Air Pollution Running Mask

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3 GOOD HEALTH AND WELL-BEING

Problem Statement: Professional runners inhale an large amount of PM 2.5 while performing, which reduces their pace and their health

Engineering Solution: Design a nanofiber-based mask that will effectively filter out PM 2.5 and provide comfort and breathability to the runner

Background

Current Scenario

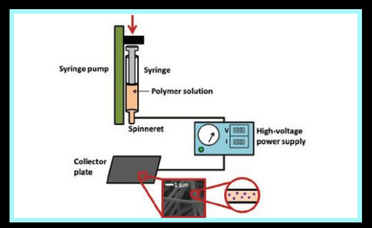
One of the most popular pastimes, especially during the COVID pandemic, is to go outdoors running (Aydin et al., 2013). However with the current growing industrial economy, more air pollutants, specifically particulate matter the size of 2.5 microns (PM 2.5) is being released into the atmosphere (Wen et al., 2024).

Health and Pace

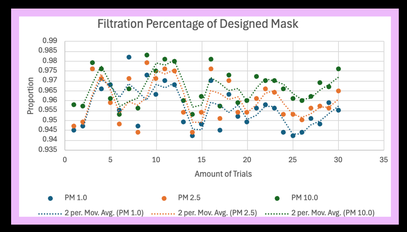
If runners inhale an excessive amount of PM 2.5, their breathability and comfort will decrease. This will lead to a reduce in pace, in terms of time (Guo & Fu, 2019). It also puts the runner at risk of developing heart diseases, lung cancer, and asthma (Nan et al., 2023).

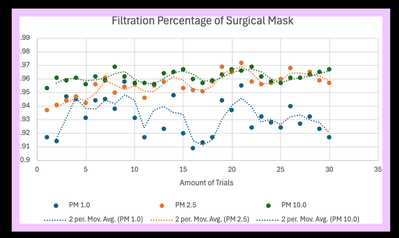
Current Masks

There are current mask models that attempt to solve this issue, such as surgical and KN95 masks. However, when exercising in them, they begin to dampen, causing suffocation and discomfort (Runergy, 2020). The material used is too thick, which makes breathing difficult.



Data





Average Filtration % Designed Mask
- PM 1.0: 95.64463%
- PM 2.5: 96.01759%
- PM 10.0: 96.67623%
- Total: 96.11282%

Average Filtration % Surgical Mask
- PM 1.0: 93.18667%
- PM 2.5: 95.57667%
- PM 10.0: 96.1433%
- Total: 94.969%

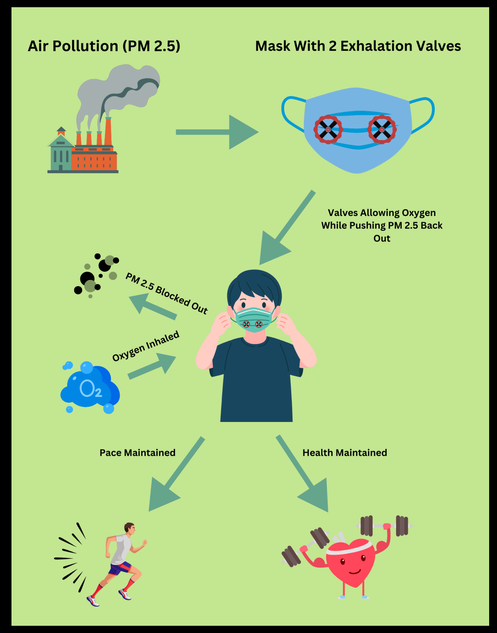
Standard Deviation Designed Mask
- PM 1.0: 0.01118
- PM 2.5: 0.01064
- PM 10.0: 0.009

Standard Deviation Surgical Mask
- PM 1.0: 0.01367
- PM 2.5: 0.00836
- PM 10.0: 0.00411

Decision Matrix

Criteria	Weight	2-Valve	1-Valve	3-Layer	Surgical
Physical Comfort	10	8	8	9	8
Cost-Effective	9	7	7	7	10
Breathability	10	10	8	7	4
Durability	7	9	8	8	6
Filtration	10	10	9	9	8
Total:		408	376	369	302

Conclusion



Methodology

Research and find a filter that inhibits electro-spun characteristics and has built-in exhalation valve holders

Figure 1: The Airinum Urban Air Mask Filter (Airinum, 2024).

Model and design exhalation valves through CAD and 3D-print them for the chosen mask

Figure 2: Two halves of the exhalation valve

Perform a particulate matter detection test with the designed mask and a surgical mask, to help determine the filtration efficiencies of both

Figure 3: Davis Instruments AirLink Air Quality Monitor (Vernier, 2024).

Materials

Airinum Mask Filter
3D Printer + OnShape
Fabric

Surgical Mask
Fabric/Cloth

Analysis

T-Test

- For each PM size, the designed mask had a higher filtration percentage than the surgical mask
- P-valves showed statistical significance

Takeaways

- With this, the designed mask is proven to be more effective than the surgical mask in filtration rates
- With the addition of exhalation valves, the runner experiences more comfort and breathability

Next Steps

- Implement the designed mask in a running-participant test for real-world applications
- Create a custom electro-spun filter

References

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