Population-Wide Facial 3D Database-Based Validation and Modification of a Filtering Half-Mask 3D Design

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Abstract

Introduction: In the initial phase of the COVID-19, a shortage of appropriate PPE became evident, leading to serious problems in controlling the spread of infection. One of the public responses was the decentralized production of new protective half-masks designs that took advantage of the flexibility and availability of 3D printing technology. However, the initial designs suffered from a lack of data on the Central European craniofacial variation. As a result, the masks weren't properly shaped, which compromised comfort and protection from viral droplets. This study summarizes the validation and modification of such a half-mask design for subadult individuals based on an existing population-wide database of 3D facial scans.

Material: Numerical and virtual validation of fitment was performed on a sample of 1137 individuals (619 females and 518 males) aged 4.06 to 18.94 years represented by facial 3D scans from the FIDENTIS 3D face database. Each scan was supplemented by 3D coordinates of seven landmarks identified on the scans according to the protocols and definitions of FIDENTIS 3D Face Database.

Methods: The proposed design of a subadult half-mask was confronted with the population craniofacial variation in terms of dimensions and direct superimposition of the 3D models within the virtual workspace of Blender 3.1 software. Subsequently, four new size categories were defined based on a facial centroid size, covering the whole size variation of the available sample. Finally, the four adjusted half-mask designs were assessed by a comparison with the average facial shapes of the subadult categories (Fig.1).

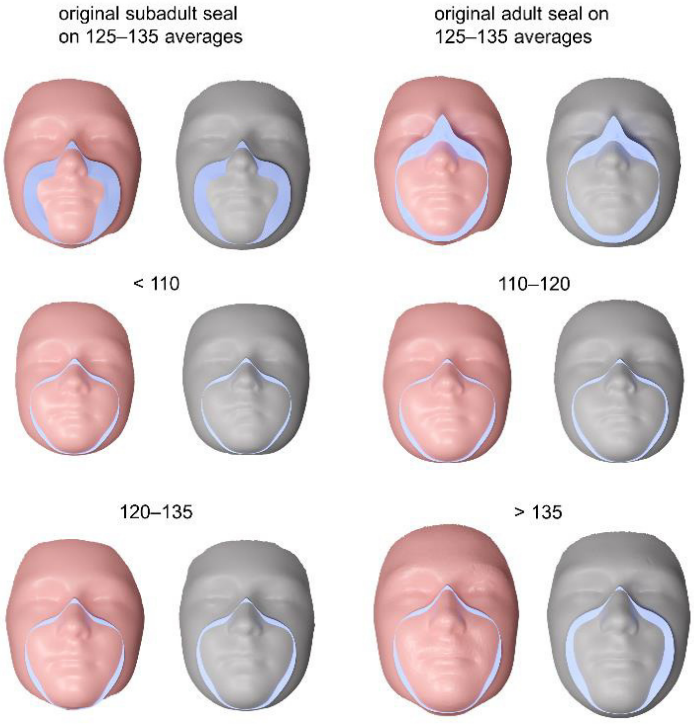

Fig. 1.

Results: The population-wide 3D databases enable rapid and flexible validation and modification of the PPE designs. The experience with the COVID-19 pandemic further augmented the significance of such ready to use, non-specific 3D morphological data. Obtaining such a sample would have been nearly impossible under the movement restrictions of the time.

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