Development of Anthropometric Tools and Technologies for the Design and Testing of Personal Protective Equipment

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1. Objective

For many years, the standard practice for assessing fit of personal protective equipment (PPE) related to head-and-face protection has been based on the anthropometry of U.S. Air Force personnel measured in the 1960s. It is largely recognized that data based on a population of young, fit military personnel from the 1960s does not likely reflect the age, sex, ethnicity, and fitness diversity of the contemporary workforce that test procedures are required to target. To address this deficiency, the National Institute of Occupational Safety and Health (NIOSH) developed head-and-face databases of diverse, civilian PPE users, respirator fit test panels, digital 3D headforms, and head and face shape modeling programs. The objective of our latest study was to develop headforms representative of workers throughout the world for testing eye and face protective devices.

2. Methods

The traditional measurement data and 3D scan data for 1169 U.S. workers and 350 Chinese workers were analyzed to define the variation of the 11 dimensions that are important to eye and face protective devices using 3D processing techniques. Traditional measurement data for four of the 11 dimensions for 317 Japanese workers were also obtained from the National Institute of Advanced Industrial Science and Technology (AIST) in Japan for comparison purposes. Fourteen existing headforms (5 sizes to represent U.S. workers and 5 sizes for Chinese workers, two EN 168 sizes, and two Japanese headforms) were compared to determine their representation of the world population.

3. Results

The largest head shape variation among the U.S. workers is between a small female head and a large male head. When comparing the average head for each dataset, the U.S. average is larger than the Chinese average except in the cheek areas. This is also true when comparing the U.S. average to the Japanese data. Comparisons revealed that the existing NIOSH small, medium and large headforms can cover the world population very well. The Chinese small, medium and large headforms can also represent Japanese workers. However, the ear positions for the NIOSH and Chinese headforms were not representative of the population data.

4. Conclusions

New headforms were created by revising existing NIOSH and Chinese headforms for possible incorporation into ISO SC6 eye and face protective devices standards. The ears were removed from the headforms and replaced by pegs in a location determined from the 3D scan data. The headforms were then rotated so that the plane passing through the apex of the eye and the top of the ear is parallel to the ground. The original NIOSH and Chinese headforms were designed for respiratory protective device testing. Therefore, testing is being done to confirm that the revised headforms are suitable for testing eye and face protective devices.

References