Safety of the Use of Face Masks in Pediatric Age

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To the Editor,

In a recently published article in *Environmental Health Insights* Martellucci et al,[1] state that the use of surgical or FFP2 masks causes an increase in inhaled air CO_2 approached the occupational exposure limit of 5000 ppm in a sample of healthy volunteers aged 10 to 90 years, concluding that the current guidelines on mask-wearing should be reevaluated.

This topic should be treated with caution, considering the important implications it could have on the spread of viruses and public health. We believe that this study has some limitations.

Firstly, the authors do not consider carbon dioxide in the blood, so the alleged link to hypercapnia is not proven. In support of this in the patients enrolled in the study, there were no significant increases in respiratory rate (the average respiratory rate was 16.8 ± 3.5 breaths per minute) and heart rate, which are the main physiological mechanisms of compensation for hypercapnia. In addition, Martellucci et al[1] do not detect episodes of decreased oxygen saturation (SaO_2) in the study (the average blood oxygen saturation was $97.4\% \pm 1.0\%$, with 98.0% of the sample at or above 96% saturation).

Second, the level of carbon dioxide considered as the limit by the authors is 5000 ppm. This is about indoor air quality, while the conditions of the environment created between the face and mask are not comparable to an enclosed environment (the mask retains CO_2 for a short time).

However, as reported on the US CDC website, the maximum concentration of carbon dioxide considered toxic with an exposure of 30 minutes is about 50 000 ppm; at this level appear the first symptoms related to the increase of CO_2, while a few minutes of exposure at 70 000 and 100 000 ppm causes alterations in the level of consciousness.[2] In this context, the authors report CO_2 levels of 5087 ± 1579 ppm with surgical masks and 9653 ± 2874 ppm with FFP2 masks, which are values well below the threshold for toxicity.

Recently, numerous scientific papers confirm the efficacy and safety of masks in both adult and child populations,[3] using partial pressure of end-tidal carbon dioxide ($PETCO_2$), heart rate, respiratory rate, and the occurrence of clinical signs of respiratory distress as assessment parameters. In particular, the evaluation of $PETCO_2$ is a very accurate method and different studies show that there is a good agreement between this parameter and blood gases (venous pCO_2 and arterial pCO_2).

Furthermore, $PETCO_2$ is an early warning system, a sign of alveolar hypoventilation more than oxygen saturation and its increase is an indication of possible future development of respiratory distress.

In our studies on the safety of the face mask in pediatric age, all participants were monitored every 15 minutes for changes in respiratory parameters for the first 30 minutes while not wearing a face mask, for the next 30 minutes while wearing a face mask and a session consisting of a 12-minutes walking test, along a 40-m long corridor, while wearing the mask.

Our research has shown that the use of surgical masks was not associated with significant changes in SaO_2 or $PETCO_2$, both at rest and during exercise in children, while only the use of an N95 mask, particularly during physical activity, could potentially be associated with an increase in $PETCO_2$, that remains in the normal range.[4] In both studies, no child showed clinical signs of respiratory distress throughout the duration of the tests. Also, Martellucci et al[1] report average values of $PETCO_2$ within 33 mmHg, confirming that the use of the mask does not cause a hypercapnia condition.

Therefore, we believe that the message is the increase in inhaled CO_2 concentration while wearing Face Masks not supported by clinical evidence could be dangerous, causing poor compliance with mask use, especially in a particular population such as pediatric.

On the contrary, it is necessary to educate children on the use of the mask to limit the spread of the virus, since the immune response decays over time[5] and the COVID-19 disease could have a severe course with long-term consequences also in pediatric age.

Furthermore, the use of masks in children represents a non-pharmaceutical intervention measure that reduces not only the spread of SARS-CoV-2 but could help to limit the diffusion of common pediatric diseases with significant benefits on health care spending.

Author Contributions

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