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Effects of body fat distribution on body size estimation accuracy among obese women

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Body fat distribution is a reliable predictor of the health risks of obesity. Abdominal obesity (AO) has been associated with various health complications whereas gluteal-femoral obesity (GFO) appears to be less hazardous. Body size overestimation, a type of body image disturbance, is found in a subset of obese persons.
OBJECTIVE: The current study examined body size estimation accuracy as a function of body fat distribution.
DESIGN: Cross-sectional, retrospective review of clinical records.
SUBJECTS: 101 obese women (Mean age = 39.4) joining a weight loss program.
MEASUREMENTS: Subjects provided body size estimates using a live video distortion procedure and were grouped into tertiles (AO; Mixed type obesity (MTO); GFO) on the basis of their waist-to-hip ratios.
RESULTS: GFO women had significantly lower body size estimates and felt thinner than did AO or MTO women. In addition, more AO women (20.6% *vs* GFO: 8.8%) overestimated their body size by more than 15% whereas more GFO women (29.4% *vs* AO: 5.9%) underestimated their body size by more than 15%.
CONCLUSION: Body fat distribution appears to be a mediator in body size estimation accuracy. These findings are discussed in terms of possible differences in perceptual and societal experiences among the groups.

Keywords: body fat distribution; body size estimation accuracy; body image

Introduction

Recent evidence suggests that the health risks of obesity differ as a function of body fat distribution. Abdominal obesity (upper body fat distribution) has been associated with increased health risks including diabetes, hypertension and hyperlipidemia[1] and with increased mortality due to cardiovascular disease and stroke.[2] In addition, upper-body fat distribution has been linked to greater accident proneness, increased likelihood of mental disorders and more frequent use of antidepressants and tranquilizers, regardless of the level of obesity.[3] On the other hand, gluteal-femoral obesity (lower body fat distribution) appears to be less hazardous.

Body image refers to the mental image that one has of his/her body and includes both an affective and perceptual component. Several investigators have found disturbances in body image in obese persons including overestimation of body size,[4,5] and negative attitudes towards the body.[6]

Greater variability in the accuracy of body size estimation has been noted in the obese relative to normal-weight controls. In one study,[7] researchers found that 16% of obese subjects underestimated their size by more than 15%, 32% overestimated their size by more than 15%, and 52% made an accurate estimate. In contrast, 80% of normal-weight controls made an accurate estimate of their body size and only 10% either underestimated or overestimated their size by more than 15%.

To date, no factors have been proposed that may account for this variability in estimation accuracy within the obese population. Perhaps body fat distribution is a mediating factor accounting for this variance. Upper body fat is more visible and therefore, persons with abdominal obesity are more frequently confronted with their excess weight. Perhaps these continual reminders of their obesity predispose the abdominally obese to harbor negative thoughts and feelings about their bodies which, in turn, result in a tendency to overestimate body size.

The current study examines the relationship between body fat distribution and body size estimation accuracy among women joining a weight loss program. It was expected that women with abdominal obesity would overestimate body size to a greater degree than women with gluteal-femoral obesity.

Methods

Subjects

The charts of 101 obese women who joined a weight loss program were retrospectively reviewed. All measures were obtained at entry as per the clinical protocol for a comprehensive weight loss program which

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included behavior modification, nutritional counseling, and exercise enhancement. The sample had a mean percentage overweight of 53.2% and were primarily married (62.4%) and white (94.3%). They ranged in age from 19–74 y (Mean = 39.4).

Procedure
Subjects were weighed (to the nearest 0.1 kg). Height, waist and hips circumference, and elbow breadth were obtained. Circumference measures were obtained over everyday clothing after all bulky items were removed (namely, wallets, belts, jackets, etc). The narrowest part of the waist and the widest part of the hips were used as landmarks. The waist-to-hip ratio (WHR) was computed as a measure of body fat distribution. Percent overweight was used as an index of overall obesity and calculated as the percent above ideal body weight for a given height and frame size (determined by elbow breadth) from the Metropolitan Life Insurance Tables (1983).[8] The upper limit of the weight range given in the tables was used as the standard.

Body size estimates. Subjects estimated their body size using the live video distortion procedure described by Freeman, Thomas, Solyom, and Hunter (1984).[9] Subjects, wearing everyday clothing, stood in the corner of a room against a solid unmarked background while a live image of their entire body was fed into a TV monitor via a video-camera. An assistant adjusted the video distortion beginning at either largest (+58%) or smallest (−52%) range of images (randomly determined) until the subject indicated to stop. Minor adjustments were then made until the image appeared as the subject wanted. The meter setting was recorded and the procedure was repeated, beginning from the opposite extreme of distortion. Measures taken from both the largest and smallest extreme of ranges were subsequently averaged for each variable. Subjects indicated, separately, when the image on the monitor matched (1) their objective estimate of their body size or how they thought they *really* looked (REAL), and (2) their affective estimate of their body size or how they *felt* they looked (FELT). These measures were obtained for both front and side views. The dial settings corresponding to these measures were then converted to a percentage of distortion from actual body size.

Results

The sample was divided into tertiles on the basis of body fat distribution as determined by WHR. Thirty-four women were classified as having gluteal-femoral obesity (GFO: WHR $\leq$ 0.75), and thirty-four were classified as having abdominal obesity (AO: WHR > 0.843), while thirty-three women were classified as having mixed-type obesity (MTO: WHR = 0.75–0.843). Table 1 displays the means, standard deviations, and ranges for WHR, age, weight, height, BMI, and percent overweight for the three WHR groups.

Duncan multiple range tests were performed on those descriptive measures which produced significant F-ratios on one-way analyses of variance. AO women were found to be significantly older than MTO women but not GFO women. Moreover, AO women were significantly heavier than GFO or MTO women (AO > GFO = MTO), and taller than MTO women (AO > MTO) but not GFO women. When weight was considered in the context of height (% overweight), AO women were found to be significantly more overweight than GFO women but not MTO women.

Correlation coefficients were computed between front and side REAL and FELT measures, percent overweight and age. These data are presented in Table 2. Significant correlations ($p > .05$) were found between all body size estimates and percent overweight. However, none of the body size estimation measures was significantly correlated with age.

Body size estimates
A series of 2 (view: front *vs* side) by 3 (WHR group: GFO *vs* MTO *vs* AO) analyses of covariance (ANCOVA) were performed on the body size estimates. Because WHR groups differed significantly in

Table 1 Mean and standard deviations for descriptive variables by body fat distribution type

	Body fat distribution type		
	Gluteal femoral (n = 34)	*Mixed (n = 33)*	*Abdominal (n = 34)*
Waist-hip ratio	0.72 ± 0.03^{a}	0.81 ± 0.05^{b}	0.90 ± 0.04^{c}
Range	0.67–0.75	0.76–0.85	0.85–1.0
Age	38.1 ± 12.4^{ab}	36.5 ± 10.2^{b}	43.5 ± 12.9^{a}
Range	19–55	21–66	21–70
Weight (kg)	88.3 ± 19.9^{a}	96.7 ± 20.2^{ab}	105.6 ± 17.7^{b}
Range	53.1–141.0	65.9–164.7	67.1–146.2
Height	163.8 ± 7.2^{a}	163.3 ± 6.7^{a}	167.1 ± 5.4^{b}
Range	149.9–179.0	152.4–177.8	157.5–179.1
% overweight	42.4 ± 27.6^{a}	52.0 ± 26.1^{ab}	62.2 ± 26.3^{b}
Range	−8.0–115.5	9.9–108.9	13.5–135.4
Body mass index	32.8 ± 6.4^{a}	36.1 ± 6.4^{b}	37.9 ± 6.5^{b}
Range	20.4–45.9	24.9–51.9	24.9–57.0

Note: Means with the same superscript do not differ, $p > .05$.

Table 2 Correlation coefficients among body size estimates, percent overweight and age

	% Overweight	*Age*
Front REAL	.22*	−.01
Side REAL	.24*	−.09
Front FELT	.21*	−.13
Side FELT	.23*	−.10

Note: REAL = objective estimate of body size; FELT = affective estimate of body size.
*$p < .05$.

Table 3 Means for REAL, and FELT body size estimates before and after adjusting for percent overweight by body fat distribution type

	Gluteal-femoral (*n* = 34)	*Mixed* (*n* = 33)	*Abdominal* (*n* = 34)
REAL			
Unadjusted	-4.1^a	2.9^b	5.8^b
Adjusted	-4.5^a	4.1^b	6.8^b
FELT			
Unadjusted	-3.8^a	6.5^b	4.6^b
Adjusted	-3.7^a	9.2^b	4.7^b

Notes: REAL = objective overestimate of body size; FELT = affective estimate of body size; Means with same superscript do not differ, $p > .05$.

Table 4 Percentage table for categories of body size estimation accuracy by body fat distribution type

	GFO	*MTO*	*AO*	*Row %*
Underestimators ($\leq 15\%$)	29.4%	6.1%	5.9%	13.9%
Accurate (-14% and $+14\%$)	61.8%	84.8%	73.5%	73.3%
Overestimators ($\geq 15\%$)	8.8%	9.1%	20.6%	12.9%
Column %	100%	100%	100%	100%

χ^2(df 4, *N* 101) = 12.5, $p = .01$.
Note: GFO = gluteal-femoral obesity; MTO = mixed type obesity; AO = abdominal obesity.

percent overweight, and body size overestimation is known to be related to degree of obesity, percent overweight was used as a covariate to control for its effect on the body size estimates. Table 3 presents the means for the REAL, and FELT body size estimates before and after adjusting for percent overweight for each WHR group.

Both before and after adjusting for percent overweight, the GFO group underestimated while the MTO and AO groups overestimated their body size. Duncan multiple range tests performed on the group means revealed that GFO body size estimates were significantly lower than both MTO and AO estimates which were not significantly different from one another. Similar results were obtained for the FELT body size estimates. After adjusting for percent overweight, the GFO group was found to feel significantly thinner than either the AO or the MTO groups which again, did not significantly differ from one another on Duncan multiple range tests.

In order to determine the extent of body size distortion within each group, the cut-points used previously[7] were employed to classify subjects as either underestimators ($\leq -15\%$) or overestimators ($\geq 15\%$) or accurate estimators ($\geq 15\%$ and $< 15\%$) of actual body size using their mean REAL body size estimates. A percentage table for estimation accuracy by WHR group is presented in Table 4.

As predicted, significantly more AO women were classified as overestimators and more GFO were classified as underestimators ($\chi^2 = 12.5$, df = 4, N = 101, $p = .01$) whereas more MTOs were accurate in their size estimations.

Discussion

Obese women with lower body fat distribution tended to underestimate their body size and professed to feel thinner than they actually are. On the other hand, obese women with upper and mixed-type body fat distributions tended to overestimate their body size and feel heavier than they actually are. In addition, more GFO women were classified as underestimators and more AO women were classified as overestimators of body size. Taken together, these findings support the notion that body fat distribution is a mediating factor for body size estimation accuracy.

One possible explanation for these results is that AO women are more aware of their excess adipose tissue. Upper body fat is concentrated in more visible areas such as the face, neck, chest and waist. These body sites are more often confronted when looking in the mirror or at pictures of oneself. In addition, these areas tend to be more variable kinaesthetically. The abdomen is subject to changes in size after eating or drinking, perhaps heightening awareness of excess mass in the area.

Conversely, lower body fat is not confronted by its bearer in as many situations. Most glimpses in the mirror do not involve a full-frontal or posterior view which is necessary in order to adequately perceive the size of the hip area. In addition, fat stores below the waist may be more easily disguised and/or hidden by everyday clothing, thereby allowing a slimmer appearance. These factors may permit GFO women to minimize their weight problem which subsequently leads to the underestimation of body size.

Altogether, these findings have important implications for the study of body image disturbances in obese women. This study examined body size estimation accuracy, but did not address many other important aspects of body image such as body satisfaction and attitudes towards the body. In addition, this study did not address variables such as onset of obesity[10] or teasing history[11] which have been theorized to be related to body image disturbance in obese women. Research examining these variables in relation to body fat type is required for a fuller understanding of the psychological implications of variations in body fat distribution.

In addition, differences in societal attitudes and perceptions of GFO and AO women would appear to be an important area for future investigation. Perhaps AO women are more negatively stereotyped or perceived by others as being heavier than are GFO women thereby leading to the differences in size estimation noted. The importance of societal influences in body image measures is well-established[12] but as of yet, has not been examined as a function of body fat distribution.

An alternative explanation for these findings may involve physiological responses to stress. In this model, a defeat reaction to stress may encourage the deposition of abdominal fat through increased cortisol production.[13] Here, the overestimation of body size may reflect a general cognitive style in which problems become magnified and solutions are not forthcoming; this is consistent with a defeat reaction which has been associated with increased cortisol production and deposition of abdominal fat. In this model the direction of the relationship is reversed with the cognitive style which includes overestimation of problems indirectly leading to the deposition of abdominal fat. Such psychological factors may in turn interact with metabolic factors to increase health risks. Longitudinal research which examines the change in fat distribution as a function of cognitive styles and body size estimation accuracy would help to clarify this relationship.

Although these findings support the notion the body fat distribution is a mediating factor for body size estimation accuracy, further research is needed to test the robustness and replicability of these findings and to explore their generalizability to the non-obese as well as to men and adolescents.

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