Could Face Masks Be Harboring Bacteria?

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Abigail Davis describes and reports on a scientific study of bacterial presence on the skin and face masks of 25 test subjects during the COVID-19 pandemic, revealing compelling evidence that face masks contribute to skin disease and irritation, possibly meriting precautionary measures among the mask-wearing public. This essay was written for Scientific Writing with Drs. Jason Shaw and David Reed.

Abstract

Skin irritations such as acne and skin dermatitis have become more prevalent during the coronavirus outbreak. Face masks are now worn daily for long periods of time and are often required to be worn everywhere in public. Face masks provide a perfect environment for bacteria to thrive. Samples were taken from the face, hands, and inside and outside a face mask of 25 test subjects. The results were analyzed for abundance and statistically showed high concentrations of bacteria on the inside of the mask and on the face. This significance shows that the high abundancy of bacteria could be the cause of the increase of skin irritations in the population since the coronavirus outbreak.

INTRODUCTION

THE COVID-19 PANDEMIC has brought about more issues than just a severe acute respiratory syndrome. Many people have been experiencing other difficulties when it comes to protection against the virus. Wearing personal protective equipment (PPE) has become required in most countries during this time, especially among health care workers. Wearing equipment such as face masks for long periods of time has helped keep the virus from spreading, but it is causing other issues. Issues such as dermatitis and acne have become prevalent due to the coronavirus pandemic.

The novel coronavirus started in December of 2019 in Wuhan, China, and has spread rapidly to every other continent except Antarctica (Darlenski et al., 2020). To prevent the spread of the virus, it is encouraged to wear a mask to limit the dispersal of water droplets that come from coughing, sneezing, and talking (Han et al., 2020). These forms of moisture can start to collect under the mask. The mask is there to help protect oneself and surrounding people from the spreading of germs. Masks are not fully beneficial. It is known that PPE can have harmful effects on the skin (Szepietowski et al., 2020). The prolonged use of a face mask can result in contact dermatitis, seborrheic dermatitis, acne, and a variety of dermatological diseases along with worsening pre-existing skin diseases (Singh et al., 2020). These issues occur because of sheer friction and the mask sticking due to heavy sweating and other moisture derived from oil and humidity (Masen, 2020). The accumulation of moisture under the face mask can break down the skin and cause infections (Desai et al., 2020). The infections can have an increasing effect on the face.

The most affected anatomical sites include the nose, cheeks, and forehead (Alkubaisi, 2020). What is not understood by the public is the fact that people need to routinely clean their skin and add moisturizers at least one hour before wearing a face mask (Desai et al., 2020). Irritations caused by the face masks could discourage people from using them (Gheisari et al., 2020). This prolonged use could put people, such as health care workers, at risk. The most reported skin disease for healthcare workers is occupational contact dermatitis (OCD). OCD accounts for 70-90% of all skin diseases reported in the workplace in the United States and Europe; however, this correlation between face mask use and OCD is not always documented in the healthcare setting (Al Badri, 2017). The fact that people other than health care workers are required to wear face masks for long durations may shine a light on the issue of unintended skin irritations.

The face mask may not be the direct cause of the skin irritations. Microscopic organisms such as bacteria are known to influence skin infections. Bacteria are everywhere and have symbiotic relationships with humans. There are different commensal microbiomes inside and outside the human body. The skin microbiome plays many important roles when it comes to skin diseases and the overall health of the skin (Fitz-Gibbon et al., 2013). The complex diversity of the microbiota forms a barrier against outside influences on the surface microbiome and that of the skin appendices (Dreno et al., 2017). Changes in the normal composition of the skin microbiota have been linked to chronic inflammatory skin diseases including atopic dermatitis and acne. It has been shown that microbe-related human diseases are often caused by certain strains of bacteria, not the entire species (Fitz-Gibbon et al., 2013). There are three common bacteria that are found on the skin: *Corynebacterium*, *Propionibacterium*, and *Staphylococci* (Dreno et al., 2017). Microbial involvement is one of the main contributors to the development of acne vulgaris, more commonly known as acne (Fitz-Gibbon et al., 2013).

Acne is one of the issues that has risen amid the prolonged use of face masks. Acne is an inflammatory disorder that is caused by increased sebum production, hyperkeratinization, inflammation and *Cutibacterium acnes*, also known as *Propionibacterium* (*P. acnes*) (Zaenglein, 2018). This type of bacteria, along with other strains, may be correlated with the increased cases of skin irritations when using face masks. Acne is one of the most common skin diseases among all ages, but it is more prevalent in teenagers (Fitz-Gibbon et al., 2013). Cutaneous bacterial communities are known to be involved in the immune homeostasis and its associated inflammatory responses, resulting in acne (Dreno et al., 2017). The bacterial strain that causes acne is called *Propionibacterium acnes,* but it is also a prevalent bacterium that appears in the normal skin flora (Fitz-Gibbon et al., 2013). Scientists are unsure whether *P. acnes* helps the health of human skin, plays a pathogenic role in acne, or both. *P. acnes* also inhabits the sebaceous follicle, inhibiting the invasion of some pathogenic bacteria and allowing other commensal strains to grow (Dreno et al., 2017). *P. acnes* is anaerobic and is the main microorganism in the pilosebaceous follicle, which produces extracellular enzymes and secretes chemotactic factors that attract the cells that play a role in the inflammatory response. This inflammatory response is the one that is responsible for the production of acne (Burkhart et al., 1999). This informs scientists that *P. acnes* is directly contributing to the existence of this skin disease. The growing number of bacteria on the face can affect the prevalence of skin irritations like acne.

Bacterial communities prefer to grow in high-humidity conditions. Face masks allow warm, moist breath and other forms of water droplets to stay close to the face (Dannemiller et al., 2017). It can be inferred that the rise in humidity levels, caused by wearing face masks for long periods of time, could contribute to the growth of bacteria on the face. The most commonly worn face masks are made from cotton. Particles containing bacteria and other microorganisms can be rubbed through materials like these (Ransjö et al., 1979). Most people continue the habit of touching their face while wearing the mask. Cotton is only five times better as a barrier garment than other materials tested for particle penetration and has a penetration rate of about 10%. The percentage increases to 100 with wet cotton. Cotton face masks are used to prevent water droplets from escaping, and when these droplets are caught in the masks, the cotton becomes damp. This allows bacteria to penetrate through the mask, and all the bacteria one encounters could be transferred to the face, collect, and grow under the mask. This collection of bacteria is what was tested in the experiment.

In this experiment, data on the abundance and diversity of bacteria that is found on the face, hands, inside and outside of face masks was collected from 25 test subjects. From research and prior knowledge, it seems logical that the inside of the mask and the subject's face would have the greatest number of bacteria present. This can be inferred because of the closeness of the face mask to the face and the humidity created underneath the mask from water droplets, sweat, and oil secretions. This experiment could help scientists connect the effect of bacterial growth caused by face masks to the higher prevalence of skin diseases/irritations due to the coronavirus pandemic. This work seeks to address the following questions: Are masks creating and/or worsening acne problems? Could this be correlated to the number of bacteria found on or inside the mask itself? Is the mask creating a perfect home for bacteria to grow?

Methods

THE EXPERIMENT STARTED with the production of nutrient agar (Atlas, 1993). The agar was then poured into more than a hundred petri dishes labeled with a number and the word "face," "hands," "inside," or "outside" to correlate with the test site and test subject. Samples were taken from 25 different test subjects. Each subject was asked four survey questions. After the questions were answered, the subject was asked to swab each of the four testing sites (face, hands, inside mask, and outside mask) using a sterile Q-tip. The sample was then inoculated onto the appropriately labeled petri dish and the Q-tip was discarded. All experimentalists wore masks and gloves and monitored correct sterile technique for each sample collected. After sample collection, the petri dishes were incubated for approximately 30 hours at 37 °C. The resulting cultures were counting and analyzed according to diversity and abundance of bacteria. Data was collected, and two separate bar graphs were generated in Excel to display the mean and overall abundance. Fungi were present, but not included in data for this experiment. Statistical data was made by performing t-tests on the means between the inside and outside of the mask, the inside of the mask and the face, and the face and inside of the mask. Results were analyzed for significance.

Figure 1 *Abundance of Bacteria on the Face, Inside of Mask, and Outside of Mask on 25 Test Subjects*

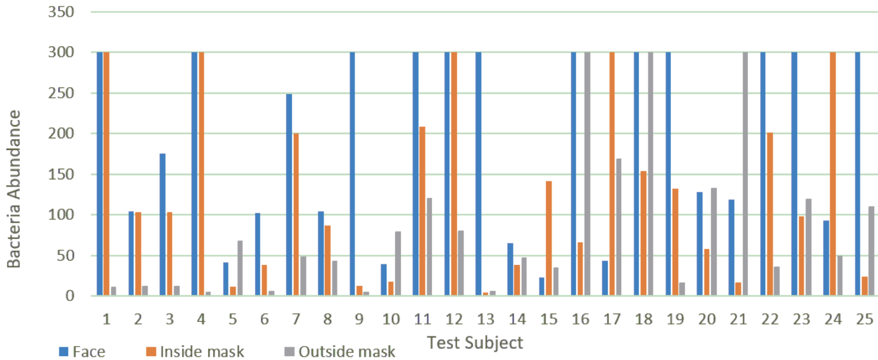
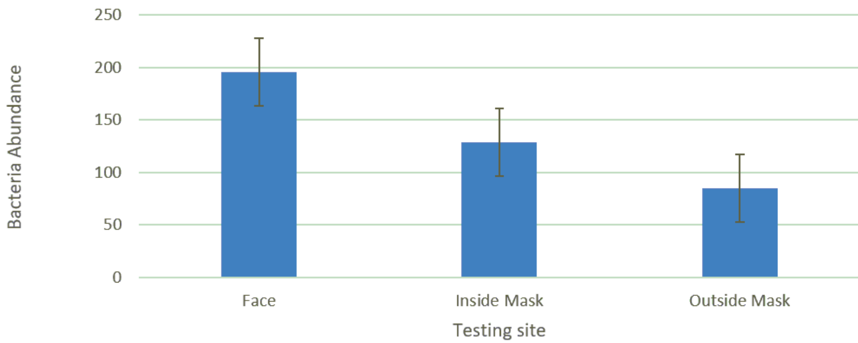


Figure 2 *Average Bacteria Abundance on the Face, Inside of Mask, and Outside of Mask on 25 Test Subjects*



Results

THERE WAS AN increase in abundance of bacteria on the inside of the mask and on the face. The outside of the mask only had a higher abundance for six out of the twenty-five test subjects (Fig. 1). The average abundance of bacteria was 195.56 on the face, 128.8 on the inside of the mask, and 85.04 on the outside of the mask (Fig. 2). The means were used to perform t-tests. The t-test between the face and the inside of the mask produced a p-value of 0.0225. This value is slightly lower than the 0.05 alpha level. The t-test between the inside and the outside of the mask produced a p-value of 0.077. The t-test between the face and the outside of the mask produced a P-value of 0.0003.

Discussion

THE RESULTS SHOW that the mean of bacterial abundance was higher on the face and inside the mask as compared to the outside of the face mask. The significance of these findings can be seen in the statistical results. For the t-test between the face and the inside of the mask, the p-value was slightly smaller than the alpha number. This result shows a small significance between the two abundancies. The p-value between the face and the outside of the mask showed less significance because it is substantially smaller than the alpha number. The p-value for the inside and outside of the mask showed greater significance because it was higher than the alpha number. This supports the original hypothesis of the experiment.

These results support the statement that bacterial abundance is higher on the face and inside the mask compared to the outside. This finding could help support the idea that prolonged wearing of a face mask could increase the cause of skin irritations such as acne. Since the outbreak of COVID-19, masks have become essential and, in most places, required (Darlenski et al., 2020). Face masks can be seen worn by people for more than a few hours at a time, especially in the healthcare setting (Al Badri, 2017). The proximity of the mask to the face and the water droplets that are collected inside of it can create a humid environment, which is a perfect place for bacteria to collect and grow (Masen, 2020). Reports of “maskne” and skin irritations are rising in the populations that have increased the use of masks.

The results of this experiment affirm that bacterial abundance is greater on the face and inside of the mask but do not definitely prove that this trend is the exact cause of acne. These findings could show that face masks may be a contributor to the rising skin issues that have arose during this pandemic. For future work expanding on this experiment, it would be beneficial to further culture the bacteria samples. Taking samples and studying the diversity of bacteria could further increase our understanding of these bacterial species. It could also help find the answer to whether masks directly cause facial acne or not. Taking the information from this experiment and moving forward could aid finding better answers to the questions that were posed in the initial experiment.

CONCLUSION

The prevalence of skin irritations such as contact dermatitis and acne has increased since the COVID-19 outbreak. Face masks are now mandated in public places and are being worn for long durations of time. This could be a correlation of why skin issues have become so prevalent. Face masks create a perfect breeding ground for bacteria to thrive and reproduce. Where are the most bacteria found when wearing a mask? As seen in the results of the experiment, bacteria are most abundant on the face and inside of the face mask. With these results, it can be concluded that the increase in bacteria could be a contributor to facial skin irritations. ►►

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