Anthropometric Change in the US Army 1988-2012: Implications for Design

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Introduction: The safety and performance of military personnel depends, among other things, upon the fit of their personal protective equipment (PPE) and workstations. For this reason, the US Army periodically conducts large scale anthropometric surveys of its personnel, and since WWII the Army has maintained a team of biological anthropologists at the US Army Natick RD&E Center to conduct statistical analyses of anthropometric data and provide ergonomic design criteria for clothing designers and engineers. The most recent Army anthropometric survey (ANSUR II) was conducted in 2011-2012 and comprised 94 directly measured body dimensions and 3D scans of the head/face, feet, and whole body on each of 10,587 soldiers. This paper compares the ANSUR II results (Gordon et al., 2014) for 20 body dimensions important to PPE sizing and workstation design against the ANSUR 1988 results (Gordon et al., 1989). Method: 6,866 male soldiers and 3,721 female soldiers were measured during ANSUR II using standardized protocols to minimize observer error and maximize comparability to the 1988 ANSUR survey database (Hotzman et al., 2011). ANSUR II participant sampling was based on access to a cross-section of Army functional units with stratified random sampling of sex, age, and racial/ethnic groups; sex, age, and racial/ethnic minority groups were intentionally oversampled for research purposes. After the survey, male and female working databases matching the sex-specific and racial/ethnic distributions of the Total Army were derived using stratified random sampling of the survey data pool (see Gordon et al., 2014). The ANSUR II working databases include 4,082 male and 1,982 female soldiers. Two-sided t-tests assuming unequal variances and a Bonferroni adjustment for 20 comparisons were used to identify statistically significant differences between the 1988 (n=1774 males, 2208 females) and 2012 body dimension means. Because body weight is not normally distributed, Wilcoxon rank-sum tests were used to confirm those t-test results. Results: Statistically significant differences were found for 16 of the 20 dimensions tested in males and 17 of the 20 dimensions in females. On average, US Army males in 2012 were only .4mm taller than in 1988 (p=.8318), but 7.0kg heavier (p=.0000); Army females were .9 mm shorter than in 1988 (p=.6493) and 5.7kg heavier (p=.0000). Given the large increase in average weight with no significant increase in average height, it is not surprising that large differences were also found in trunk dimensions influenced by soft tissue depth. Army males in 2012 had an average chest circumference 67.3mm larger, waist circumference 78.2mm larger, and buttock circumference 35.9mm larger than in 1988 (p=.0000 for all). Male biacromial & bideltoid breadth means were both 18.7mm larger and the hip breadth sitting mean was 12.5mm larger than in 1988 (p=.0000 for all). The results were similar for female soldiers: Army females in 2012 had an average chest circumference 39.8mm larger, waist circumference 69.0mm larger, and buttock circumference 54.4mm larger than in 1988 (p=.0000 for all). The female bideltoid breadth mean was 17.7mm larger and hip breadth sitting mean was 14.5mm larger than in 1988 (p=.0000 for both). Compared to the changes observed in male and female trunk dimensions, the magnitude of 1988 vs. 2012 differences in limb lengths, head, hand, and foot dimensions were relatively small, and in some cases smaller than the interobserver error magnitudes recorded in the surveys. Discussion: Body weight and trunk circumference means and variances of US Army soldiers have increased substantially since the 1988 Army survey, indicating that PPE sizing and workstation clearances for today’s US Army may need to be carefully re-evaluated. Since the variance of trunk dimensions also increased substantially from 1988 to 2012 (requiring that t-tests be conducted under an unequal variance assumption), the dimensional range required to capture 90% or more of users is substantially greater and thus more sizes of some PPE may be required.

Keywords: Military Anthropometry, Secular Change, Sizing, Cewstations

References:

