



Journal of the International Society for Respiratory Protection

Vol. 38, No. 2, 2021

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Necessity of the Fit Test Panel for Korean Respirator Users: Application to Korean Healthcare Workers

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ABSTRACT

With the recent novel coronavirus disease (COVID-19) outbreak, the importance of respirator fit has been increasing. We attempted to classify the face sizes of Korean Healthcare Workers (HCWs) using the National Institute for Occupational Safety and Health (NIOSH) Bivariate Panel and compared the fit factor by category.

A quantitative fit test was conducted on 56 HCWs from five medical institutions using two types of N95 filtering facepiece respirators manufactured in South Korea. The length and width of the face were measured using calipers. The results of the fit test of the participants categorized using the NIOSH Bivariate Panel were compared among the groups. The face sizes were distributed in and out of the NIOSH Bivariate Panel. There was a significant difference in the distribution of face sizes between our study participants and those in the NIOSH Bivariate Panel ($p=0.009$). The 111 fit test results that we collected did not show a significant difference among the face size categories ($p>0.05$). The pass rates according to the small, medium, large, and outlier categories were not significantly different between the groups ($p=0.767$). Our study has a limitation that it is not representative of all Korean users. Despite this, the difference in face size distribution between the NIOSH Bivariate Panel subjects and Korean HCWs is noteworthy.

There was no difference in the fit test results when the NIOSH facial category was applied, suggesting that applying the NIOSH Bivariate Panel to the face size of Koreans HCWs is not precise. Therefore, it is necessary to develop a Korean test panel and design respirators based on Korean face dimensions. Further, manufacturers should provide varying respirator sizes and styles based on these dimensions to improve respiratory protection for users.

Keywords: coronavirus disease; fit factor; healthcare workers; National Institute for Occupational Safety and Health Bivariate Panel; quantitative fit test

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A Modified Method for Measuring Pressure Drop in Non-medical Face Masks with Automated Data Acquisition and Analysis

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ABSTRACT

Background: Non-medical face masks, such as face coverings donned by the general population play an important role in reducing transmission of respiratory pathogens. Pressure drop or breathability of such masks is an important attribute especially with the advent of new standards such as ASTM F3502-21 that have specified pressure drop limits for general use of face coverings. Although several standards are available that discuss pressure drop measurement techniques, the methodologies reported are typically complex or are part of more sophisticated and expensive instruments. Thus, the applicability of such methods is often limited to medical device manufacturers.

Objective and Methods: This manuscript adapts from the pressure drop measurements proposed in British Standard EN 14683:2019 and describes a methodology to create a simple 3D printed model of a pressure rig for measuring the breathing resistance across non-medical face masks. The method also enables real time pressure drop data acquisition and analysis of multiple samples or batches using Python and MATLAB scripts.

Results: We performed a validation study by comparing the pressure drop obtained for one brand of respirators with our set up and compared it with data obtained by traditional means by CDC. An unpaired two-tailed student t-test (n=3) between the two means implied no statistically significant difference.

Conclusion: The method we have developed can be easily implemented at community levels for characterizing the breathability of non-medical grade face masks.

Keywords: pressure drop, breathing resistance, face coverings, COVID-19, masks, facemasks

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An Overview of Usability and Ergonomics Aspects of PAPRs & EHMRS in Healthcare

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ABSTRACT

During the COVID-19 pandemic, many healthcare facilities instituted the continuous use of N95 filtering facepiece respirators to provide respiratory protection from SARS-CoV-2. These disposable, single use respirators soon were in critical shortage. However, due to their high demand and limited availability, healthcare workers were reusing them and, in some cases, had no access to supplies. This created an urgent problem since healthcare workers are continually being exposed to hazardous pathogens. Therefore, it was pertinent to find suitable replacements for N95 FFRs. Powered Air-Purifying Respirators and Elastomeric Half-Mask Respirators were and continue to be recommended by the Centers for Disease Control and Prevention for respiratory protection. These respirators and any respirator used in United States workplace settings, require National Institute for Occupational Safety and Health approval. The objective of this review is to focus on the ergonomics of these respirators in healthcare settings and documented user concerns. To achieve this, databases such as Summon, MEDLINE, Emtree, and CINAHL were used, searching key words to gather information. During this literature study, it was found that while comfort is subjective, there are documented stressors related to breathability and thermal environment that play a major role. Powered Air-Purifying Respirators have little breathing resistance and are generally cool because of the blower device. Elastomeric Half-Mask Respirators are similar to N95 FFRs, in that a hot and humid microclimate can build up inside the respirator and over time, breathing resistance can increase, an issue because they are negative pressure respirators. Powered Air-Purifying Respirators, Elastomeric Half-Mask Respirators, and N95 FFRs can impair senses, negatively affecting communication, as well as diminished field of vision with full-face respirators. Nonetheless, despite these ergonomic barriers, healthcare workers are likely to condone these issues during high-risk conditions for adequate respiratory protection. Even so, there are a considerable number of gaps in the literature on Elastomeric Half-Mask Respirators, more so than for other respirators.

Keywords: PAPR, EHMR, N95, Ergonomics, Usability, Healthcare, Respirator efficiency

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Elastomeric Half Mask Respirators: An Alternative to Disposable Respirators and a Solution to Shortages during Public Health Emergencies

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ABSTRACT

During public health emergencies such as an influenza pandemic, disposable filtering facepiece respirator (FFR) shortages have a significant impact on the national response, affecting many types of workplaces that rely on respiratory protection. During the COVID-19 pandemic, severe FFR shortages led the CDC to publish strategies for optimizing the supply of N95 FFRs. These strategies included the extended use and limited reuse of FFRs, wearing decontaminated FFRs, wearing respirators that meet an international respirator standard, or wearing FFRs that were past their manufacturer-designated shelf life. An additional strategy to mitigate supply shortages that was highlighted during the COVID-19 pandemic was to wear reusable respirators, such as elastomeric half mask respirators (EHMRs), or powered air-purifying respirators, which can be cleaned, disinfected, and reused. A decade of nationwide initiatives to increase the utility of EHMRs in healthcare settings were realized during the COVID-19 pandemic as EHMRs became more well-known and were used in healthcare settings for respiratory protection. This expanded use of EHMRs led to an increase in federal procurement, research, guidance, and private sector research and development of innovative EHMR designs by manufacturers to respond to workers' needs for both respiratory protection and source control. This paper describes the role of reusable EHMRs before and during the COVID-19 pandemic, and reviews past and current research, to inform successful EHMR implementation in healthcare and first responder settings.

Keywords: COVID-19, elastomeric half mask respirator, EHMR, N95 respirator shortage, pandemic

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Using Public Feedback about the use of Elastomeric Half Mask Respirators to Inform a National Deployment Study within Health Settings

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ABSTRACT

Reusable elastomeric half mask respirators (EHMRs) have been encouraged for use during conventional, contingency, and crisis capacity in healthcare delivery settings as an alternative to disposable N95 filtering facepiece respirators (FFRs). However, standard, operationalized guidelines for implementing EHMRs in healthcare and first responder settings are needed to facilitate such integration. Specifically, research is needed to identify and address specialized concerns in healthcare delivery settings beyond hospitals to understand the widespread barriers to EHMR use and how organizational culture can support or hinder EHMR adoption. The Strategic National Stockpile (SNS) requested support from the National Institute for Occupational Safety and Health (NIOSH) to develop its strategy to purchase and distribute EHMRs to interested health organizations. To support this SNS effort, NIOSH published a Federal Register Notice (FRN) to request formative input from the public on the nationwide distribution of EHMRs and provided the technical analysis of the responses. Twenty-two representatives from first responder organizations, healthcare and dental associations, manufacturers, higher education, medical/nursing societies, and a union provided comments for consideration. This feedback was qualitatively analyzed to identify themes among the comments. This paper discusses patterns that emerged in the feedback provided within the primary topics of perceived advantages and disadvantages of EHMRs and key considerations for a successful national deployment of EHMRs. This paper also discusses how the formative feedback received was critical to informing the SNS's strategy to purchase and deploy EHMRs for longitudinal demonstration projects with the goal to produce updated EHMR implementation guidelines and best practices.

Keywords: elastomeric half mask respirator (EHMR); healthcare; public safety; PPT adoption; respiratory protection program; qualitative thematic analysis

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