for artificial and natural nails.

2. Pipette 1 ml of Dulbecco's Phosphate-Buffered Saline (DPBS) into each test tube.
3. Place one cotton swab into each test tube and seal.
4. Allow all artificial nail participants to fill out the artificial nail questionnaire.
5. Using swabs from the labeled test tubes, collect the nail samples for four artificial nail participants for all nails on their dominant hand.
6. Place each swab back into its corresponding test tube and seal with a lid.
7. Repeat steps 6 and 7 for four natural nail participants.
8. Place all test tubes into the freezer at -79 degrees Celsius (used to preserve samples).
9. Remove the test tubes from the freezer and keep at room temperature for 24 hours.
10. Pour 3.5 g of Difco LB Agar into a beaker and add 100 ml of water to it.
11. Cover with foil and place in the autoclave at 121 degrees Celsius for 30 minutes at 15 psi on liquid cycle.
12. Remove the beaker from the autoclave.
13. Divide 8 Petri dishes into 5 equal parts.
14. Using a pipette, distribute 10 ml of agar mixture into each Petri dish.
15. Let solidify for two hours.
16. Swab one of the five sections of the Petri dish for each cotton swab.
17. Place all the Petri dishes into the incubator at 30 degrees Celsius.
18. Check for microbial colonies after 24 and 48 hours.
19. For washed nail samples, let participants wash their hands for 20 seconds using Dial Complete Liquid Antibacterial Hand Soap, and dry them.
20. Repeat steps 1-17 for all washed nail samples.

Data Collection and Analysis

Variables

Independent Variables

1. Type of nail (artificial and natural)
2. Length of nail

Dependent Variables

1. Number of bacterial colonies on nails

Controlled Variables

1. Sample size for both nail types
2. Amount of DPBS in the test tube
3. Amount of nutrient agar distributed into Petri dishes
4. Sterilization time
5. Time spent in the incubator
6. Stored in the freezer at the same time and temperature

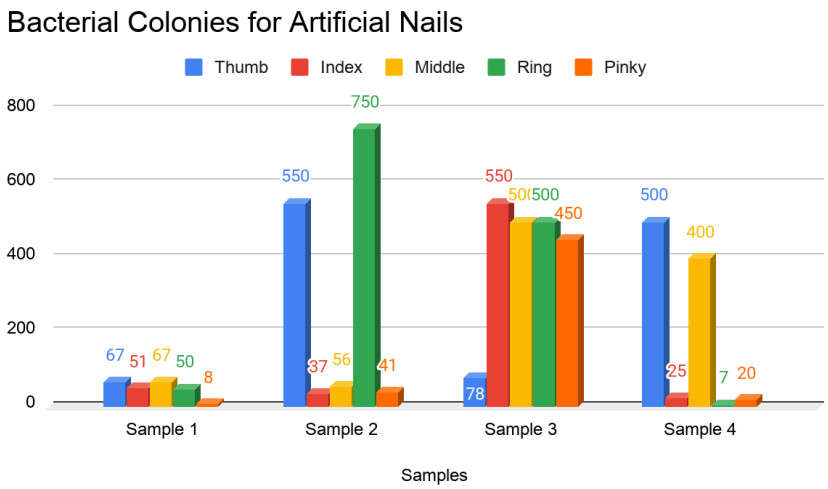
The type of data that was collected was qualitative and quantitative data. The qualitative data consisted of the data that was collected from the questionnaires which asked artificial nail participants about if their nails were either gel or acrylic, how often they get their nails managed, the last time they had a fill-in, which is where the polish and acrylic powder is replaced, but not the nail itself, and how long they have had a full, new set, which is where the artificial nail itself, along with the acrylic powder and polish are added. The quantitative data are the approximate number of bacteria colonies collected on the cotton swab. The statistical test that will be used is

ANOVA which will compare the number of bacterial colonies collected from natural and artificial nails, washed and unwashed.

Proposed Data Table and Graphs

Finger	Sample 1	Sample 2	Sample 3	Sample 4
Thumb	67<	550<	78	500<
Index	51	37	550	25
Middle	67	56	500	400<
Ring	50	750<	500	7
Pinky	8	41	450	20

Artificial Nail Bacterial Colonies



The data table displays an approximated amount of bacterial colonies collected from unwashed, artificial nails. The "<" represents that the number behind this symbol was the maximum amount that could be counted with the naked eye. The graph shows the approximate amount of bacterial colonies for each finger and each artificial nail participant. The unwashed natural nail samples, as well as the washed natural and artificial nail samples, will have graphs that resemble the ones displayed above. Each color represents each finger for one hand on each participant. The x-axis shows the number of participants, or samples, of which the bacterial colonies came from. The y-axis shows the number of approximated bacterial colonies, which ranges from 8-750.

Summary

The purpose of this study is to stress the dangers of artificial nails in the healthcare field by swabbing the nails of healthcare professionals and comparing the microbial presence on each type of nail. Since the amount of microflora is able to be vividly seen, it can be easily determined if artificial nails are a threat to the sanitation level of a healthcare facility. The listed materials and procedures are essential for completing the project. The variables help to organize the various aspects of the project. The data will be analyzed using the statistical analysis test, ANOVA. The proposed data and graphs show an example of how data will be analyzed. At this point, the final set of data is being collected from the experimentation.

Chapter Four

The Findings

According to the statistical analysis conducted, the results can be identified as quantitative data. During the experiment, multiple bacteria samples were collected from artificial and natural nails, both washed and unwashed. The purpose of this was to test whether artificial or natural nails harbored more bacteria, and whether or not washing hands with antibacterial soap would have an impact on microbial presence. This experiment was conducted in order to test the effectiveness of hygienic procedures put in place by healthcare facilities. The bacteria colonies from each type of nail were collected in order to compare the growth between the four types of bacteria groups. After the results from the experiment were recorded, a one-way ANOVA statistical test was utilized to determine if the bacterial colonies collected from each nail produced significant results. Based on the data produced from this statistical analysis, a conclusion can be drawn between the microbial presence on artificial and natural nails, both washed and unwashed.

Presentation of the Data

The results gathered from this experiment were the approximate amount of bacterial colonies present under each nail of the participant's dominant hand. The table and graph present below display the amount of bacterial colonies collected from artificial nails in their unwashed and washed states.

Finger	Sample 1	Sample 2	Sample 3	Sample 4
Thumb	67	550	78	500
Index	51	37	550	25
Middle	67	56	500	400
Ring	50	750	500	7
Pinky	8	41	450	20

Table 1. Approximate amount of microbial colonies on artificial nails, unwashed.

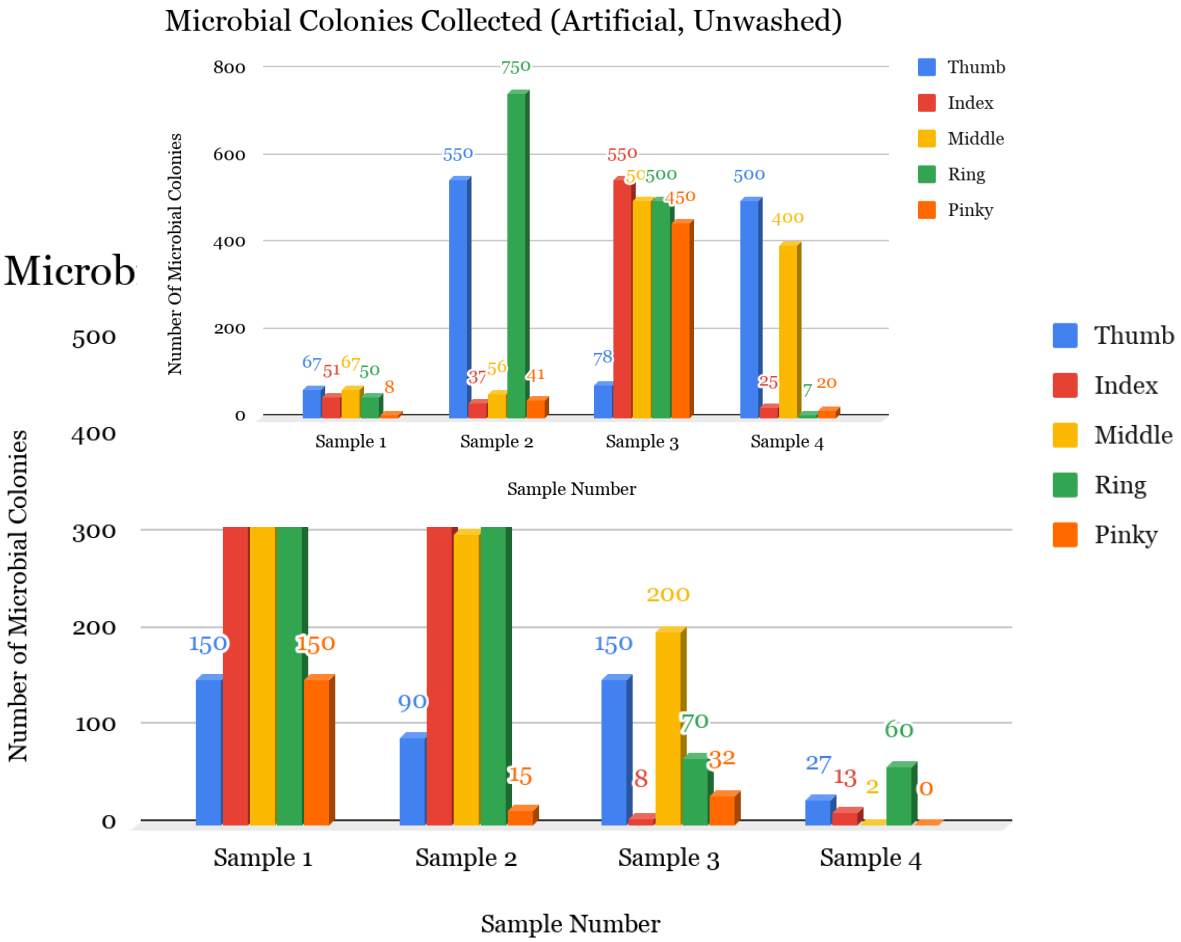
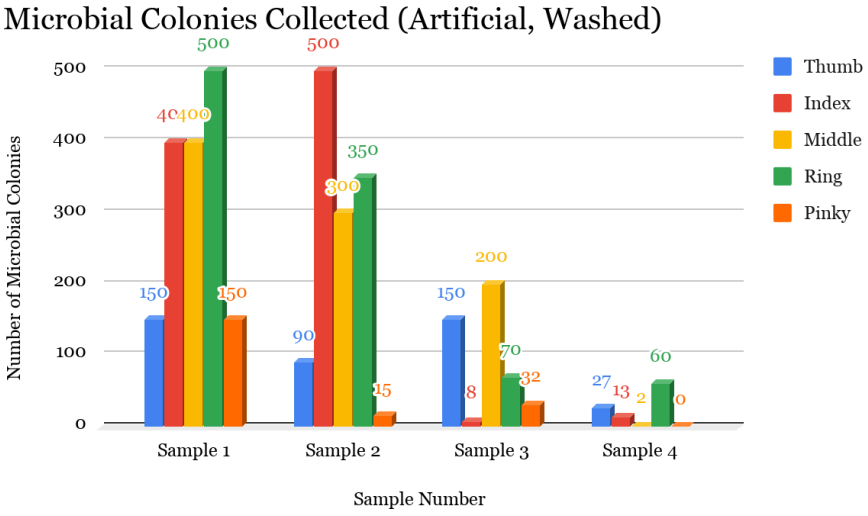


Figure 1. Visual representation of microbial colonies on artificial nails, unwashed.

Finger	Sample 1	Sample 2	Sample 3	Sample 4
Thumb	150	90	150	27
Index	400	500	8	13
Middle	400	300	200	2
Ring	500	350	70	60
Pinky	150	15	32	0

Table 2. Approximate amount of microbial colonies on artificial nails, washed.

Figure 2. Visual representation of microbial colonies on artificial nails, washed.



Likewise, bacteria samples were collected from natural nails in both their unwashed and washed states. The tables and graphs below display the amount of microbial colonies present on participants with natural nails.

Finger	Sample 1	Sample 2	Sample 3	Sample 4
Thumb	50	16	300	12
Index	50	1	50	12
Middle	100	16	45	4
Ring	150	1	55	1
Pinky	250	0	1	7

Table 3. Approximate amount of microbial colonies present on natural nails, unwashed.

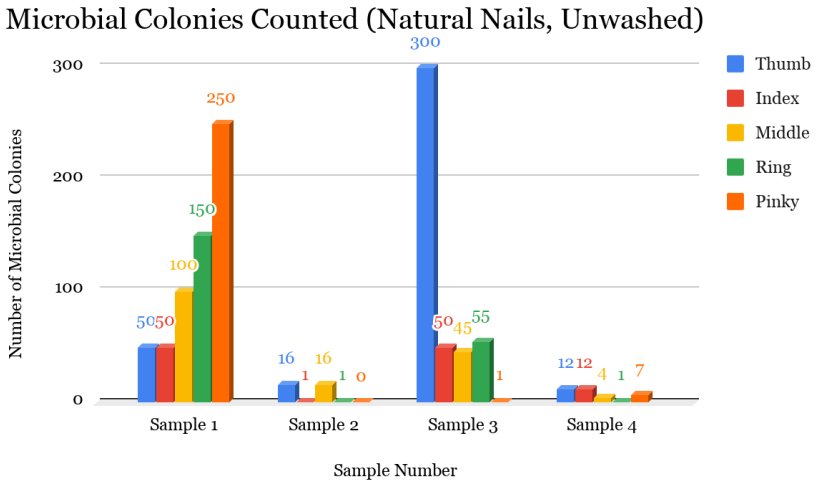


Figure 3. Visual representation of microbial colonies on natural nails, unwashed.

Finger	Sample 1	Sample 2	Sample 3	Sample 4
Thumb	200	13	60	0
Index	300	0	4	13
Middle	40	0	7	10
Ring	28	0	0	2
Pinky	2	0	0	130

Table 4. Approximate amount of microbial colonies present on natural nails, washed.

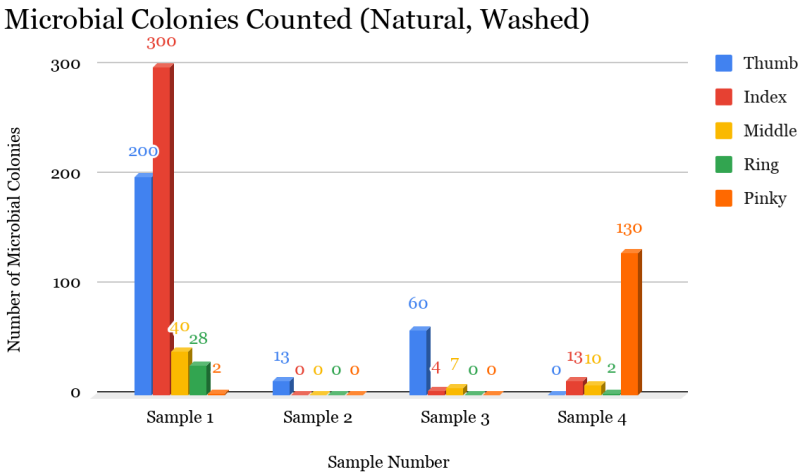


Figure 4. Visual representation of microbial colonies on natural nails, washed.

According to the data provided by the tables and graphs, there was a significant difference in microbial presence on artificial nails compared to that of natural nails. Artificial nails ultimately had the most microflora present. In both their unwashed and washed states, approximately 700-800 colonies were counted by the naked eye, while both sets of data for natural nails did not exceed 300 bacterial colonies.

Data Analysis

The null hypothesis of this experiment predicts that there is no difference in the amount of microflora present on artificial versus natural nails, while the alternative hypothesis predicts that there is a difference in the microflora presence on artificial versus natural nails. The statistical analysis test, which is one-way ANOVA, was utilized in order to determine whether the data accepted or rejected the null hypothesis. The alpha value from the statistical analysis is 0.05 and 80 samples were collected in total. Since the P value was 0.10 and greater than the alpha value, the data is non-significant, which led to the rejection of the hypothesis. The critical value is 25%, resulting in the insignificance in the data collected. Other reasons that led to the

data being insignificant is that the artificial nail participants changed their nails before the washed trials were conducted, and only a limited number of microbial samples were collected.

Summary

The following data presented was utilized in order to accept or reject the null hypothesis. Data collected from the experiment were present in the form of tables and bar graphs, which displayed the approximate amount of microbial colonies counted for artificial and natural nails while they were washed, as well as unwashed. The statistical analysis test used was one-way ANOVA, which determined the significance of the collected data and allowed for a conclusion to be drawn. Based on the data that was gathered and analyzed, conclusions can be drawn to acknowledge the solution to the problem of the experiment.

Chapter Five

Conclusion

Summary of Findings

As healthcare facilities around the world treat hundreds of patients every day, it is vital for its workers to stay as sterile as possible in order to give patients the best possible care. This is only possible if healthcare workers keep the most essential tool clean—their hands. Artificial nails have become extremely popular over the years, and continues to do so as people find more creative designs and methods to try. Even though artificial nails may be enjoyable for their versatile lengths and designs, they tend to harbor more microflora due to their increased surface area. Because a healthcare worker's nail length can directly affect the patients that are treated, it must be stressed that these nail beautification methods are not allowed in the workplace. Since the presence of artificial nails in healthcare facilities and improper hand hygiene are still ongoing problems, this study is the solution to that problem.

As a result of making people, especially healthcare facilities, more aware of the dangers of artificial and long nails in the workplace, this could urge healthcare facilities all over the world to implement more rigid hand hygiene procedures for its workers. The subject of concentration in this study is the amount of microflora under a healthcare worker with artificial nails compared to that of natural nails. Artificial nails are thicker than natural nails due to the artificial nail itself, plus the use of acrylic polymers, gel, and silk to create the nail. Because of this, the goal of this study was to prove that the increased surface area of artificial nails and its concealing of natural nails resulted in an increased microflora presence compared to natural nails.

In this study, hypothesis-based procedures were used in order to successfully conduct the trials. For the collection of the microflora, 20 test tubes with 1 ml of DBPS and a cotton swab were prepared and labeled for artificial nails, both unwashed and washed, and for natural nails, both unwashed and washed. After this, 4 artificial and 4 natural nail participants were swabbed with the corresponding swabs from the test tubes for each nail on their dominant hand. The artificial nail participants filled out a brief questionnaire in order to collect data on if the artificial nails were acrylic or gel, how often the nails were maintenced, and the last time that the set was full and completely new. For the washed trials, each participant washed their hands for 20 seconds with Dial Antibacterial Soap, and then proceeded to the swabbing step. All swabs collected were placed into a freezer for 24 hours while the nutrient agar mixture was prepared, which was used to cultivate the collected bacteria and poured into Petri dishes. After the cotton swabs were swabbed onto the Petri dishes with nutrient agar and placed into the incubator, the microbial colonies were counted and approximated for each type of nail. These results were recorded in a data table and graphed using a bar graph with one-way ANOVA.

Conclusions and Discussion

The hypothesis for this study was that if natural nails are concealed by the artificial nails, then artificial nails will yield the highest amount of microflora compared to natural nails alone. The averages for each nail type are as follows: unwashed artificial nails had an average of 235 microbial colonies, washed artificial nails had an average of 170 microbial colonies, unwashed natural nails had an average of 57 microbial colonies, and washed natural nails had an average of 40 microbial colonies. Even though the Dial Antibacterial Soap reduced the amount of microflora under the nails, artificial nails had a significantly greater microbial presence than

natural nails. Because few artificial nail participants changed their nails before the washed nail trials were conducted and a small sample size was used, this caused the statistical analysis to produce skewed data. After one-way ANOVA was used, it was shown that the data is non-significant, which resulted in the hypothesis being rejected.

The data collected from the study were rational with minor inconsistencies, as previously stated. Firstly, the sample size was small. Because the study was being conducted in an actual healthcare facility, it would have been difficult to receive approval in order to conduct the study with a larger amount of people in such a short amount of time. Also, since the experimentation process lasted over a two-month span and artificial nails require maintenance every two weeks, most artificial nail participants changed their nails before the washed trials were conducted. Because of this, the nails of the participants would have had less of a microbial presence, compared to if the nails of the artificial nail wearers stayed the same throughout.

Recommendations

If anyone attempted to replicate this study, some improvements would need to be made in order to get more accurate and credible data. Firstly, the sample size would need to be increased so that the conclusion that artificial nails harbor more microflora would be more credible. Second of all, the time between the collection of unwashed and washed samples would have to be decreased. This would make the experiment more controlled by making sure that each artificial nail participant had their same nail set throughout the entire experiment and that the microflora presence would not be altered.

Future Implications

In the future, it would be helpful if the individual or individuals who replicated this study had approval to conduct this study in a healthcare setting with more participants who worked hands-on with patients. If this took place, it could allow the experimentation process to be quicker and more efficient, as well as make the study more relevant to healthcare facilities around the world.

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