Modeling the Interactions Between Droplet Particles and Face Shields

Face coverings, particularly face masks, have been vital in reducing the spread of COVID-19[1]. While face masks have been heavily studied, less literature pertaining to face shield efficacy exists despite several benefits over face masks. Several advantages include easier disinfection, increased sustainability, comfort, and ease of communication within the deaf community. Per the National Deaf Center, face masks impair ASL communication by preventing lip reading and hiding facial features and expressions essential for speaking or signing communication, causing "increased stress, fatigue, and anxiety"[2]. Underscoring that the deaf community has the right to communicate comfortably and safely in the midst of COVID-19, it is imperative to explore the efficacy of face shields in COVID-19 transmission prevention. With aerosol COVID particles being the main mode of transmission, computational fluid dynamic (CFD) models are pertinent to mathematically quantify and qualitatively observe particles interacting with the face shield and the wearer. Our 2D, transient state model utilizes literature-driven flow rates to simulate micron-sized particles being ejected from a mouth-like area under sneezing and breathing conditions [3]. Simulations consisted of particle flow between permutations of two shielded and unshielded individuals. The model outputs each particle velocity and X, Y position that is then plotted to display the frequency of both velocity magnitude and particle distance travelled. The efficacy of the face shield is shown by comparing the particle distance travelled in the various simulations. With both individuals unshielded, the maximum distance traveled is 7.49ft with an average distance of 1.92 ± 1.95ft. Contrastly, with one individual shielded and the other unshielded, the maximum and average distance travelled decreases to 4.28ft and 1.20 ± 1.05ft respectively. Even with only one participant shielded, the model indicates that face shields significantly reduce particle transmission distances post-ejection into the surroundings by decreasing the frequency of droplets that travel farther distances (~6 ft). With the increased rate of vaccinations, the results imply that face shields could become more widely adopted to not only protect the wearer from COVID-19 but also permit the deaf community to comfortably and safely communicate and partake in society.

Reference

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