International Journal of Obesity (2001) 25, 1517–1524
 0307–0565/01 $15.00
www.nature.com/ijo

PAPER

Relating body mass index to figural stimuli: population-based normative data for Caucasians

CM Bulik[1]*, TD Wade[2], AC Heath[3], NG Martin[4], AJ Stunkard[5] and LJ Eaves[6]

[1]*Virginia Institute for Psychiatric and Behavioral Genetics, Department of Psychiatry, Medical College of Virginia of Virginia Commonwealth University, Richmond, Virginia, USA;* [2]*Department of Psychology, Flinders University, Adelaide, Australia;* [3]*Department of Psychiatry, Washington University School of Medicine, St Louis, Missouri, USA;* [4]*Queensland Institute of Medical Research, Brisbane, Australia;* [5]*Department of Psychiatry, University of Pennsylvania School of Medicine, Philadelphia, Pennsylvania, USA; and* [6]*Virginia Institute for Psychiatric and Behavioral Genetics, Department of Human Genetics, Medical College of Virginia of Virginia Commonwealth University, Richmond, Virginia, USA*

OBJECTIVE: To establish body mass index (BMI) norms for standard figural stimuli using a large Caucasian population-based sample. In addition, we sought to determine the effectiveness of the figural stimuli to identify individuals as obese or thin.
DESIGN: All Caucasian twins born in Virginia between 1915 and 1971 were identified by public birth record. In addition, 3347 individual twins responded to a letter published in the newsletter of the American Association of Retired Persons (AARP). All adult twins (aged 18 and over) from both of these sources and their family members were mailed a 16 page 'Health and Lifestyle' questionnaire.
SUBJECTS: BMI and silhouette data were available on 16 728 females and 11 366 males ranging in age from 18–100.
MEASUREMENTS: Self-report information on height-weight, current body size, desired body size and a discrepancy score using standard figural stimuli.
RESULTS: Gender- and age-specific norms are presented linking BMI to each of the figural stimuli. Additional norms for desired body size and discrepancy scores are also presented. Receiver operating curves (ROC) indicate that the figural stimuli are effective in classifying individuals as obese or thin.
CONCLUSIONS: With the establishment of these norms, the silhouettes used in standard body image assessment can now be linked to BMI. Differences were observed between women and men in terms of desired body size and discrepancy scores, with women preferring smaller sizes. The figural stimuli are a robust technique for classifying individuals as obese or thin.
International Journal of Obesity (2001) **25,** 1517–1524

Keywords: body mass index; silhouettes; norms; figural stimuli

Introduction

Figural stimuli were introduced by Stunkard *et al*[1] as an easy-to-administer self-report measure of body image. The administration of Stunkard's standard silhouettes requires respondents to choose the silhouette that most closely resembles how they usually look as well as the silhouette that represents how they would like to look. This results in three measures: current size, desired size and a discrepancy score (current − desired), which has been interpreted as a measure of body dissatisfaction.[2]

The original figure rating scales have been widely used in epidemiologic investigations[3–5] as an adjunct to measured or self-reported height and weight. The scales also show promise as means of estimating body size of individuals who are deceased (eg parents). Silhouette ratings by children of their parents' weights 15 y earlier were highly correlated with archived data of measured heights and weights of the parents.[3] Moreover, the silhouette selection by children was not influenced by their own age, sex, height, body mass index (BMI), skinfold thickness or confidence in ratings.

Critics of figural stimuli highlight the coarse and ordinal nature of the scale, restricted in range of response options, and inconsistent size differences between successive figures

*Correspondence: CM Bulik, Virginia Institute for Psychiatric and Behavioral Genetics, Department of Psychiatry, Medical College of Virginia of Virginia Commonwealth University, PO Box 980126, Richmond, VA, 23298-0126, USA.
E-mail: cbulik@hsc.vcu.edu
Received 27 September 2000; revised 15 March 2001; accepted 28 March 2001

as potential pitfalls to its use.[6] Despite these perceived shortcomings, the scale appears to be highly robust, to be significantly and highly correlated with measured percentage overweight ($r = 0.79$), and to be a reliable predictor of obesity both alone and in combination with self-reported height and weight.[1] The elegant simplicity of the scale is attractive. There is little evidence that more sophisticated methods of body size estimation offer substantial improvements in reliability or validity.[7]

What has been critically lacking from research with the figural stimuli is normative data on large populations linking the silhouettes with BMI (kg/m^2). The goals of the present study are: to present normative data on the figural stimuli for females and males from a large population-based sample of twins and their families; to introduce gender-specific BMI norms for the silhouettes in Caucasians; and to test the ability of the stimuli to predict obesity and thinness.

Methods

Participants

The participants were twins and their family members from the Virginia 30 000 data set. This data set includes twins and their family members, ascertained from two sources. Details of ascertainment and response rates are presented elsewhere.[8] Briefly, public birth records in the Commonwealth of Virginia were matched with other public records to obtain current addresses for Caucasian twins born in Virginia between 1915 and 1971 (77% of the sample), known as the Virginia Twin Registry (VTR). The remainder of the sample (23% of the sample) responded to a letter published in the newsletter of the American Association of Retired Persons (AARP). In 1987, after a pilot mailing of the questionnaire, all adult twins (aged 18 and over) and their family members were mailed a 16 page 'Health and Lifestyle' questionnaire which among other topics asked respondents to list their current height and weight and to choose, based on the standard figural stimuli developed by Stunkard *et al*[1] 'Which silhouette is closest to your usual appearance?' and 'Which figure would you like to look like?' (see Figure 1). The average age of the twin sample at the time of completing the questionnaire was 50.6 y (s.d. = 18.4). Complete BMI and silhouette data were available on 16 728 females and 11 366 males ranging in age from 18 to 100.

Analyses

Norms for the figural stimuli are reported separately by gender. In addition to reporting summary norms, the sample was divided into six age cohorts: 18 – 30, 31 – 40, 41 – 50, 51 – 60, 61 – 80 and > 80.

We explored two options for determining the criteria for 'thinness' and 'obesity'. Obesity is commonly considered to be indicated by a BMI > 30. Indeed this closely approximates the 90th percentile value for both women (BMI = 30.10 kg/m^2) and men (BMI = 29.87 kg/m^2). We therefore followed convention and used a BMI of 30 as an indicator of obesity. The criterion for definition of thinness was less

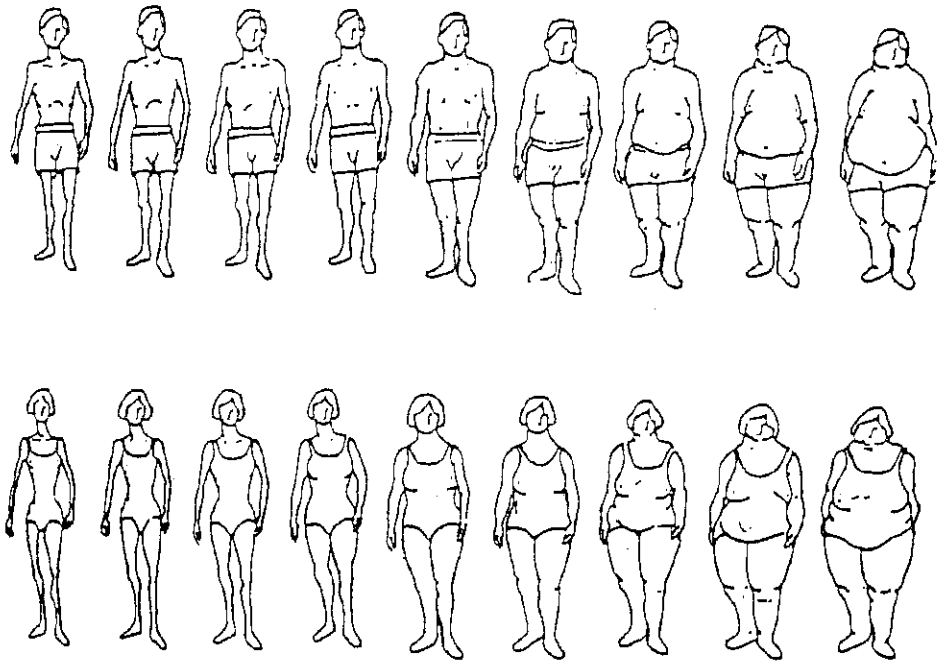

Figure 1 Standard figural stimili. ©Dr A Stunkard. Reproduced with permission.

clear. The gender-specific 10th percentile values were 19.39 for women and 21.52 for men. Rather than presenting normative data based on the specific values derived from our population, we chose a BMI < 20 to indicate thinness in order to facilitate generalizability across populations and across time when shifts in the distribution of BMI in populations may continue. Receiver operating curves (ROC) were generated using PROC Logistic in order to determine how well the silhouettes perform in predicting obesity and thinness. All analyses were performed using SAS Version 6.12.[9]

Results

Reliability check for self-reported BMI data

Prior to beginning our analyses, we explored the extent to which self-reported BMI data were reliable. Measured heights and weights were available for a small subset of women ($n = 181$) and men ($n = 160$). Correlations between self-reported and measured heights were 0.90 for men and 0.94 for women. For weight, the figures were 0.97 for men and 0.98 for women. In addition, a second set of self-reported heights and weights were available for 1390 men and 3556 women. For height, the correlations between the two measures were 0.95 for men and 0.96 for women, and for weight 0.94 for men and 0.93 for women. Given these high correlations, we remained confident in our use of self-reported BMI in the following analyses.

BMI norms by gender and age

The polyserial correlations between the log of BMI and the figural stimuli were 0.81 for females and 0.73 for males. Tables 1 and 2 present the number of individuals in each age cohort who selected each of the nine silhouettes as best representing their usual appearance, and the mean and standard deviation reported by individuals in each cell.

The modal silhouette chosen across all age cohorts for women was silhouette 4, which corresponded to a mean BMI of 23.1 (±2.2) which is somewhat lower than the actual mean BMI of the female sample of 24.1 (±4.7). Silhouette 4 was the modal figure for all age cohorts except for 18–30 (where 0.5% more endorsed silhouette 3 than 4) and 41–50 (silhouette 5).

The modal figure chosen across all age cohorts for men was silhouette 5, which corresponded to a mean BMI of 25.8 (±2.2), which is near the actual mean BMI of the male sample of 25.5 (±3.6). Silhouette 5 was the modal figure for all age cohorts except for 18–30, where 4 was chosen most frequently.

Ideal size

Table 3 presents normative data for females and males on desired body size. For females of all ages, as well as within each age cohort, the most commonly chosen figure representing how they would like to look was silhouette 3. Desired body size clustered primarily around silhouette 2–4 with individuals rarely choosing figures larger than silhouette 5.

For men of all ages, as well as within each age cohort, silhouette 4 was the most commonly chosen figure for desired body size. Responses clustered around silhouette 4–6 with choices of silhouette 1,2,7 and 8 being relatively rare.

Discrepancy scores

The difference between current body size and desired body size has often been considered to be a measure of body dissatisfaction. Table 4 presents the mean discrepancy

Table 1 Usual size (women); body mass index of the individuals who chose each silhouette by age group

	Silhouette number ('Which silhouette is closest to your usual appearance?')[a]								
Age range	*1 (smallest)*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9 (largest)*
All ages	115 (0.7)	1273 (7.6)	3850 (23.0)	5837 (34.9)	3576 (21.4)	1560 (9.3)	545 (3.3)	115 (0.7)	52 (0.3)
18–100	**18.3 (3.0)**	**19.3 (1.7)**	**20.9 (1.8)**	**23.1 (2.2)**	**26.2 (3.0)**	**29.9 (3.8)**	**34.3 (4.7)**	**38.6 (6.2)**	**45.4 (7.8)**
($n = 16\,728$)									
18–30	19 (0.6)	376 (12.3)	1043 (34.0)	1029 (33.5)	389 (12.7)	149 (4.9)	49 (1.6)	10 (0.3)	5 (0.2)
($n = 3069$)	**17.8 (1.4)**	**18.8 (1.3)**	**20.3 (1.6)**	**22.6 (2.1)**	**26.4 (3.2)**	**31.3 (4.0)**	**36.7 (5.2)**	**40.8 (12.7)**	**44.1 (10.0)**
31–40	7 (0.2)	286 (8.6)	888 (26.7)	1183 (35.5)	599 (18.0)	234 (7.0)	94 (2.8)	22 (0.7)	15 (0.5)
($n = 3328$)	**17.6 (1.6)**	**18.9 (1.3)**	**20.5 (1.5)**	**22.6 (2.1)**	**26.0 (3.2)**	**30.6 (4.2)**	**36.3 (4.5)**	**41.4 (6.0)**	**48.4 (7.2)**
41–50	5 (0.4)	88 (0.3)	365 (4.8)	666 (20.0)	406 (36.5)	191 (22.3)	80 (10.5)	17 (4.4)	6 (0.9)
($n = 1824$)	**17.5 (1.4)**	**19.3 (1.6)**	**21.0 (1.7)**	**22.9 (2.0)**	**26.2 (3.0)**	**30.1 (3.8)**	**34.7 (4.2)**	**40.0 (3.4)**	**45.5 (8.6)**
51–60	12 (0.4)	152 (5.3)	475 (16.7)	948 (33.3)	726 (25.5)	338 (11.9)	146 (5.1)	31 (1.1)	16 (0.6)
($n = 2844$)	**17.7 (2.2)**	**19.8 (1.6)**	**21.5 (1.9)**	**23.4 (2.1)**	**26.4 (2.9)**	**29.7 (3.6)**	**33.4 (4.4)**	**38.1 (4.2)**	**45.7 (7.6)**
61–80	46 (0.9)	312 (6.0)	924 (17.7)	1818 (34.8)	1325 (25.4)	588 (11.3)	171 (3.3)	30 (0.6)	8 (0.2)
($n = 5222$)	**18.9 (4.1)**	**19.8 (2.1)**	**21.4 (2.0)**	**23.6 (2.3)**	**26.2 (2.9)**	**29.5 (3.6)**	**33.1 (4.6)**	**36.9 (5.0)**	**41.1 (5.5)**
>80	22 (5.0)	37 (8.4)	99 (22.4)	138 (31.3)	102 (23.1)	34 (7.7)	4 (0.9)	4 (0.9)	1 (0.2)
($n = 441$)	**18.4 (2.5)**	**19.5 (1.9)**	**21.0 (2.1)**	**23.1 (2.6)**	**24.9 (2.7)**	**28.1 (3.2)**	**30.1 (1.8)**	**30.2 (6.3)**	**31.2 (—)**

[a]Values on the first line are the number of individuals in the cell and the percentage of individuals of that age cohort who chose each silhouette. Bold numbers on the second line are the mean (s.d.) body mass index for individuals in the cell.

Table 2 Usual size (men); body mass index of the individuals who chose each silhouette by age group

	Silhouette number ('Which silhouette is closest to your usual appearance?')[a]								
Age range	*1 (smallest)*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9 (largest)*
All ages	76 (0.7)	383 (3.4)	1172 (10.3)	2857 (25.1)	3959 (34.8)	2372 (20.9)	518 (4.6)	90 (0.8)	20 (0.2)
18–100	**19.8 (2.1)**	**21.1 (2.1)**	**22.2 (2.0)**	**23.6 (1.9)**	**25.8 (2.2)**	**28.1 (2.8)**	**31.5 (4.0)**	**35.2 (5.0)**	**41.5 (10.9)**
(*n*=11 366)									
18–30	12 (0.6)	83 (4.2)	295 (15.0)	736 (37.4)	611 (31.1)	189 (9.6)	32 (1.6)	6 (0.3)	3 (0.2)
(*n*=1967)	**18.8 (1.3)**	**20.2 (1.6)**	**21.4 (1.9)**	**22.9 (2.0)**	**25.4 (2.1)**	**28.2 (3.2)**	**33.1 (4.8)**	**35.8 (3.6)**	**49.4 (5.7)**
31–40	7 (0.3)	46 (2.0)	236 (10.1)	654 (28.0)	852 (36.5)	439 (18.8)	85 (3.6)	9 (0.4)	4 (0.2)
(*n*=2332)	**19.6 (1.9)**	**20.5 (1.4)**	**21.9 (1.7)**	**23.5 (1.7)**	**25.6 (2.0)**	**28.2 (3.1)**	**33.1 (4.5)**	**37.6 (4.4)**	**45.4 (7.3)**
41–50	6 (0.4)	29 (2.1)	101 (7.3)	264 (19.1)	500 (36.3)	381 (27.6)	76 (5.5)	18 (1.3)	4 (0.3)
(*n*=1379)	**21.1 (1.1)**	**21.2 (1.8)**	**22.3 (2.0)**	**23.9 (1.6)**	**25.9 (2.0)**	**28.4 (2.6)**	**32.2 (3.5)**	**37.3 (4.4)**	**43.2 (17.8)**
51–60	12 (0.7)	45 (2.5)	128 (7.1)	342 (18.9)	629 (34.7)	508 (28.1)	117 (6.5)	28 (1.5)	2 (0.1)
(*n*=1811)	**19.8 (2.4)**	**21.4 (2.0)**	**22.8 (2.2)**	**24.2 (1.9)**	**26.1 (2.7)**	**28.4 (2.7)**	**31.0 (3.5)**	**35.0 (5.3)**	**43.6 (15.8)**
61–80	31 (0.8)	152 (4.2)	377 (10.3)	791 (21.7)	1265 (34.6)	806 (22.1)	197 (5.4)	28 (0.8)	6 (0.2)
(*n*=3653)	**19.9 (2.5)**	**21.7 (2.4)**	**22.9 (2.0)**	**24.0 (2.0)**	**25.9 (2.2)**	**27.7 (2.7)**	**30.7 (3.6)**	**32.6 (4.0)**	**34.8 (6.2)**
>80	7 (3.1)	25 (11.2)	27 (12.1)	49 (21.9)	69 (30.8)	37 (16.5)	8 (3.6)	0	1 (0.4)
(*n*=224)	**19.6 (1.4)**	**20.6 (2.2)**	**21.9 (1.6)**	**23.6 (2.6)**	**25.3 (2.2)**	**26.6 (3.0)**	**27.9 (3.9)**	—	**30.4 (—)**

[a]Values on the first line are the number of individuals in the cell and the percentage of individuals of that age cohort who chose each silhouette. Bold numbers on the second line are the mean (s.d.) body mass index for individuals in the cell.

Table 3 Ideal size, women and men (bold); number of individuals who chose each silhouette by age group

		Silhouette number ('Which figure would you like to look like?')[a]								
Age range	n	*1 (smallest)*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9 (largest)*
All ages	16 567	0.8	14.3	53.2	28.5	3.0	0.2	0	0	0
18–100	**11 129**	**0.2**	**2.7**	**15.5**	**50.5**	**30.0**	**1**	**0**	**0**	**0**
18–30	3037	0.8	20.9	58.3	18.7	1.3	0.03	0.03	0	0
	1928	**0.05**	**1.4**	**11.8**	**49.5**	**36.2**	**0.9**	**0.1**	**0**	**0**
31–40	3314	0.5	15.8	57.2	24.3	2.1	0.09	0	0	0
	2308	**0.04**	**1.3**	**12.1**	**54.1**	**31.6**	**0.7**	**0.1**	**0**	**0**
41–50	1816	0.4	11.0	54.2	31.1	3.3	0.06	0	0	0
	1354	**0.2**	**1.8**	**12.5**	**52.7**	**32.0**	**0.9**	**0**	**0**	**0**
51–60	2825	0.6	12.6	50.5	32.4	3.7	0.2	0	0	0
	1780	**0.4**	**2.5**	**17.5**	**47.2**	**31.0**	**1.2**	**0.1**	**0**	**0**
61–80	5156	1.2	12.0	49.0	33.7	3.8	0.3	0.02	0	0
	3551	**0.3**	**4.5**	**19.4**	**49.8**	**24.7**	**1.2**	**0.1**	**0.1**	**0**
>80	419	2.9	9.8	50.1	31.3	5.3	0.7	0	0	0
	208	**1.0**	**6.3**	**23.1**	**43.8**	**25.0**	**1.0**	**0**	**0**	**0**

[a]Values are percentage of individuals in each age group who chose each silhouette as their ideal figure.

scores for women and men by age cohort. Values approaching zero reflect less discrepancy (ie the respondent chose the same figure to represent their current size and their ideal size).

For women, individuals who chose silhouettes 1 and 2 as their current size generally desired to be larger. For all age cohorts, individuals who chose silhouette 3 as their current size were closest to being satisfied (ie difference score of 0), but even they desired to be somewhat smaller. As current size increased across the silhouette spectrum, so did discrepancy scores.

For men, individuals who endorsed silhouettes 1–3 as their current size, on average desired to be larger. For the age 18–30 cohort, even individuals who endorsed silhouette 4 as their current size desired to be larger. The men with the lowest discrepancy scores (ie difference scores closest to zero), were those who chose silhouette 4 as their current size. As with the women, discrepancy scores increased with endorsement of larger current silhouettes.

Effectiveness of silhouettes in identifying individuals who are obese and thin

Figures 2 and 3 present the percentage of women and men respectively who endorsed each figure as their current size who according to our definition can be classified as 'obese' or 'thin'. A comparison of the curves indicates that the graph for females is phase shifted by one silhouette to the left.

Table 4 Discrepancy, women and men (bold); ideal silhouette minus current silhouette by age and current silhouette[a]

		Self-reported current silhouette								
Age range	n	*1 (smallest)*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9 (largest)*
All ages	16 530	1.61 (1.0)	0.37 (0.7)	− 0.26 (0.6)	− 0.89 (0.5)	− 1.42 (0.6)	− 2.1 (0.7)	− 2.85 (0.7)	− 3.84 (0.9)	− 4.87 (1.1)
18 – 100	**11 105**	**2.22 (1.3)**	**1.14 (1.0)**	**0.46 (0.8)**	**− 0.07 (0.6)**	**− 0.8 (0.7)**	**− 1.5 (0.7)**	**− 2.28 (0.7)**	**− 3.14 (0.9)**	**− 4.11 (1.4)**
18 – 30	3033	1.32 (1.1)	0.3 (0.6)	− 0.28 (0.5)	− 0.87 (0.5)	− 1.5 (0.6)	− 2.11 (0.6)	− 2.92 (0.8)	− 4.3 (0.8)	− 5.6 (1.5)
	1927	**2.36 (1.3)**	**1.42 (0.9)**	**0.75 (0.8)**	**0.16 (0.6)**	**− 0.53 (0.6)**	**− 1.22 (0.6)**	**− 1.91 (0.5)**	**− 3.33 (0.8)**	**− 3.67 (0.6)**
31 – 40	3314	1.71 (0.8)	0.32 (0.6)	− 0.27 (0.5)	− 0.89 (0.5)	− 1.44 (0.6)	− 2.16 (0.6)	− 2.93 (0.6)	− 3.9 (0.8)	− 4.81 (1.1)
	2305	**2 (1.1)**	**1.36 (1.1)**	**0.54 (0.7)**	**− 0.04 (0.6)**	**− 0.71 (0.6)**	**− 1.38 (0.6)**	**− 2.21 (0.6)**	**− 3.11 (0.3)**	**− 4.0 (0.8)**
41 – 50	1815	2 (0.7)	0.37 (0.7)	− 0.24 (0.5)	− 0.89 (0.5)	− 1.38 (0.6)	− 2.16 (0.6)	− 2.9 (0.6)	− 3.7 (0.9)	− 5.0 (1.1)
	1354	**2.67 (1.5)**	**1.19 (1.0)**	**0.46 (0.7)**	**− 0.12 (0.6)**	**− 0.83 (0.6)**	**− 1.49 (0.7)**	**− 2.32 (0.6)**	**− 3.11 (0.3)**	**− 3.67 (0.6)**
51 – 60	2822	1.67 (1.07)	0.34 (0.7)	− 0.29 (0.6)	− 0.94 (0.5)	− 1.41 (0.6)	− 2.11 (0.6)	− 2.96 (0.8)	− 3.7 (0.79)	− 4.75 (1.1)
	1778	**2.33 (1.6)**	**1.11 (1.1)**	**0.27 (0.7)**	**− 0.24 (0.6)**	**− 0.91 (0.7)**	**− 1.51 (0.7)**	**− 2.32 (0.8)**	**− 3.36 (0.6)**	**− 4.33 (1.5)**
61 – 80	5137	1.61 (1.0)	0.46 (0.8)	− 0.24 (0.6)	− 0.88 (0.6)	− 1.41 (0.6)	− 2.06 (0.7)	− 2.67 (0.7)	− 3.97 (0.8)	− 4.78 (1.0)
	3536	**2.21 (1.1)**	**0.89 (1.0)**	**0.28 (0.7)**	**− 0.22 (0.6)**	**− 0.94 (0.7)**	**− 1.61 (0.8)**	**− 2.3 (0.7)**	**− 2.93 (1.0)**	**− 4.4 (2.4)**
> 80	409	1.63 (1.1)	0.76 (0.9)	− 0.03 (0.6)	− 0.8 (0.7)	− 1.31 (0.7)	− 1.91 (0.8)	− 3.25 (0.5)	− 2.67 (1.2)	− 4.0 (—)
	205	**2 (1.7)**	**1.23 (1.2)**	**0.18 (0.8)**	**− 0.07 (0.5)**	**− 0.86 (0.8)**	**− 1.77 (0.9)**	**− 2.56 (1.0)**	—	**− 5.0 (—)**

[a]Values are the mean discrepancy score for individuals of each age group who selected each figure as their current weight. Positive values indicate a desire to be larger, zero indicates no difference between current and ideal shape, and negative values indicate a desire to be smaller.

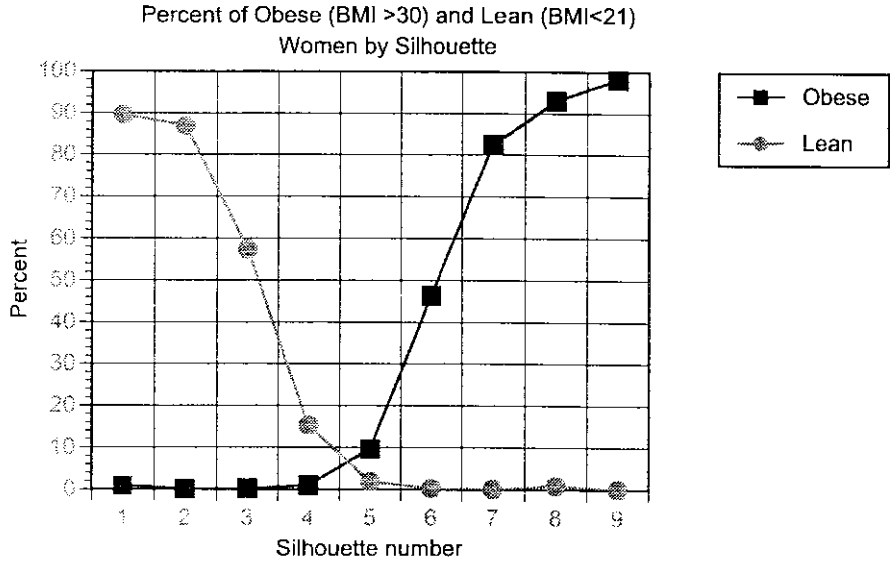

Figure 2 Classification as 'obese' or 'lean' by silhouette, women.

These figures indicate that, with very few exceptions, individuals who select silhouettes 8 and 9 are indeed obese by our definition. The accuracy of the lower end of the scale is less clear with slightly over 80% of females and 70% of males who endorse silhouette 1 actually meeting our criterion for 'thinness'.

We then further explored the differential ability of the silhouettes as a 'diagnostic test' of obesity and thinness by developing gender-specific ROC. An ROC graph plots a test's true positive rate (sensitivity) as a function of its false positive rate (1-specificity). The curve can then be used to determine the optimal cut-off score for maximizing sensitivity and minimizing the false positive rate.[10] Figure 4 presents the ROC curves for women and men, reflecting the ability of the silhouettes to correctly identify individuals classified as obese and thin by our definitions. If a test correctly classifies 100% of subjects, then the area under the curve (AOC) will equal unity. Performance at the level of chance is reflected in an AOC of 0.5. The AOCs for the four graphs reveal that the silhouettes perform quite well in correctly classifying individuals as obese (0.93 for women and 0.88 for men) or thin (0.87 for women and 0.88 for men). For obesity, sensitivity

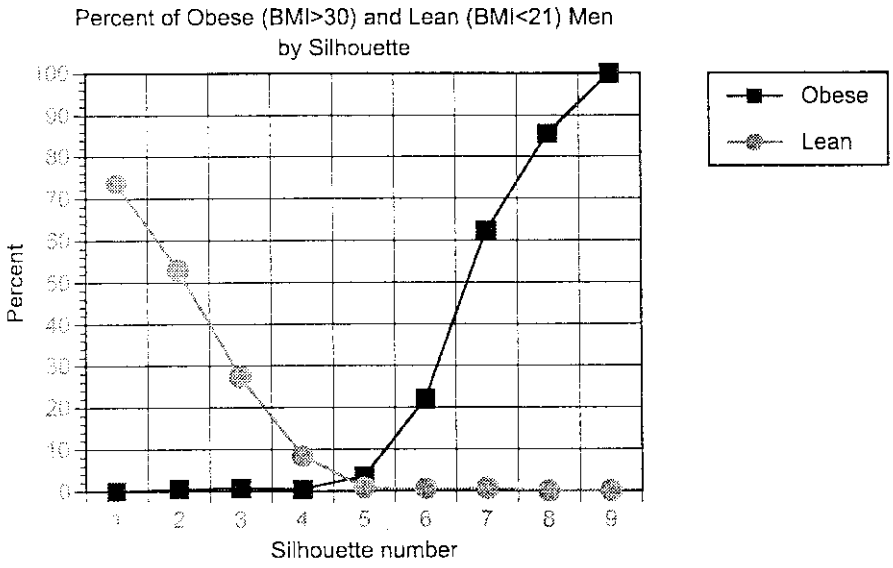

Figure 3 Classification as 'obese' or 'lean' by silhouette, men.

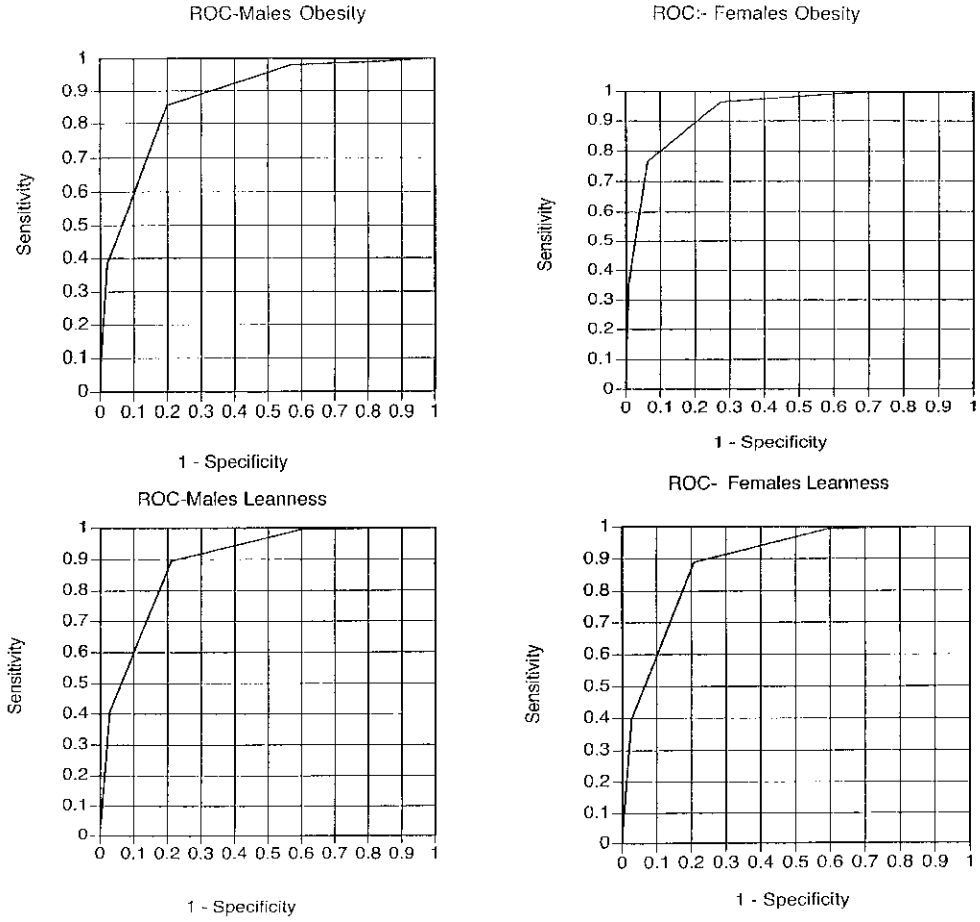

Figure 4 Receiver operating curves for obesity and thinness in women and men.

and specificity appear to be optimal using the sixth figure as a cut-off, with very few non-obese individuals choosing figures greater than this size. For thinness, the fourth silhouette appears to be the optimal cut-off, with very few thin individuals choosing silhouettes larger than this size.

Discussion

Until now, despite being the most widespread measure of body size, large-scale population-based norms linking BMI to the nine silhouettes that comprise Stunkard's figural stimuli have not been available. The norms published herein will allow researchers and clinicians to make associations between an individual's choice of a particular silhouette and their self-reported height and weight. The size of our sample was sufficiently large that we could produce gender- and age-specific norms across a wide age range (18 – 100) of Caucasian individuals.

In developing the norms, gender differences were apparent, especially when using the silhouettes to identify desired body size and to explore the discrepancy between current and ideal size. For desired body size, the distribution for women was shifted to the left by one silhouette, with women generally desiring to be a smaller size than men. Of particular interest, for both women and men, the modal desired body size did not differ across the various age cohorts. Although this could theoretically reflect differences in the male and female drawings, given the widespread emphasis on thinness for women,[11] it is more likely to reflect accurately their greater desire to be thinner.

In terms of discrepancy scores, a similar phase shift was observed. In general, men who endorsed the smallest three silhouettes as their current body size desired to be larger and those who endorsed silhouette four as their current body size had the lowest discrepancy scores. For women, only those in the bottom two silhouettes desired to be larger, and on average, even those women who endorsed the third silhouette (which was most commonly chosen as the ideal body size) desired to be smaller.

The silhouette approach also appears to be a potentially accurate method with which to classify individuals as obese or thin. For both women and men, the sixth silhouette emerged as the optimum cut-off for the identification of obesity by correctly classifying the greatest number of obese individuals as obese, and by minimizing false positives. For thinness, silhouette four provided the optimal balance of sensitivity and specificity. The areas under the ROC curves for both genders for obesity and thinness suggest that the silhouettes are a robust tool for identification of these two phenotypes.

Several limitations should be noted to this study. First, our sample consisted entirely of Caucasian individuals. As BMI,[12–14] and possibly body image,[15,16] are known to differ by ethnic group, it would be unwise to apply these norms to non-Caucasian populations. Second, our BMI norms are based on self-reported height and weight. For a population as large as ours, measured heights and weights are not feasible; however, our validity study suggested high correlations between measured and self-reported BMI, similar to that reported in other studies,[17,18] increasing our confidence in our self-reported data. Third, the question could be raised whether twins and their family members differ in meaningful ways from the general population that would limit generalizability of these findings. Although twins are at increased risk of prenatal and perinatal complications and are at increased risk for short gestation and low birthweight,[19,20] in terms of BMI, there is only scant evidence that male, but not female members of twin pairs may be somewhat leaner than male singletons.[21] More importantly, the mean BMI for males and females in this sample is within the expected range for males and females in Virginia as reported by the Centers for Disease Control (www.cdc.gov/nccdphp/brfss), suggesting comparability of our sample to the general population. Finally, as the prevalence of obesity in the United States continues to rise and the severity of obesity increases, there is legitimate concern that the largest silhouette will no longer accurately reflect the body image of severely obese individuals.

Despite these limitations, the silhouette method of body image is an easy-to-administer scale that appears to be a robust approach to the detection of obesity and thinness. The establishment of normative data will enrich the yield of the figural stimuli by establishing the typical BMI of individuals who endorse each silhouette.

Acknowledgements

This work was supported by grants: GM-30250; AG-04954; AA-06781; MH-40828, HL-48148; and K01-MH01553

References

1 Stunkard A, Sørensen T, Schulsinger F. Use of the Danish Adoption Register for the study of obesity and thinness. In: Kety S, Roland L, Sidman R, Matthysse S (eds). *The genetics of neurological and psychiatric disorders*. Raven Press: New York; 1983.
2 Fallon AE, Rozin P. Sex differences in perceptions of desirable body shape. *J Abnorm Psychol* 1985; **94**: 102 – 105.
3 Sørensen T, Stunkard A, Teasdale T, Higgins M. The accuracy of reports of weight: children's recall of their parents' weights 15 y earlier. *Int J Obes* 1983; **7**: 115 – 122.
4 Sørensen T, Stunkard AJ. Does obesity run in families because of genes? An adoption study using silhouettes as a measure of obesity. *Acta Psych Scand* 1993; **370**(Suppl): 67 – 72.
5 Stunkard A, Sørensen T, Hanis C, Teasdale T, Chakraborty R, Schull W *et al*. An adoption study of human obesity. *New Engl J Med* 1986; **314**: 193 – 198.
6 Gardner RM, Friedman BN, Jackson NA. Methodological concerns when using silhouettes to measure body image. *Percept Motor Skills* 1998; **86**: 387 – 395.
7 Stunkard A. Old and new scales for the assessment of body image. *Percept Motor Skills* 2000; **90**(3 Pt 1): 930.
8 Truett K, Eaves L, Walters E, Heath A, Hewitt J, Meyer J *et al*. A model system for analysis of family resemblance in extended kinships of twins. *Behav Genet* 1994; **24**: 35 – 49.
9 SAS Institute Inc. *SAS/STAT = AE software*: *Changes and enhancements through Release 6.11*. SAS Institute, Inc.: Cary, NC; 1996.

10 Moosman D, Somoza E. ROC curves, test accuracy, and the description of diagnostic tests. *J Neuropsychiat* 1991; **3**: 330–333.
11 Brownell K. Dieting and the search for the perfect body: where physiology and culture collide. *Behav Ther* 1991; **22**: 1–12.
12 Norgan NG. Population differences in body composition in relation to the body mass index. *Eur J Clin Nutr* 1994; **48**(Suppl 3): S10–25 (discussion S26–27).
13 Lynch J, Wang XL, Wilcken DE. Body mass index in Australian children: recent changes and relevance of ethnicity. *Arch Dis Child* 2000; **82**: 16–20.
14 Katzmarzyk PT, Mahaney MC, Blangero J, Quek JJ, Malina RM. Potential effects of ethnicity in genetic and environmental sources of variability in the stature, mass and body mass index of children. *Hum Biol* 1999; **71**: 977–987.
15 Altabe M. Ethnicity and body image: quantitative and qualitative analysis. *Int J Eat Disord* 1998; **23**: 153–159.
16 Miller KJ, Gleaves DH, Hirsch TG, Green BA, Snow AC, Corbett CC. Comparisons of body image dimensions by race/ethnicity and gender in a university population. *Int J Eat Disord* 2000; **27**: 310–316.
17 Stunkard A, Waxman M. The accuracy of self-reports of food intake: a review of the literature and a report of a very small series. *J Am Diet Assoc* 1981; **79**: 547–551.
18 Pirie P, Jacobs D, Jeffery R, Hannan P. Distortion in self-reported height and weight data. *J Am Diet Assoc* 1981; **78**: 601–606.
19 Cunningham F, MacDonald P, Gant N. *Multifetal pregnancy*. Appleton and Lange: Norwalk, CT; 1989.
20 Kendler KS. Twin studies of psychiatric illness. *Arch Gen Psychiat* 1993; **50**: 905–915.
21 Pietilainen KH, Kaprio J, Rissanen A, Winter T, Rimpela A, Viken RJ *et al*. Distribution and heritability of BMI in Finnish adolescents aged 16 y and 17 y: a study of 4884 twins and 2509 singletons. *Int J Obes Relat Metab Disord* 1999; **23**: 107–115.