Developing a Mask Containing Nanofiber Filtration Methods for Optimal Breathability and Comfort for Professional and Recreational Runners

One of the most popular pastimes in the modern world is to go running outdoors (Aydin et al., 2013). However, there are extreme threats that endanger the safety of runners, such as air pollution released from industrial and economical causes. (Wen et al., 2024). The most prevalent pollutant to come from the industrial exhaust is particulate matter under the size of 2.5 micrometers (PM 2.5). It was shown that air pollution significantly increases the pace for a runner, in terms of the time it takes to run a certain distance. When a runner performs in a densely polluted area, their minute ventilation increases, which ultimately leads to the increase in their pace due to the excessive amount of pollutants they inhale (Giles & Koehle, 2013). This would be a very serious issue, particularly for competitive runners (Guo & Fu, 2019). Not only that, but if runners are constantly exposed to these threats, there is a possibility they may have difficulty breathing, develop asthma, or even develop heart and lung diseases (Department of Health and Human Services, 2024).

Previous Models

In response, multiple studies have taken different directions to tackle this obstacle. One is to create or use a mask. Originally, past methods were to use standard masks like the surgical and KN95 models. A study conducted by Runergy displayed that running in surgical and KN95 masks causes discomfort and some suffocation (Runergy, 2020). They experienced shortness of breath as well. But a redeeming feature in surgical and KN95 masks are that they have a filtration rate of 95%, meaning they filter out 95% of all pollutants in the atmosphere (Wang et al., 2023).

However, there is a mask specifically designed for runners exercising in densely polluted areas, and that mask is the Airinum Urban Mask 2.0. Although this mask offers high-tech filtration methods consisting of two ventilation valves, a big issue is its lack of comfort. Reviews on this mask written by

consumers stated that the mask was too big on the face and the material used was somewhat scratchy (Airinum, 2025). However, the filter used was very efficient in filtering out PM 2.5 (Airinum, 2025). Its electro-spun properties make it so the mask can filter out the smallest of particulates, while maintaining breathability and comfort.

Electrospinning was proven to be an efficient and effective method when creating a filter. Deng et al. (2022) attempted to electro-spin a polymer to create a nanofiber. This nanofiber was used as a filtration device, which successfully filtered and prevented nanoparticles from passing through. It also resulted in better air permeability and flexibility. However, this study did not try to implement the fiber into a mask.

Knowledge Gaps

In recent mask models, significant aspects of the mask are excluded in the design. The most important one is the balance between filtration and breathability efficiency. Surgical and KN95 masks are proficient in filtering out the larger-sized air pollutants encompassing the atmosphere (Wang et al., 2023). However, their breathability could be better (Wang et al., 2023). Its thickness in material causes the exhaled carbon dioxide to be trapped in the mask. Additionally, air pollutants vary in size and those models do not account for the smaller particles. Surgical masks cost around $15.19 for a pack of 50 masks (DEMETECH, 2025). Although it is cost-effective, the downsides heavily outweigh the benefits.

Throughout the economic market, there is a low number of masks that can adequately balance between the two. And the ones that do cost a significant amount of money, ranging from $40 to $60 (Airinum, 2025).

Another prominent issue in the mask industry is the negligence of filtering out the smaller air particles. Face protection devices often do not filter out the smaller air pollutants and only filters the more prominent pollutants, like the KN95 mask, and this mainly derives from the use of inefficient materials (Wang et al., 2023). Smaller particles can still cause heavy damage to the body, similar to the effects of the larger-sized particles.

Current mask models utilize material that lacks the essential attributes that will efficiently help professional runners perform. To adequately protect runners, these gaps need to be resolved. This study aimed to gain a comprehensive understanding of the risks in the air and develop a mask that produced efficient breathability and comfort for the user, specifically for professional and recreational runners. This research revolutionized the way we protect runners from air pollution, significantly improving their performance and health.