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Cotton versus medical face mask influence on skin characteristics during COVID-19 pandemic: A short-term study

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Abstract

Background: In the still ongoing COVID-19 pandemic, one of the main prevention strategy remain to be the use of protective face masks. Changes in skin characteristics and dermatological problems related to wearing different types of masks have been observed. The aim of this study was to compare the short-term effects of cotton versus medical masks on skin biophysical parameters in general population.

Materials and methods: Twenty-eight human volunteers were enrolled and divided in cotton mask and medical mask wearing groups. We measured four skin biophysical parameters: trans-epidermal water loss (TEWL), stratum corneum hydration (SCH), skin pH, and erythema index (EI) before and 3 h after wearing masks on both uncovered and mask-wearing face area.

Results: TEWL increased after 3 h on exposed skin in cotton mask group and slightly decreased in medical mask group There was an increase in SCH after 3 h of wearing protective face masks in both groups. pH of the covered skin slightly decreased while EI increased after 3 h in both groups; changes were not statistically significant. Parameters did not change significantly on uncovered skin.

Conclusion: There were no differences between the influence of cotton versus medical protective masks on the skin of healthy volunteers in our study. Both types of masks could be recommended for short-time protection in individuals with healthy skin during COVID-19 pandemic.

KEYWORDS
biophysical skin parameters, cotton face mask, COVID-19, medical mask, skin changes

1 | INTRODUCTION

Coronavirus disease 2019 (COVID-19), in its hardest form, is followed by severe pneumonia, acute respiratory distress syndrome, septic shock and multiple organ failure.[1] On March 11, 2020, the World Health Organization (WHO) declared COVID-19 (coronavirus) pandemic.[2] At this time, more than 1 year later, the main prevention strategy and advice by WHO still remain to be the use of protective face masks.[3] It is mandatory to wear masks indoors, while wearing masks outdoors was recommended in many countries.[4] People who do not work in healthcare still have to wear masks while doing regular daily activities. According to the WHO, fabric and disposable medical masks are recommended in the community settings for protection from coronavirus transmission. Respirators (N95, N99, FFP2, or FFP3) are recommended only for health workers.[5]

Wearing face masks can cause many physiological side effects – besides feeling discomfort,[6] people report headache,[7] difficulty while breathing, difficulty while concentrating, and can experience dermatological problems.[8–10] The most reported side effects of wearing masks were acnes, pruritus, greasy skin, and skin irritation.[11] During

the pandemic, a new term was coined – "*maskne*"; it refers to the acnes caused by the use of protective face masks, but the mechanism of maskne development is still not fully understood.[12,13]

The effects of protective masks on the skin of health workers were investigated during the past year, but not many studies were focused on the effects of masks on general population, who work from home and/or wear masks only when necessary during daily activities. Biophysical skin changes during wearing of KN95 face masks have been the subject of some studies[14,15]. It should be emphasized that these masks are recommended only to healthcare workers and not to general public.[16] Although dermatologists have recommended cotton as the only comfortable tissue suitable for patients with dermatological conditions, the use of surgical masks is common. Searle et al. emphasized that the comparison of the effects of cotton and surgical face masks usually made from polypropylene on facial skin is required.[17] To our knowledge, no study has compared the changes of biophysical skin parameters during usage of fabric versus cotton medical mask in general population.

This study aimed to investigate and compare the influence of short-term use of two different types of protective masks, commonly worn by general population during COVID-19 pandemic– fabric (cotton) and medical (surgical) face masks on relevant skin biophysical parameters.

2 | MATERIALS AND METHODS

2.1 | Study protocol and conditions

A short-term in vivo non-invasive study was conducted on 28 healthy volunteers of both genders, mean age 31.54 ± 10.89 years. The volunteers declared that they did not have past nor present history of skin diseases, and that they were not using systematic nor topical drugs within a month prior to the study. All participants were fully informed about the aims and the study protocol and signed a written informed consent. The study was permitted by the Ethics Committee of the Medical faculty in Niš, Serbia (decision number 12-8818-2/2) and carried out in accordance with the Declaration of Helsinki.

The following biophysical skin parameters were measured: the electrical capacitance (EC), which illustrates the moisture level of *stratum corneum*, using Corneometer® CM 825, while for the estimation of the transepidermal water loss (TEWL), which reflects the skin barrier function, Tewameter® TM 300 was used as a measuring probe. The pH of the skin was measured using skin-pH-Meter® PH 905 while the erythema index (EI) was measured using Mexameter®MX 18 (all Courage + Khazaka, Germany). All parameters were measured according to the published guidelines and documents.[18,19] Volunteers were asked to properly clean the face the night before the study and not to put any cosmetics products before measurements.

All participants were randomly divided into two groups – one group was assigned to wear cotton mask while the other group wore a surgical mask (Winner Medical, Huanggang, Hubei, China). The biophysical measurements were performed on both uncovered (upper cheek) and the mask-wearing area of the face – beneath the left corner of the mouth, before and after 3 hours of mask use. Initial measurements were conducted under precisely defined conditions to which the volunteers were subjected before the measurement (30 min of acclimation with no face mask, at room temperature 21 ± 2°C and relative humidity 45 ± 3%).

2.2 | Statistical analysis

All data are given as means ± standard error of the means (SEM). In vivo measured parameters were expressed as absolute changes to baseline (Δ values). Also, the changes between the groups were analyzed (the group wearing fabric mask and the group wearing medical disposable mask). The statistical analysis (Shapiro-Wilk test for testing the normality of the data and Student's *t*-test for statistical comparison) was performed using IBM SPSS Statistics 22 (IBM Corp., Chicago, USA). Statistical significance was set at $p < .05$.

3 | RESULTS

Two groups of 14 participants, each wearing a different type of mask, were included in the study. The results are shown in Figures 1 and 2; absolute changes to baseline of four assessed biophysical skin parameters (EC and EI in Figure 1; and TEWL, pH in Figure 2) were presented. A slight increase of each of the measured parameters was recorded on uncovered skin after 3 h, but there were no statistically significant differences related to baselines.

Regarding the covered skin, the results showed that after 3 h of wearing protective face mask in both groups there was an increase in *stratum corneum* hydration, as expected. In fact, it is known that occlusion itself causes EC to increase.[20] The increase of EC values was statistically significant in both groups of participants ($p < .05$). However, a statistically significant increase in EC was recorded on skin 3 h after wearing both types of masks, when compared to uncovered skin (Figure 1). The slight increase of skin hydration was also measured on uncovered skin, but without any significance.

On the other hand, TEWL did not change in the same manner regarding both groups (Figure 2). TEWL increased after wearing a cotton face mask and slightly decreased after wearing mediical mask for 3 h. However, both changes were not statistically significant.

pH value of the covered skin slightly decreased after 3 h in both groups (Figure 2).

Even though it can be noticed that the value of erythema index, as a sign of skin irritation, increased in both groups, the changes were not statistically significant (Figure 1). Covering facial skin with cotton or medical mask for 3 h did not cause skin redness, regardless of the type of mask used.

The results also showed that there were no statistically significant differences in measured parameters between the two tested groups. However, cotton masks caused a more significant increase in skin hydration and insignificant increase in erythema index compared to disposable masks while TEWL was almost unchanged, indicating that

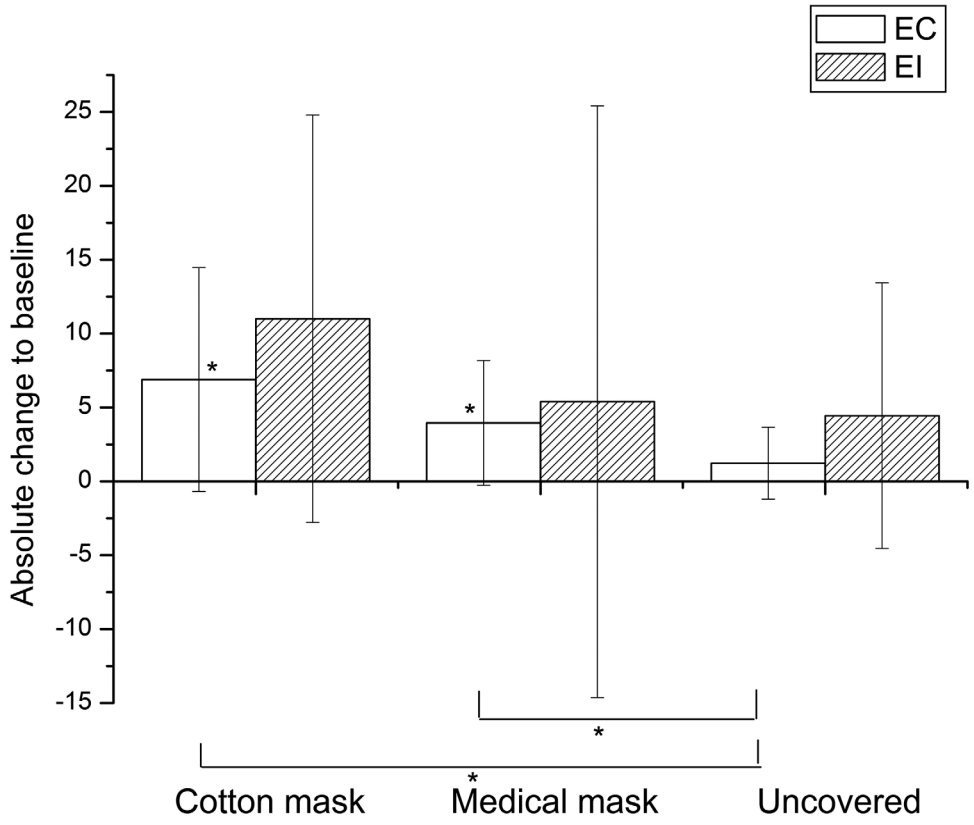

FIGURE 1 TEWL and pH after 3 h of wearing medical, cotton masks as well as on uncovered skin; the results are shown as absolute changes of mean values and standard error of means. Significant differences are marked with $^*p < .05$. The effects of different types of masks on skin parameters were related to baseline and compared mutually as well as to values measured on uncovered skin

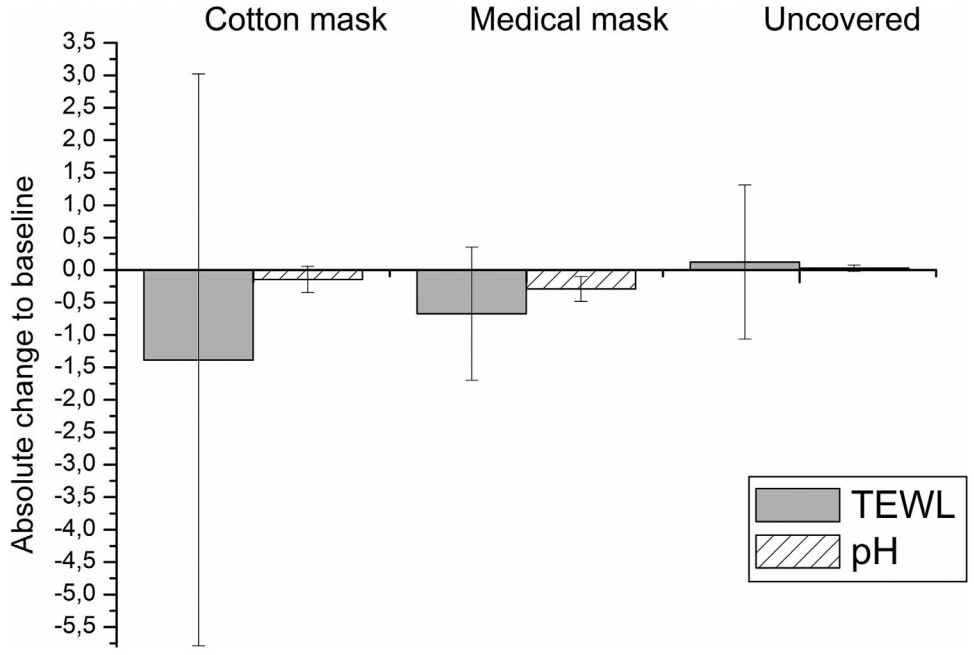

FIGURE 2 EC and EI after 3 h of wearing medical, cotton masks as well as on uncovered skin; the results are shown as absolute changes of mean values and standard error of means. Significant differences are marked with $^*p < .05$. The effects of different types of masks on skin parameters were related to baseline and compared mutually as well as to values measured on uncovered skin

there were no changes in skin barrier function after 3 h after for both mask types.

4 | DISCUSSION

The human skin, with its complex structure, protects the body from the external factors and microbes and participates in homeostasis, thermoregulation, and immunological reactions. Therefore it is very important to preserve skin integrity and its barrier function.[21] As the surface human organ, the skin is often exposed to many different exogenous factors. Nowadays, since the world was embraced by the COVID-19 pandemic, human facial skin often comes into contact with a protective face mask; is an inevitable way of protection against the virus, but also a certain stress on the skin. Epidermis hydration, transepidermal water loss, erythema index, and the pH of the skin are the biophysical parameters that can provide insight into the state of the epidermal barrier.[22] It was noticed that the biophysical effects of wearing a face mask are multiple, and the skin properties were modified in healthcare workers after wearing protective masks, particularly skin barrier function, skin hydration, and pH.[15,23] However, the use of face masks is a novelty for general public, so it is necessary to focus more on this issue.

In our study, the participants were asked to wear a face mask for 3 h, since we wanted to mimic everyday conditions in general public that work from home and do not have to wear protective masks the whole time at work, but only while performing necessary outdoors daily activities. This time period is also compatible with conclusions made about mask wearing suggested time periods during which the mask is efficient and safe to be used. There are evidence that extended wear-time of one mask can lead to unwanted skin conditions,[23] so it is recommended to change the mask frequently.

Kim et al. investigated the changes in skin parameters after 6 h of wearing face mask (KF94 mask). Their results showed that after the test period, TEWL and redness significantly increased, while pH significantly decreased compared to baseline.[14] Similar results, regarding pH and skin redness were observed by Park et al., who examined changes in parameters after 1 and 6 h of wearing protective mask. They found that hydration of the skin increased after 1 h, but decreased after 6 h in the area covered with face mask. The changes of TEWL were not statistically significant.[15] Hua et al. tested skin parameters after 2 and after 4 h, and their results showed that skin moisture, TEWL, pH, and erythema index significantly increased in all cases.[24] In all studies, subjects wore KN 95 face mask. However, it should be emphasized that these masks are recommended only to healthcare workers and not to general public, which emphasizes a need to investigate changes in biophysical skin parameters after skin covering with masks that are more common among much larger general population- cotton and medical masks.

Our results showed that 3h wearing of both disposable medical and cotton masks led to an increase of *stratum corneum* hydration and skin erythema index, while both pH and TEWL slightly decreased. There was no significant impact of 3 h mask wearing on barrier function of covered skin. However, the only statistically significant change was the increase of *stratum corneum* hydration in both groups that could be connected to elevated breathing rate, noticed in people during use of masks.[25] Also, an increase in humidity can be a result of increased temperature of the skin; one of the explanations is that increase in temperature is a result of the temperature of the exhaled air.[23] Higher temperature of the skin is connected to the increase in sebum excretion rate (an increase of 10% for each temperature rise of 1°C).[25]

It could be concluded that occasional, short-term use of neither cotton nor medical mask could not be responsible for skin conditions related to the use of protective masks. It could be assumed that prolonged use of face mask, connected to repeated skin exposure to increased temperature, humidity, and sebum, might be one of the reasons for the development of acne (so-called "maskne"), and other skin conditions connected to everyday use of face masks reported in the general population.

5 | CONCLUSION

Our results suggest that 3 h of wearing either medical or cotton mask that are usual in COVID-19 pandemic in general population, does not lead to significant changes of biophysical skin parameters (pH, EI, TEWL). Also, there were no differences between the impact of cotton versus medical mask on the skin of healthy volunteers in our study, indicating that both types of protective masks could be recommended for healthy skin. Further studies should investigate and compare the possible impact of cotton versus medical mask on biophysical skin parameters regarding repeated (every day) use or on volunteers with compromised skin.

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