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Brief Report

Accuracy of Anthropometric Equations in Estimating Body Fat Percentage in Transgender Men Undergoing Gender-Affirming Hormone Therapy

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Abstract

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Transgender people may opt for the use of sex steroids and, in some cases, hormone blockers, which can lead to changes in body fat distribution. The aim of this study was to verify the accuracy of anthropometric equations to estimate the body density (BD) of transgender men who are undergoing Gender-Affirming Hormone Therapy (GAHT). Four transgender men (25-32 years old), who had performed GAHT for at least six months and used the hormone testosterone cypionate participated in the study. The reference criteria for BD was air displacement plethysmography (ADP). In addition, BD was estimated using anthropometric equations for both male and female sexes (Durnin & Womersley, 1974; Jackson & Pollock 1980; Lohman, 1981). The body fat percentage (%BF) was estimated by the Siri equation. For two participants (Cases 1 and 3), the equations for males underestimated the %BF, while only for Case 3 the equation for both sexes underestimated the %BF. For the other two participants (Cases 2 and 4), all equations overestimated the %BF. Of note, one participant undergoing GAHT for six months showed a %BF assessed by ADP like values obtained using equations for cisgender women, while those with longer time on GAHT presented similar %BF obtained by ADP to obtained by equations developed for cisgender men. In conclusion, the results of this study indicate the need to develop specific anthropometric equations for the transgender population. In addition, the time on GAHT of the transgender person seems to be a critical factor.

Keywords: Transgender, skinfolds, air displacement plethysmograph, female to male

Introduction

Transgender is an umbrella term that represents a wide variety of gender identities and expressions. People who designate themselves as transgender do not identify either fully or partially with their sex assigned at birth.[1] It is estimated that 0.5% of the world's population identifies as transgender.[2] There are also those who undergo medical interventions, such as Gender-Affirming Hormone Therapy (GAHT), to align their physical characteristics with their gender identity.[3]

One of the possible aspects of undergoing GAHT may involve the administration of steroid hormones and, in some cases, hormone blockers, leading to changes in external physical appearance, which can result in alterations in body fat distribution.[3] Testosterone use in transgender men may lead to menstrual suppression, increases in body and facial hair, voice changes, as well as changes in fat distribution — with more fat deposited in the android region (abdomen) — in addition to higher fat-free mass (FFM) indices when compared to control groups.[4] Klever et al reported that after 12 months of intervention with GAHT, transgender men show mean increases of 1.9 kg in body mass, 3.9 kg in muscle mass, and reductions of 2.6 kg in fat mass.[5]

According to Yeung et al,[6] the measurement of body composition in the bicompartmental model (fat mass and fat-free mass) has a wide range of applications, from monitoring changes in body composition in situations involving pathologies, to nutritional and drug interventions, as well as interventions with physical training programs.

Body composition has commonly been assessed by indirect and doubly indirect methods. Among the indirect methods, those considering body density, hydrostatic weighing, and air displacement plethysmography stand out.[7] Despite the precision of these techniques in measuring body density (body mass/body volume), they require trained human resources for their application, in addition to being expensive and out of reach for the general population. The doubly indirect methods, on the other hand, calculate body density values through regression equations. The fact that they are affordable and low-cost[8] has made them widespread in public and private health systems. The regression equations used to estimate body density can be developed either for specific groups or for the general population and consider anthropometric measures (gender, body mass, height, skinfolds, and circumferences), physical condition, age, and sex.[9]

Among the studies that evaluated the body composition of transgender people who undergo GAHT, it is common to use dual-energy x-ray absorptiometry-DEXA[10,11-15] or doubly indirect methods, such as bioelectrical impedance.[16,17] However, it is essential to improve the application of low-cost and easily accessible techniques to assess the body composition of this population, in order to help public and private health systems in the proper monitoring of transgender people during their harmonization process. To the best of our knowledge, no studies in the literature have used regression equations involving skinfolds to estimate the percentage of body fat in transgender people. In this sense, the aim of the current study was to compare the percentage of body fat obtained through generalized anthropometric equations with the values obtained by air displacement plethysmography in four transgender men undergoing GAHT.

Methods

Participants

Participants in this study were recruited through convenience sampling via personal networks and social media platforms. Eligibility criteria included self-identification as a transgender man, age between 18 and 40 years, and absence of any diagnosed metabolic, cardiovascular, or musculoskeletal disorders. Participants also could not be using medications that might affect body composition, apart from GAHT. The sample consisted of four transgender men, aged 24 to 32 years.

Case Presentation.

Case 1: Age 31 years, height 1.66m, body mass 92.4kg. Has performed GAHT for 6 months. Applies 2ml of Testosterone Cypionate every 21 days. According to the IPAQ-Short Version questionnaire is considered active. Case 2: Age 24 years, height 1.62m, body mass 70.6kg. Has performed GAHT for 18 months. Applies 2ml of Testosterone Cypionate every 15 days. According to the IPAQ-Short Version questionnaire is considered very active. Case 3: Age 25 years, height 1.72m, body mass 72.8kg. Has performed GAHT for 18 months. Applies 2ml of Testosterone Cypionate every 15 days. According to the IPAQ-Short Version questionnaire it is considered irregularly active. Case 4: Age 32 years old, height 1.62m, body mass 79kg. Has performed GAHT for 60 months. Applies 250mg of Testosterone Cypionate every 15 days. According to the IPAQ-Short Version questionnaire is considered irregularly active. All participants provided written informed consent prior to participating in the study. This research was carried out fully in accordance with the ethical standards of the *International Journal of Exercise Science*.[18]

Protocol

Body composition evaluation - Air displacement plethysmograph (ADP).

The body composition (fat mass and fat-free mass) of all participants was evaluated using ADP (BODPOD – Body Composition System; Life Measurement Instruments, Concord, CA, USA) according to the manufacturer's instructions. The ADP method has been shown to be reliable and valid compared to hydrostatic weighing.[19]

The ADP system was calibrated through the computation of the ratio of pressure for an empty chamber and a known volume (56.056 L). The scale attached to the device was also calibrated using a known reference (20 kg). After an explanation of the procedures, the participants entered the ADP system wearing minimal clothing. A swimming cap was used to decrease hair volume, and all metal objects (e.g. earrings, rings and piercing) were removed. The participants remained seated inside the device, and the ADP system door was open throughout each step of the evaluation; the test lasted four minutes on average. During the evaluation, the subject's raw body volume was determined according to Boyle's law. To assess the pulmonary volume of the participant's, predicted values were used. This procedure did not affect the estimate of body composition (14). The body density (BD) was determined by the pressure and volume values, and the %BF was calculated using the Siri equation.[20]

Anthropometry and skinfold thickness measures.

All measurements followed the procedures described by the International Society for the Advancement of Kinanthropometry (ISAK).[21] The height of the participants was calculated using a measuring tape attached to the wall (to 0.1cm accuracy), and weight was measured on a scale with 0.001 kg accuracy, linked to the ADP system. The skinfold thickness was measured at nine body sites (triceps, biceps, subscapular, chest, midaxillary, suprailiac, abdominal, thigh, and medial calf), using a calibrated caliper (CESCORF®, São Paulo, Brazil), with 0.1 mm accuracy. The circumferences of the arm, forearm, and abdomen were measured using a flexible tape (CESCORF®, São Paulo, Brazil) with 0.1 mm accuracy. After collection of anthropometric data, the body density for the genders was estimated using the selected generalized equations (Table 1) and the %BF was calculated using the Siri equation.[21]

Table 1. Predictive equations for estimating body density (BD).

Gender	Author	Equation	Age	r^2	SEE
Male	Durnin & Womersley (1974)	BD= 1.1765 – 0.0744*LOG10. (Y4)	17-61	-	0.0103
	Jackson & Pollock (1978)	BD= 1.1010 – 0.00041150*(X11) + 0.00000069*(X11)2 – 0.00022631*(age) – 0.000059239*(Cabd) + 0.000190632*(Cabc)	18-61	0.916	0.0073
Female	Durnin & Womersley (1974)	BD =1.1567 - 0.0717 * LOG10* (Y4)	17-68	-	0.0116
	Jackson & Pollock (1980)	BD= 1.0970 – 0.00046971*(X11) + 0.00000056*(X11)2 - 0.00012828*(age)	18-55	0.852	0.0083
Both	Lohman (1981)	BD = 1.0982 - 0.000815*(L5) + (0.00000084*(L5)2)		0.92	0.0071

Where: SEE= standard error of the estimate; r= Pearson's Correlation (data not reported); X11= Sum of seven skinfolds (subscapularis, triceps, pectoral, middle axillary, suprailiac, abdominal, and thigh); Y4= Sum of four skinfolds (triceps, subscapularis, biceps, and suprailiac); L5 = Sum of three skinfolds (triceps, abdominal, and subscapular); Cabd= Circumference of the abdomen (cm); Cabc= Circumference of the forearm (cm).

Statistical Analysis

Considering the low number of participants "4", descriptive statistics and percentage differences obtained between the anthropometric equations and the reference measure (ADP) were chosen.

Results

The individual results, as well as the sum of the nine skinfolds evaluated are shown in table 2. It is noted that subjects 3 and 4 had the highest values for the sum of skinfolds, while subjects 1 and 2 presented the smallest values.

The %F values evaluated by both the reference method (ADP) and the regression equations are described in table 3.

The differences between the %F estimated by the regression equations and the reference measure (ADP) are shown in figure 1. Note that for Case 1, the smallest differences were found when using equations for cisgender women and by the Lohman equation developed for both sexes.[22] For Case 2, all equations used overestimated the %F values, and the equations initially developed for cisgender women most overestimated the values. For Case 3, only the equation of Durnin & Womersley[8] overestimated the %F values, the other equations underestimated the values. For Case 4, all the equations used overestimated the %F values, but the smallest differences were found for the equations developed exclusively for cisgender men.

Table 2. Individual skinfold thicknesses and circumferences.

	Cases			
Skinfold thickness (mm)	Case 1	Case 2	Case 3	Case 4
Triceps	31.33	14.03	13.50	33.33
Biceps	11.23	6.83	16.23	6.87
Subscapularis	35.00	20.67	20.00	35.60
Pectoral	22.33	16.37	14.77	19.80
Middle axillary	23.93	24.03	15.30	45.83
Suprailiac	36.63	19.17	15.70	47.23
Abdominal	34.23	25.60	19.70	41.33
Thigh	54.40	44.07	34.40	49.90
Middle Calf	46.23	1.61	10.60	28.67
Sum	172.4	160.2	308.6	295.3
Circumference (cm)				
Arm	29.73	28.40	29.00	37.00
Forearm	27.47	23.20	24.00	28.00
Abdominal	84.60	88.40	97.00	98.00

Table 3. Individual values of body fat percentage (%BF) evaluated by ADP and regression equations for transgender males undergoing GAHT.

		Cases			
		Case 1	Case 2	Case 3	Case 4
ADP (Reference Method)		39.2	15.9	30.7	32.2
Male	Durnin & Womersley (1974)	33.7	24.2	25.3	34.8
	Jackson & Pollock (1978)	28.4	22.9	25.3	34.8
Female	Durnin & Womersley (1974)	40.5	31.1	32.2	41.6
	Jackson & Pollock (1978)	38.7	29.7	25.4	41.8
Both	Lohman (1981)	37.0	21.8	19.2	40.9

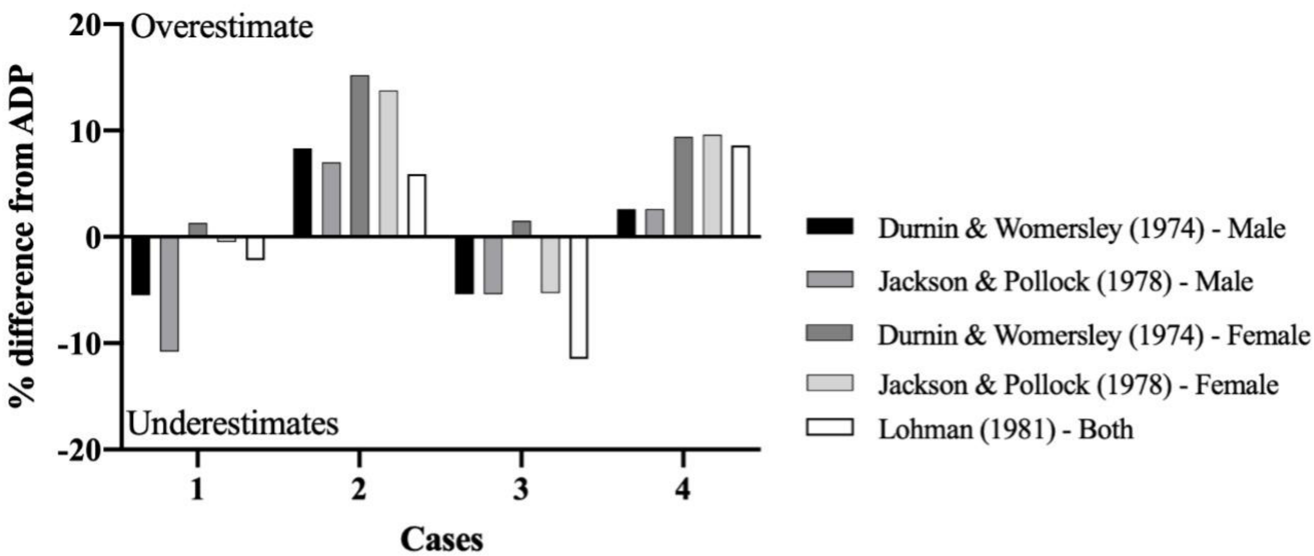

Figure 1. Percentage difference between ADP and anthropometric equations for the participants of the study.

Discussion

The aim of the present study was to compare the results of estimating %BF in transgender men undergoing GAHT, obtained through generalized anthropometric equations and the ADP technique (reference method). To the best of our knowledge, this is the first study to compare these methods in this population. As we only evaluated 4 transgender men, the discussion will be elaborated on a case-by-case basis.

In Case 1, the %BF value estimated through the ADP (39.2%) was very close to values estimated by the equations for cisgender women, with 40.5%[8] and 38.7%,[25] as well as 37% for the equations developed for both sexes[24] with differences of 1.3, 0.5, and 2.2%, respectively. It is worth noting the fact that Case 1 is considered physically active and has the largest body mass (92.4kg) and the shortest GAHT time (6 months). In this context, the short time of GAHT may explain, in part, these results, since in most of the testosterone therapy protocols, male physical characteristics can be seen in almost all users after at least 6 months of therapy, and the maximum virilization effects are usually achieved after 3 to 5 years of regular use of the hormone.[24]

Our hypothesis is reinforced when looking at Case 4, who has the longest GAHT time (5 years) and despite being insufficiently active, his %F values estimated by the ADP (32.2%) were very close (2.6% difference) to those estimated using equations developed for cisgender men where the %BF was 34.8%.[8,23] The result obtained for Case 4 corroborates the findings of Narasimhan and Safer.[4] According to the authors, the chronic use of testosterone by transgender men causes alterations in the distribution of body fat, with a higher index deposited in the android region, as well as higher fat-free mass indices.

Case 2 and Case 3 have the same GAHT duration (18 months), however, Case 2 presents smaller differences between the %F obtained by the ADP (15.9%) and the equations developed for cisgender men (24.2%) by Durnin & Womersley, 1974 and 22.9% by Jackson & Pollock, 1978) and equations developed for both sexes (21.8% by Lohman, 1981). On the other hand, Case 3 presents the smallest differences between the ADP values (30.7%) and the equations developed for cisgender women (32.2% by Durnin & Womersley, 1974) and (25.4% for Jackson & Pollock, 1978). We believe that part of this explanation may be associated with the different levels of physical activity between Case 1 and Case 2. While Case 2 was classified as very active, practicing strength training and Cross-fit®, Case 3 was classified as being insufficiently active. Although we did not find studies in the literature that investigated the effects of interventions with physical exercise programs on the %BF of transgender men who undergo GAHT, data from recent reviews indicate that strength training is efficient in reducing %F, fat mass, and visceral fat mass in cisgender people.[25] In this sense, although we have data from only 2 transgender men, the results indicate the possibility of a positive association between the level of physical activity and GAHT to enhance changes in body composition for the stated gender. However, there are still few studies that support this statement, and we recommend that future research address this limitation.

Among the limitations of our study, we highlight: a) the low number of participants, which prevents generalization of the results; b) the analysis of body composition with a focus on body fat, despite knowing that GAHT causes alterations in other body tissues, especially bone tissue[11]; and c) the use of only three generalized equations developed for cisgender men and women. However, our study has strengths such as: a) being the first study to compare body composition in transgender men using indirect methods that consider body density (BDA) and doubly indirect methods (skinfold thickness); b) raising hypotheses about the positive association between GAHT and level of physical activity on the acceleration of the process of alignment with gender identity.

Based on the analysis of these 4 case studies, we can conclude that there are inconsistencies between %BF estimates derived from ADP and from commonly used anthropometric equations in transgender men undergoing GAHT. Equations developed for cisgender men yielded values more aligned with ADP in participants with longer GAHT duration and higher physical activity levels. These findings underscore the limitations of applying cisnormativity models to transgender populations. Future research should aim to develop tailored anthropometric equations that account for hormonal duration and physical activity to improve accuracy and inclusivity in body composition assessment.

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