

Source Control Efficiency of Child Masking

Hicham El Khayri, Sean D. Peterson & Serhiy Yarusevych

Department of Mechanical and Mechatronics Engineering, University of Waterloo, Waterloo, Ontario, CANADA

Children, despite generally developing more mild COVID-19 symptoms than adults, shed similar viral loads when infected (Gotzinger et al. , 2020; Costa et al. , 2021). A critical method of reducing airborne transmission of a virus is the donning of a well-fitting mask. When masks designed for the larger adult head are donned by a child, the poor fit is expected to result in a degradation of filtration efficiency. With that in mind, certain manufacturers have introduced smaller versions of their masks to be worn by children. While the source control efficiency of adult masking has been well documented, few studies have been conducted analyzing the effectiveness of child masking for source control. This study aims to quantify the filtration efficiency of the N95 respirator and adult and child versions of the KN95, CSA certified CA-N95, and ASTM level 3 Surgical Masks using a child head form.

Tests are performed using a manikin representative of a 7 year old Dutch child with very soft Shore 00-20 skin. A Laskin-Style nozzle is used to simulate exhaled breath particles in the $0.2 - 1 \mu m$ range. The manikin is placed in a large chamber with the mouth connected to an actuating piston that both simulates exhalation and injects aerosol-laden air into the chamber. To monitor variations in particle generation, a plenum is placed between the piston and the chamber. Apparent filtration efficiency is calculated as:

$$\eta_{AFE,M} = 1 - \frac{c_{sat,2,M}/c_{sat,1,M}}{c_{sat,2,NM}/c_{sat,1,NM}} \quad (1)$$

Where $c_{sat,1}$ and $c_{sat,2}$ are saturation particle number concentrations in the plenum and chamber, respectively. Calculation of apparent filtration efficiency requires testing using both donning a mask and no mask, indicated by the subscripts 'M' and 'NM', respectively. Ensemble mean apparent efficiency is presented in Table 1 with results for both adult and child versions in addition to modified adult masks versions with increased ear loop tension to be similar to the child versions.

Table 1: Ensemble mean apparent efficiency on child head form with 95% confidence interval.

Test Case	$\bar{\eta}_{AFE}[\%]$		
	Adult	Modified Adult	Child
N95	43.1 ± 6.7	-	-
CA-N95	10.9 ± 1.8	53.6 ± 4.6	66.8 ± 4.2
KN95	37.3 ± 6.9	50.7 ± 5.6	60.9 ± 5.3
Surgical Mask	8.8 ± 1.4	9.8 ± 1.9	25.9 ± 4.3

The large drop in apparent filtration efficiency from adult to child versions presented in the results highlights the importance of a properly fitting mask and the need for an update to N95 standards accounting for the smaller head shapes of children.

References

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