A STUDY ON BARRIER PERFORMANCE OF MEDICAL FACE MASKS

Muhammad Usman Munir (*), Daiva Mikučionienė
Kaunas University of Technology 1, Studentu str. 56-249, LT-51424, Kaunas, Lithuania
(*) *Email:* Muhammad.munir@ktu.edu

Abstract

The sudden outbreak and rapid transmission of SARS-Covid-19 virus has urged people around the world to adopt safety measures to help stop the spread of this infectious disease. Thus, there comes a sudden increase in demand for PPEs such as face masks and gowns. This increase in demand has paved the way for low-quality medical face masks to the public, causing a serious threat to the contamination of the Covid-19 virus. Therefore, to verify the real picture of the performance quality of medical face masks, we carried out a study to check their barrier performance as per the requirements of International Standards EN 14683 and ASTM F2100. We conducted the bacterial filtration efficiency, particle filtration efficiency and differential pressure tests on all the medical face masks samples and found that almost all the masks fall under 95% filtration to bacterial aerosol requirement, 95% filtration efficiency to latex sphere, and had differential pressure in limits. Our study has also concluded a correlation between these performance criteria, and it would be a great help and time saving if we adopted the findings of this research. The out has helped to create public confidence in their quality performance

Materials and Methods

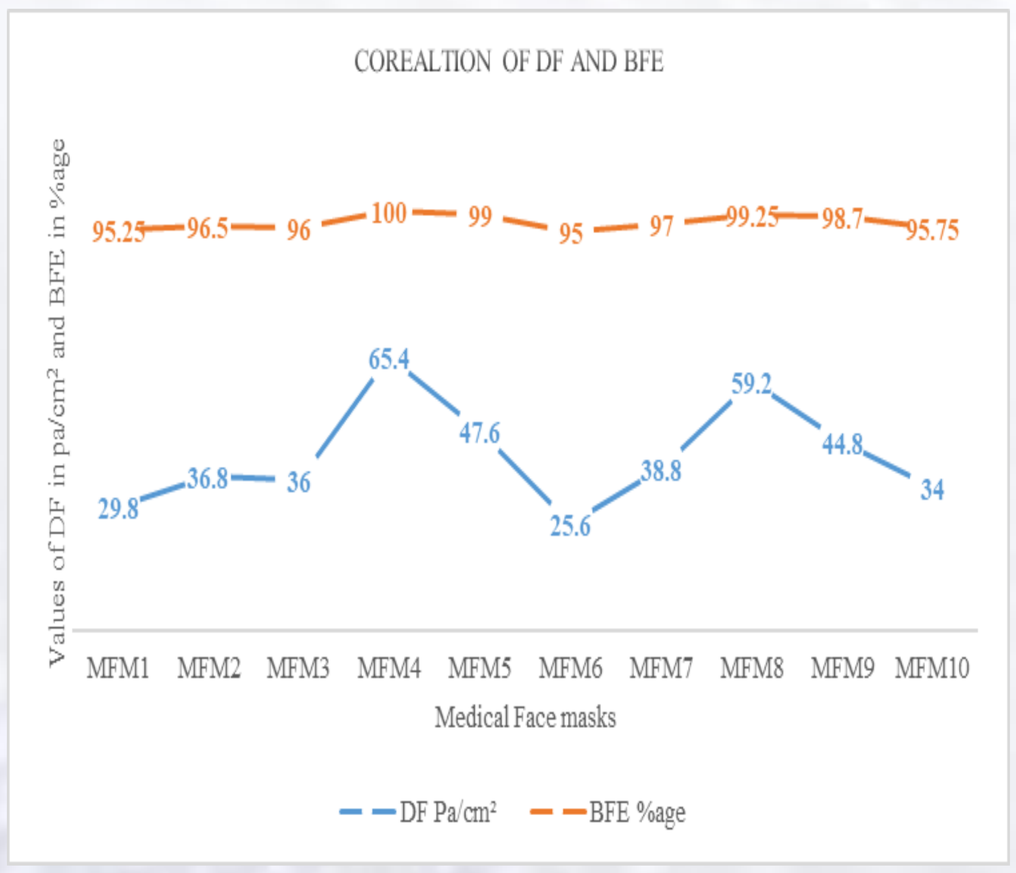
We collected medical face masks from 10 different pharmacies and are treated anonymously. The medical face masks are generally made of polypropylene. The notation of the 10 medical mask samples is as follows: MFM1, MFM2, MFM3, MFM4, MFM5, MFM6, MFM7, MFM8, MFM9 and MFM10. All medical face masks were tested against the performance criteria defined in EN 14683: 2019 and ASTM F2100-19 (ASTM, 2020). As our focus is to check the barrier performance of medical face masks, we have focused only on Bacterial Filtration Efficiency, Particle Filtration Efficiency and Differential pressure of these masks

Results and Discussion

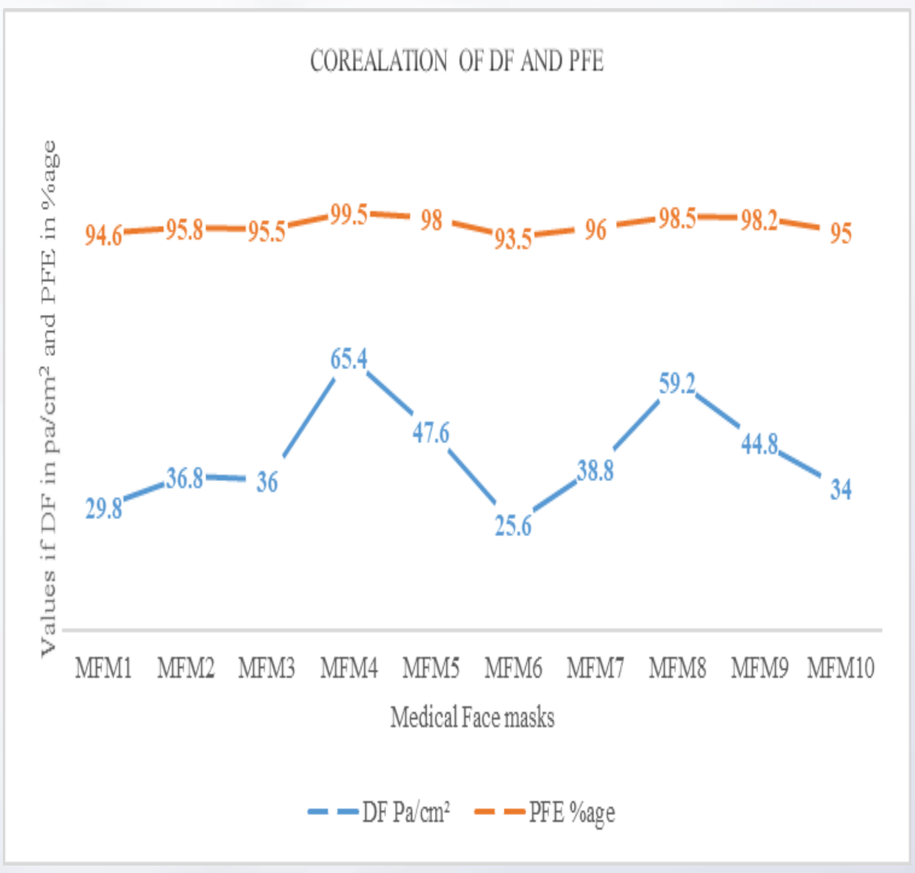
It has been observed that all medical face masks tested have BFE in limits defined by EN 14683:2019 and ASTM F2100:20 i.e ≥95%, ranging from low values of 95% to maximum BFE of 100%. None of the medical face masks samples under testing exhibits poor BFE, depicting a higher filtration efficiency of these medical face masks available to public.

Regarding PFE, most of the face masks under testing exhibits good PFE at 0.1 microns particle size. MFM4 showed highest PFE of 99.5% and we can denote it as Type III medical face mask. Only MFM1 and MFM6 got failed to this barrier performance test with PFE values of 94.6% and 93.5% against minimum requirement of 95% PFE. We have also found a correlation of BFE and PFE, by comparing the results of BFE and PFE it can be seen that a medical face mask with highest BFE of 100% also shows a highest PFE of 99.5%. PFE of MFM4 is lower as compared to its BFE, this can be explained by the fact that in PFE we have particle size of 0.1 microns, so more particles get their way through MFM4 and thus the filtration efficiency is on lower side. Contrary to this in BFE we have particle size of 3 microns, so more of the bacterial aerosol are filtered resulting in 100% BFE for MFM4.

Differential pressure testing shows that most of the medical face masks have differential pressure values under acceptable limits, also these define what type of category they fall into. Type I and Type II medical face masks requires the differential pressure to be than 40 pa/cm^2 and Type II medical face mask requires the values to be under 60 pa/cm^2. By these categorization MFM1, MFM2, MFM3, MFM6, MFM7, MFM10 falls under Type I and Type II medical face mask and MFM5, MFM8 & MFM9 falls in Type III category. Only MFM4 exceeds the threshold of less than 60 pa/cm2 and has a value of differential pressure of 65.4 pa/cm^2.



Samples	DF Pa/cm²	BFE %age	PFE %age
MFM 1	29.8	95.2	94.6
MFM 2	36.8	96.5	95.8
MFM 3	36.0	96.0	95.5
MFM 4	65.4	100	99.5
MFM 5	47.6	99.0	98.0
MFM 6	25.6	95.0	93.5
MFM 7	38.8	97.0	96.0
MFM 8	59.2	99.25	98.5
MFM 9	44.8	98.7	98.2
MFM 10	34.0	95.8	95.0



Conclusion

After this study, it has been concluded that almost all the tested medical face masks available on the market exhibit barrier properties as defined in the European and American standards. In addition, a correlation has been found between bacterial filtration efficiency, particle filtration efficiency and differential pressure. If we compare the results of BFE and PFE, we can see that the BFE of a medical face mask is always higher than the PFE, this is because in the BFE test the bacterial aerosol has a size of almost 3 microns and in the PFE the latex sphere aerosol has a particle size of 0.1 microns. Also, if we know the PFE of medical face masks, we can now predict its BFE as it would be some fractions higher than that of PFE and we can skip the long-time taking BFE testing procedure. Also, as the differential pressure increases, the BFE and PFE of the medical face mask also increases, because as the pore size gets smaller the differential pressure increases and more particles of bacterial or latex sphere are filtered, increasing the barrier performance of these medical face masks. Thus, if we know the PFE, we can predict its DF and its BFE.