Validity of Infrared 3-dimensional Scanning for Estimation of Body Composition: A 4-Compartment Model Comparison

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ABSTRACT

Multiple infrared 3-dimensional (3D) scanning technologies exist, including time of flight (ToF) scanners and structured light scanners with static (SL-S) and dynamic (SL-D) configurations. ToF scanners measure depth by using the round-trip time of reflected photons, whereas SL scanners measure deformations in light patterns and allow for creation of a depth image using geometric triangulation. Recently, 3D scanning technologies have been proposed as novel methods of body composition assessment. **PURPOSE**: The purpose of this analysis was to examine the validity of four different commercially-available 3D scanners for estimation of body fat percentage (BF%) as compared to a 4-compartment (4C) model criterion. **METHODS**: After an overnight fast, 101 adults (63 F, 38 M; age: 29.3 ± 13.5 y; BMI: 24.3 ± 3.9 kg/m^2; BF%: 24.6 ± 8.3%) completed assessments via dual-energy x-ray absorptiometry (DXA), air displacement plethysmography (ADP), bioimpedance spectroscopy (BIS), a standard body mass scale, and four infrared 3D scanners. Two scanners ($3DS_{SL-D1}$; $3DS_{SL-D2}$) utilized structured light scanning with a dynamic configuration, one utilized structured light scanning with a static configuration ($3DS_{SL-S}$), and one utilized time-of-flight technology ($3DS_{ToF}$). Using the equation of Wang et al. (2002), a criterion 4C estimate of BF% was obtained using DXA for bone mineral, ADP for body volume, scale for body mass, and BIS for total body water. BF% estimates were compared using one-way ANOVA with Bonferroni adjustment for multiple comparisons, and additional evaluations were conducted using the correlation coefficient (r), constant error (CE), standard error of the estimate (SEE), total error (TE), and 95% limits of agreement (LOA). **RESULTS**: Estimates of BF% did not significantly differ between 4C and any of the 3D scanners. However, metrics of group, individual, and prediction errors varied between scanners: $3DS_{SL-D1}$: p=1.0; CE: 0.4%; r: 0.91; SEE: 2.5%; TE: 3.6%; LOA: ±7.0%; $3DS_{SL-D2}$: p= 1.0; CE: 0.8%; r: 0.86; SEE: 4.2%; TE: 4.7%; LOA: ±9.2%; $3DS_{SL-S}$: p= 1.0; CE: 1.0%; r: 0.81; SEE: 4.0%; TE: 5.0%; LOA: ±9.7%; $3DS_{ToF}$: p=0.08; CE: -2.9%; r: 0.86, SEE: 2.5%; TE: 5.2%; LOA: ±8.6%. **CONCLUSION**: All three structured light scanners exhibited low magnitudes of group error (CE ≤ 1%) and may be valid assessment methods when analyzing the body composition of groups. $3DS_{SL-D1}$ exhibited the lowest group-level error (i.e. CE), prediction errors (i.e. SEE; TE), and individual error (i.e. LOA) of all scanners. Therefore, this device was deemed the most valid 3D scanner for body composition assessment. $3DS_{SL-D2}$, $3DS_{SL-S}$, and $3DS_{ToF}$ exhibited comparable TE, although group-level error was lower in $3DS_{SL-D2}$ and $3DS_{SL-S}$, while the SEE and individual-level error was lower for $3DS_{ToF}$. However, individual-level errors were relatively high with all scanners (LOA ≥ 7%), which calls into question the utility of these methods for assessing the body composition of individuals. Nonetheless, additional research is needed regarding the ability of 3DS to successfully detect changes in body composition over time.