Anthropometrics for Developing Headforms for Testing Respiratory and Eye Protective Devices

Ziqing Zhuang and Dennis Viscusi

National Institute for Occupational Safety and Health, National Personal Protective Technology Laboratory, Pittsburgh, PA 15236
E-mail: zaz3@cdc.gov

In a recent anthropometric survey by the National Institute for Occupational Safety and Health (NIOSH), 3,997 subjects (2,542 male and 1,455 female) were measured using traditional methods and 1,013 of them (713 male and 300 female) were also scanned using a 3D head scanner. The subjects were representative of the current U.S. civilian population of respirator wearers age 18 to 66. The subjects were classified into four race groups: White, African-American, Hispanic and Others. Height, weight, neck circumference and 18 facial dimensions were measured. The objectives of this study were to (1) compare three approaches for the development of test headforms; (2) investigate the differences and variances in facial dimensions between gender and race; and (3) determine the numerical values for key facial dimensions of the test headforms. Based on correlation analyses and relevance of some facial dimensions to respirator fit, a subset of 10 facial dimensions was identified for defining a principal component analysis (PCA) model. The PCA model divided the user population into five face-size categories. The PCA model was used to identify typical individual face sizes/shapes for the development of test headforms (1st approach). Mean facial dimensions also computed for each size category (2nd approach) as well as for extreme face sizes (3rd approach) and all can be used to develop headforms. Respirator manufacturers, standards development organizations, and government respirator certification laboratories have an interest in selecting the appropriate headforms suited to their particular requirements. One set of standard headforms would reduce the ambiguity in head and facial dimensions that currently exists worldwide.