


Beauty and the Body of the Beholder: Raters' BMI Has Only Limited Association with Ratings of Attractiveness of the Opposite Sex

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Objective: Assortative mating for adiposity increases the genetic burden on offspring, but its causes remain unclear. One hypothesis is that people who have high adiposity find other people with obesity more physically attractive than lean people.

Methods: The attractiveness of sets of images of males and females who varied in adiposity were rated by opposite sex subjects (559 males and 340 females) across 12 countries.

Results: There was tremendous individual variability in attractiveness ratings. For female attractiveness, most males favored the leanest subjects, but others favored intermediate fatness, some were indifferent to body composition, and others rated the subjects with obesity as most attractive. For male images rated by females, the patterns were more complex. Most females favored subjects with low levels of adiposity (but not the lowest level), whereas others were indifferent to body fatness or rated the images depicting individuals with obesity as the most attractive. These patterns were unrelated to rater BMI. Among Caucasian males who rated the images of the thinnest females as being more attractive, the magnitude of the effect depended on rater BMI, indicating limited “mutual attraction.”

Conclusions: Individual variations in ratings of physical attractiveness were broadly unrelated to rater BMI and suggest that mutual attraction is an unlikely explanation for assortative mating for obesity.

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Introduction

Twin studies suggest that genetics explains 65% to 70% of the variance in obesity (1,2). Assortative mating occurs when individuals in

a population do not mate randomly with respect to a given trait and is known to occur for body weight/adiposity (3–10). Therefore, assortative mating may be a contributing factor to the obesity epidemic. However, the causes of assortative mating for adiposity

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remain unclear. It is probably not because fatness is associated with other factors such as age or poverty, which are themselves subject to assortative mating (8). Moreover, it is not because individuals converge in body composition after marriage because of shared lifestyles (reviewed in Wilson (11)).

Many studies have established that, on average, people regard leaner females and males as more attractive (12-21). Despite these overall trends at the population level, individuals may have different preferences. The “mutual attraction” hypothesis suggests that people with obesity may find other people with obesity more physically attractive and, hence, they are more likely to form partnerships.

Alternatively, the “shared lifestyle” hypothesis suggests that people at different levels of adiposity may share lifestyles that bring them together. A third idea is that although individuals may regard the leanest people as the most attractive, they may choose as a lifetime partner an individual with adiposity closer to their own (22) to reduce infidelity risk. This idea is called “fidelity insurance” or “attractiveness matching.” Finally, there could be a time element, whereby the most attractive (lean) individuals mate first. Hence, the pool of available partners will contain an increasing percentage of people with obesity. Supporting this idea, adolescents with greater body weight are less likely to be dating (23), and adults with obesity at age 18 are half as likely to be married at age 40 (24). Here, we aimed to test the mutual attraction hypothesis by studying how ratings of physical attractiveness of a series of opposite sex images varied among individuals with variable levels of obesity.

Methods

Twenty-one female and fifteen male dual-energy x-ray absorptiometry soft body images, which varied in their depictions of body fatness and waist-to-hip ratio (WHR) in the female images and in shoulder-to-waist (SWR) ratio in the male images, were used (Supporting Information Figure S1). The female images had been used previously to explore the associations of body shape with physical attractiveness (13,18). A total of 559 male raters of self-identified African (Kenya, Nigeria, Morocco, South Africa, and United States), Asian (China, Iran, and Mauritius), and Caucasian (Austria, Lithuania, United Kingdom, and United States) origin and 340 female subjects of self-identified African (Nigeria, Morocco, Senegal, and United States), Asian (China), and Caucasian (Lithuania, United Kingdom, and United States) origin were included. The overall study was approved by the institutional review board of the Institute of Genetics and Developmental Biology, Chinese Academy of Sciences (IGDB-2013-IRB-005). In addition, local ethical approval in the United Kingdom was obtained at the University of Aberdeen (CERB/2014/12/1123) and in South Africa at the North-West University, Potchefstroom (NWU-00029-16-S1). All participants gave informed consent. This project has been registered with the Open Science Framework (doi:10.17605/OSF.IO/YJP2V).

All ratings were obtained through face-to-face interview. Raters were asked for some demographic information (age, sex, self-reported ethnicity, height, and weight). Self-reported height and weight are generally highly correlated with actual height and weight but lead to a consistent underestimation of BMI by 0.7 to 1.3 kg/m².

Therefore, the absolute BMI of raters may be inaccurate, but relative BMI was probably unaffected (25-27).

After recording demographic data, the male raters were given 21 shuffled female image cards and the female raters were given 15 shuffled male image cards. Raters were then instructed to reorder the cards from the most attractive on their right to the least attractive on their left. A standard score for female attractiveness followed the formula $a_n = 1 + (n - 1) \times 0.4$ (in which “n” was the rank order of the image from the least attractive to the most attractive; that is, the “n” of the least attractive image was 1, so the score was $a_1 = 1 + (1 - 1) \times 0.4 = 1$, and the most attractive image was 21, so the score was $a_{21} = 1 + (21 - 1) \times 0.4 = 9$). The standard score for the male images followed the formula $a_n = 1 + (n - 1) \times 4/7$.

Data were analyzed by using R (R Foundation, Vienna, Austria). The ratings of attractiveness followed different patterns among the individual raters. To characterize these patterns with a view to then evaluating how the patterns were related to the raters’ levels of adiposity, we fitted least squares fit regressions to the individual relationships between ratings of attractiveness and body fat percentage. We then added higher-order polynomials to the predictive equations to see whether significant amounts of additional variability could be explained. For almost all the raters of the female images, higher-order polynomials did not improve the fit, but in 20 individuals, the second-order polynomial provided the best fit. For the male images rated by females, third-order polynomial regressions generally provided the best fit to the data. These different fitted models allowed us to categorize the raters’ responses by using the coefficients and r^2 of these relationships. We were then able to establish whether particular patterns were associated with differences in the rater BMIs. We did this in two ways. First, we counted the number of raters of each type in each population and used the Fisher exact test to analyze whether there was any association between rater BMI and rater type. Second, we tested whether there were significant differences in rater BMI among the different rater types in the different populations by using one-way analysis of variance (ANOVA). Finally, we explored whether the coefficients of the attractiveness equations were associated with rater BMI by using least squares linear regression. This allowed us to evaluate exactly how rater BMI impacted the pattern of their ratings.

Results

Overall patterns

Overall, for males rating females, there was a negative relationship between attractiveness and body fatness (Figure 1, Supporting Information Figure S2). For females rating males, the overall pattern showed a peaked shape, with the lowest and highest levels of fatness both being less attractive (Figure 1, Supporting Information Figure S2). There was nevertheless tremendous variability in the ratings of attractiveness given to any particular image. The question we are asking is whether the individual variations in ratings of attractiveness can be linked to differences in the levels of rater adiposity (BMI). To do this, we first identified several different patterns in the ratings. We then asked how these patterns were related to the rater BMIs.

Males rating female attractiveness

We identified four different patterns in the ratings of the female images (Figure 2). Some male raters conformed closely with the

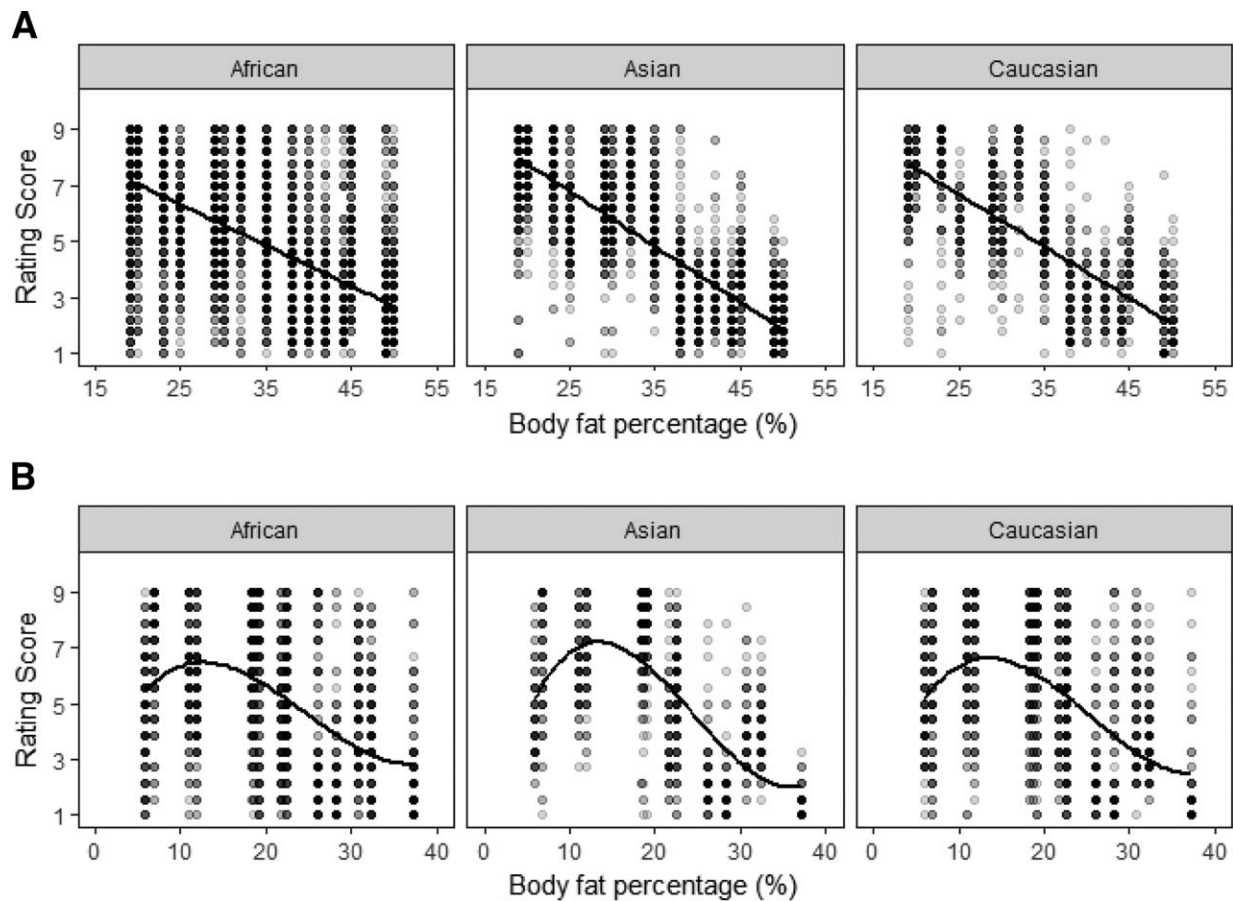


Figure 1 Rating plots of all the individuals of each population for both female and male images. (A) Individual assessment of physical attractiveness of female images rated by males. (B) Individual assessment of physical attractiveness of male images rated by females. The x-axis refers to the body fat percentage of the individual in the image and the y-axis refers to the rating score of raters for the images.

overall perspective that thinner females were most attractive (type 1). Second, some preferred intermediate levels of body fatness (type 2). Some individuals were indifferent to the body fatness (type 3) and, finally, some favored the images of people with greater adiposity (type 4). We classified each rater according to the pattern he showed by using objective criteria based on the fitted regression of his rating data to the image body fatness. We fitted regressions to the plots of body fat percentage against the ratings data and included in the type 1 group only those in which the relationship was significant ($P < 0.05$) and the slope was negative. Similarly, pattern type 4 consisted of individuals who showed a significant linear positive relationship ($P < 0.05$). To separate pattern types 2 and 3, we attempted to fit a two-term polynomial regression to the data for each individual. For those with pattern type 2, there was a significant fit to this regression model ($P < 0.05$). If we could not fit such a regression, then the pattern was deemed to be type 3. As was expected in all three populations, the most common pattern was type 1 (lean most attractive) (Table 1). This type comprised 79.1% of the Africans, 96.9% of the Asians, and 94.4% of the Caucasians. The type 2 pattern (preference for intermediate adiposity) occurred in 5.4% of Africans, 1.0% of Asians, and 2.8% of Caucasians. Type 3 (indifferent) occurred in 11.8% of Africans, 2.1% of Asians, and 2.8% of Caucasians. Finally, type 4 was only observed in Africans,

in whom it made up 3.7% of raters. The relative proportions of the different patterns were significantly different among populations ($P = 2.371e-07$, Fisher exact test).

To explore whether there was a relationship between rater BMI and the individual attractiveness patterns, we tested whether there were differences among rater BMIs of different patterns. There were no significant differences in rater BMI among the four different types of response in African and Asian populations, but there was a significant difference between Caucasians and the other groups (one-way ANOVA, female: Africans, $F_{3,292} = 0.99$, $P = 0.398$; Asians, $F_{2,191} = 1.77$, $P = 0.173$; Caucasians, $F_{2,68} = 3.39$, $P = 0.04$). The type 1 rater BMI was lower than that of the other groups.

To further explore the links between rater BMI and the exact patterns, we investigated whether there was a relationship between the slopes and intercepts of the negative relationships among attractiveness ratings, the body fat percentages of the people in the images (for those conforming to pattern 1), and the BMI of the raters (Figure 3). For the African (Figure 3A-3B) and Asian (Figure 3C-3D) populations, there were no relationships (regression: Africans $r^2 = 0.007$, $F_{1,230} = 1.54$, $P = 0.215$; Asians $r^2 = 7.545e-06$, $F_{1,185} = 0.001$, $P = 0.970$). However, for Caucasians, there was a significant positive relationship

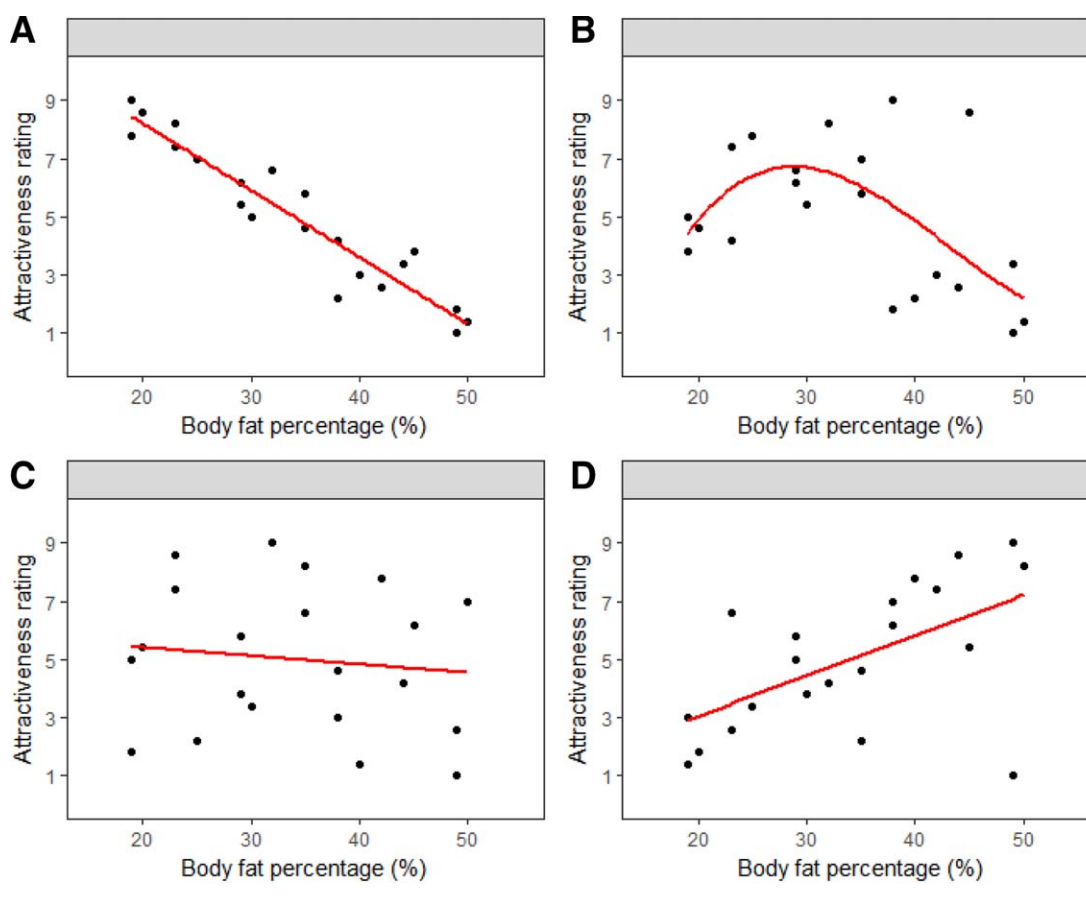


Figure 2 Examples of four types of relationship between body fat percentage and the rating score in female attractiveness. (A) Type 1 represented the standard negative relationship between body fat percentage of the image and the rating score. (B) Type 2 showed a “peaked” relationship with maximal attractiveness at intermediate levels of body fatness. (C) Type 3 showed an indifferent pattern between body fatness and rating, and (D) type 4 was the reverse trend in which high body fat percentage had a higher attractiveness rating. [Color figure can be viewed at wileyonlinelibrary.com]

between the slope (and intercept) of the regression linking attractiveness to body fat percentage and rater BMI (Figure 3E-3F) (regression: $r^2 = 0.129$, $F_{1,64} = 9.367$, $P = 0.0032$). We used the regressions to model the consequences of these relationships for the ratings of attractiveness of the images with the highest and lowest levels of adiposity. A male rater with a BMI of 18 would rate attractiveness of the leanest image with a body fat of 18% as an 8.35 (out of a possible 9), whereas a male rater with a BMI of 34 would rate the same image as a 7.6. In contrast, for the image of a person with the highest adiposity, with a body fat of 50%, the rater with a BMI of 18 would give a score of 1.22 (lowest possible score = 1.0), whereas a rater with a BMI of 34 would

score the image as a 2.05. Males with a higher BMI therefore had a less extreme polarization in the attractiveness ratings between the images of people who had the lowest and highest levels of adiposity. For raters who were indifferent to adiposity (pattern 3 in female images), we examined whether the raters were using the WHRs to judge attractiveness. In this group, there was a significant relationship between the WHR and the average ratings of attractiveness ($r^2 = 0.27$, $F_{1,20} = 6.97$, $P = 0.016$, Supporting Information Figure S3). At the individual level, 12 out of 41 individual raters demonstrated a significant relationship between WHR and attractiveness score. Eleven of these relationships were negative, indicating that they rated lower WHR as more attractive. Twenty-nine individuals seemed indifferent to both adiposity and WHR.

TABLE 1 Number of individual males of four types rating images of female attractiveness

	Type 1	Type 2	Type 3	Type 4
African	234	16	35	11
Asian	186	2	4	0
Caucasian	67	2	2	0
Total	487	20	41	11

Females rating male attractiveness

As with males rating female images, our analysis strategy for females rating male images was to first identify individual patterns in the different responses and to then ask whether such patterns were related to the rater BMI. We then explored in more detail whether rater BMI was linked to the coefficients of the fitted regression models.

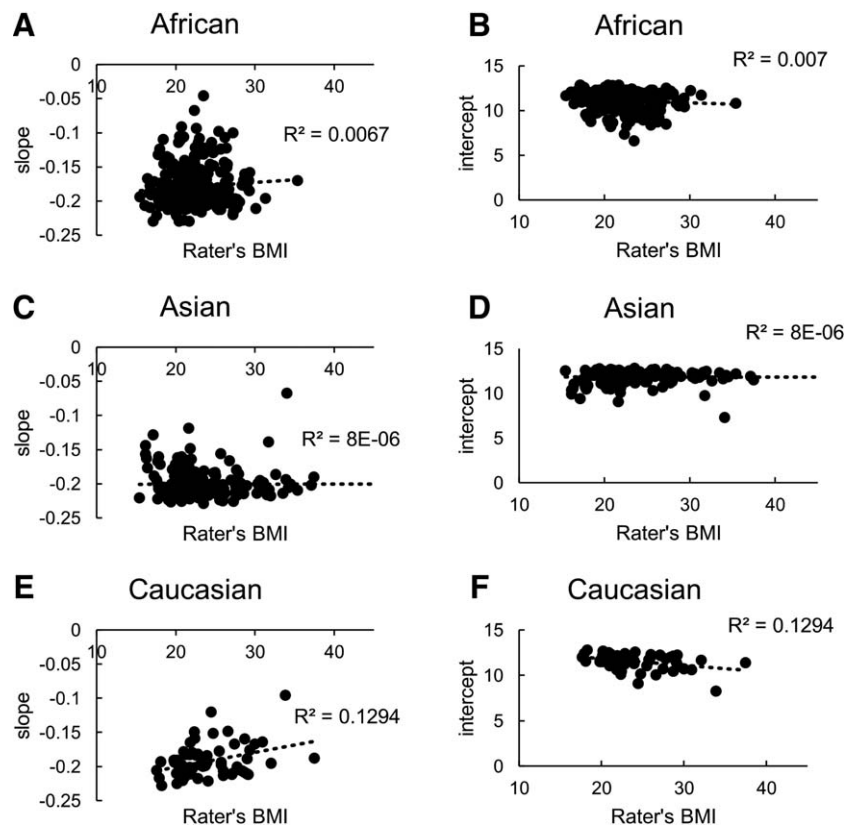


Figure 3 Rater BMI against the slope and intercept of body fat percentage with rating score for males rating female attractiveness. (A,B) African raters. (C,D) Asian raters. (E,F) Caucasian raters. For each pair, the first plot is the relationship between rater BMI and the slope of the relationship between attractiveness and image body fatness, whereas the second plot is the relationship of rater BMI and the intercept of the same fitted regressions.

We identified six different patterns in the ratings by females of the attractiveness of the images of males (Figure 4). These were classified by using the parameters of the fitted third-order polynomial regression between attractiveness and body fat percentage. The first pattern (type 1, Figure 4A) consisted of a single peak centered to the left of the distribution of body fat percentage, which started to turn upward at high body fat percentage values. The second pattern (type 2, Figure 4B) involved a single peak, which varied in position and was distinguished from type 1 by the fact that there was no evidence of any upturn on the right-hand side. Type 3 (Figure 4C) involved a linear negative relationship. Type 4 (Figure 4D) showed no overall upward or downward trend. In many cases, the response was effectively flat. Type 5 (Figure 4E) had an overall rising pattern with a single peak or trough. Type 6 (Figure 4F) showed an overall downward trend with a single trough at higher body fatness. In all three populations, type 1 and type 2 were the most abundant patterns (Table 2). Together, they comprised 68.2% of Africans, 94.7% of Asians, and 75.5% of Caucasians. The type 3 pattern (linear negative) was observed in 9.1% of Africans, 2.6% of Asians, and 11.8% of Caucasians. The type 4 pattern (indifferent) occurred in 19.5% of Africans, 2.6% of Asians, and 10% of Caucasians. The type 5 pattern (overall upward trend finding the images depicting the greatest adiposity most attractive) occurred in 2.6% of Africans, 0% of Asians, and

2.7% of Caucasians. Finally, the type 6 (overall negative trend) was only observed in Africans (0.6% of raters). The relative proportions of the different patterns were significantly different by a large margin among the three populations ($P = 3.131e-05$, Fisher exact test, Table 2).

These types were part of a continuum, which was most obvious when we located the different categories on plots of the relationships among the different coefficients of the fitted third-order polynomial regressions (Figure 5). The individual types mapped onto distinct areas of the coefficient plots. We now consider the frequencies of these different patterns in the different populations and whether they were associated with rater BMI. There were no significant differences in female rater BMI among the six different types of response (Africans, $F_{5,153} = 1.23$, $P = 0.296$; Asians, $F_{3,74} = 0.57$, $P = 0.634$; Caucasians, $F_{4,109} = 1.88$, $P = 0.120$). There were no significant relationships between rater BMI and the regression coefficients (Figure 6).

As with the analysis for males rating female images, we explored whether females who were indifferent to adiposity were perhaps using some other cue to rate attractiveness. For the 43 female raters indifferent to adiposity, there was no relationship between male attractiveness and SWR (type 4, $r^2 = 0.0004$, $F_{1,14} = 0.0048$, $P = 0.946$, Supporting Information Figure S3).

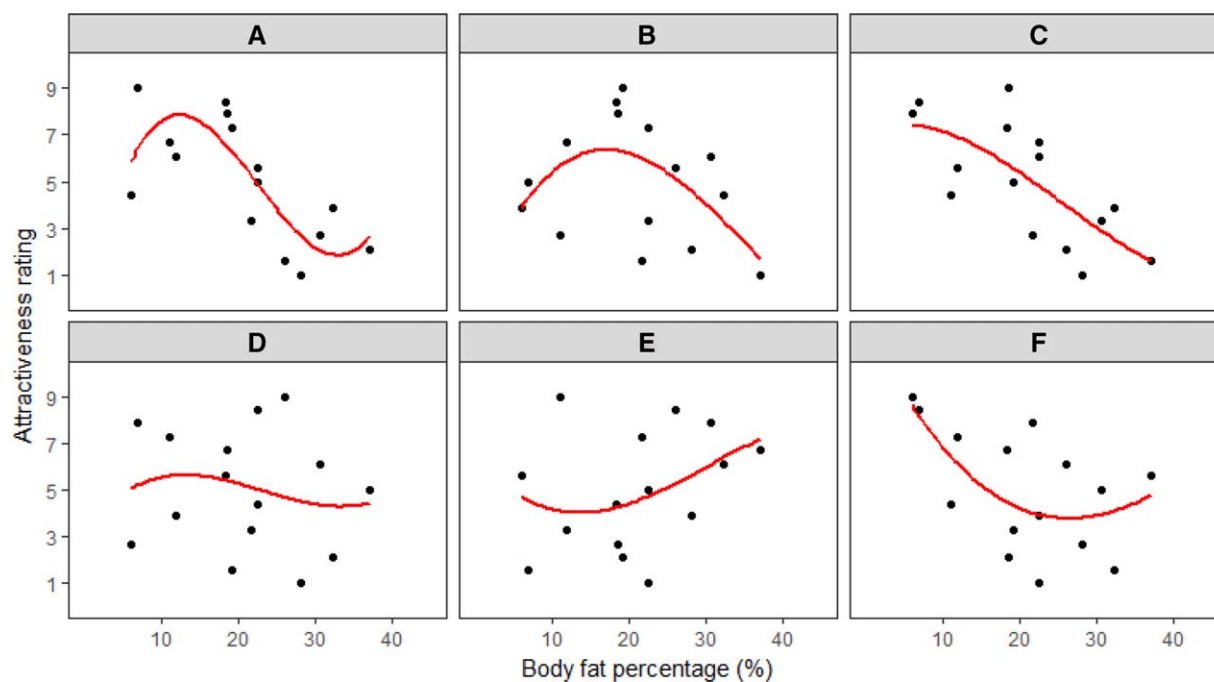


Figure 4 Examples of six types of relationships between body fat percentage and the rating score in male attractiveness. (A) Type 1 consisted of a single peak centered to the left of the distribution body fat percentage, which started to turn upward at high body fat percentage values. (B) Type 2 involved a single peak distinguished from type 1 by the fact there was no evidence of any upturn on the right-hand side of the curve. (C) Type 3 involved a linear negative relationship. (D) Type 4 showed a peak then a trough, or a trough then a peak, but no overall upward or downward trend. (E) Type 5 had an overall rising pattern with a single peak or trough. (F) Type 6 showed an overall downward trend with a single trough at higher body fatness. [Color figure can be viewed at wileyonlinelibrary.com]

Discussion

The primary aim of this work was to assess whether ratings of attractiveness of the opposite sex depend on the rater's own BMI and to assess whether this mutual attraction might be an explanation for the phenomenon of assortative mating for adiposity. By using the same set of female images, we have previously shown a strong negative linear relationship between the image body fat percentage and the average rating of physical attractiveness (13,18). Absent from our previous work was an analysis of the variability of individual raters. Here we showed large individual differences in all populations. For female attractiveness, most male raters conformed to the overall average pattern, but some showed a preference for intermediate levels of fatness and some were indifferent to adiposity, whereas some favored subjects with obesity. For male attractiveness, most female raters conformed to an average trend showing a peaked relationship between males' body fatness and attractiveness. However,

some females were indifferent to body fatness and some chose the images with higher body fatness as more attractive. The take-home message for both males and females is that, regardless of obesity level, everyone is physically beautiful to someone of the opposite sex.

A key question was whether individual raters who deviated from the average pattern had high BMIs themselves. This is important in the context of assortative mating for body composition. If raters with obesity rate images of people with obesity as more attractive, this would support the mutual attraction hypothesis. We found little evidence to support this suggestion. However, for male Caucasian raters who rated the leanest subjects as most attractive, we found a significant effect of rater BMI on their perceptions of female attractiveness. Because Caucasian males with higher BMIs on average rated images of thinner subjects slightly lower and images of individuals with obesity slightly higher, this provides some limited support for the mutual attraction hypothesis. However, the effect was small and on its own would be unlikely to generate assortative mating for adiposity. A previous study (28) also suggested that ratings of physical attractiveness were influenced by rater body composition in Caucasians. There were, however, several differences between our study and this earlier work. First, the authors of the other work studied the ratings by females of female images. Second, 30% of the raters had eating disorders and extremely low BMIs. These earlier data therefore probably reflect a different phenomenon.

We did not observe any evidence to support the mutual attraction theory with respect to female raters of male images. Another study

TABLE 2 Number of individual females of six types rating images of male attractiveness

	Type 1	Type 2	Type 3	Type 4	Type 5	Type 6
African	72	33	14	30	4	1
Asian	63	9	2	2	0	0
Caucasian	63	20	13	11	3	0
Total	198	62	29	43	7	1

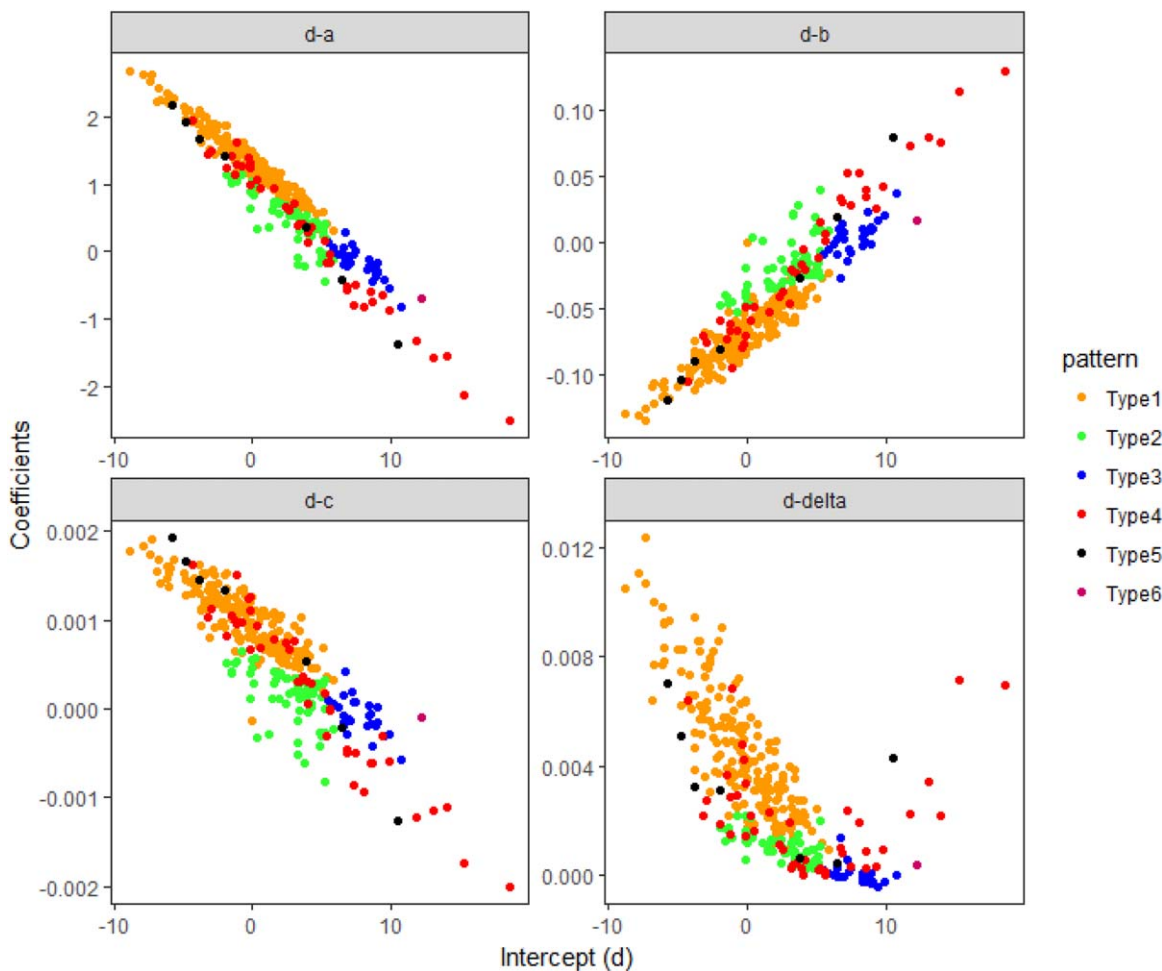


Figure 5 Relationships between the intercept (d) and coefficients (a , b , and c) of third-order polynomial fits to patterns linking attractiveness to body fat percentage for females rating male attractiveness. We fitted a third polynomial distribution of body fat percentage and rating score of each female rater ($y = d + ax + bx^2 + cx^3$, $\delta = 4b^2 - 12ac$, in which “ y ” referred to the rating score and “ x ” to body fat percentage). The categorized types of rating pattern (see Figure 4) fall on a continuum of the fitted regression parameters.

used a different protocol to explore the influence of female body morphology on mate preferences and found that females with a lower BMI and WHR found resources in males to be the most important factor driving attractiveness. In contrast, those females with higher WHR (but not BMI) were more influenced by male physical features (29). Similarly, in our study, female raters with a higher BMI did not rate males with obesity as more attractive.

Although our data did not support the mutual attraction hypothesis, the data raise several issues in relation to the evolutionary context of the relationship between attractiveness and adiposity. In the remainder of this discussion, we will highlight these issues. An important question is why the individual ratings in relation to adiposity were so diverse. We previously built an evolutionary model for the impacts of body fatness on female survival and fecundity (18). This model suggested maximal fitness at female BMIs of 17 to 20. This corresponds to the position of rated maximal attractiveness in many populations (12-18). The fitness function is relatively flat around the maximum and, hence, there is little difference between the

average fitness of a female with a BMI of 19 and one with a BMI of 23. Individual attractiveness ratings at the lower end of the BMI distribution might then be expected to be more diverse than at the high end, since there is a large fitness difference between a female with a BMI in the range of 17 to 23 and one with a BMI of 35. This was, however, not the case, and the variance in the ratings of the images was similar across the BMI range (Figure 1).

For males, the link between adiposity and fitness (survival and fecundity) is less clear and, hence, deriving expectations from an evolutionary perspective more difficult. Nevertheless, males do have a U-shaped relationship between all-cause mortality (inverse of survival) and BMI (30,31). Hence, if we ignore the unknown impact of male adiposity on fecundity, one would expect a peaked function between attractiveness and adiposity centered at a BMI of 23 to 25. This seems to better match the most frequently observed pattern, suggesting that female ratings of attractiveness may be more adaptive than those of males (18). Nevertheless, many females in all populations deviated significantly from this pattern.

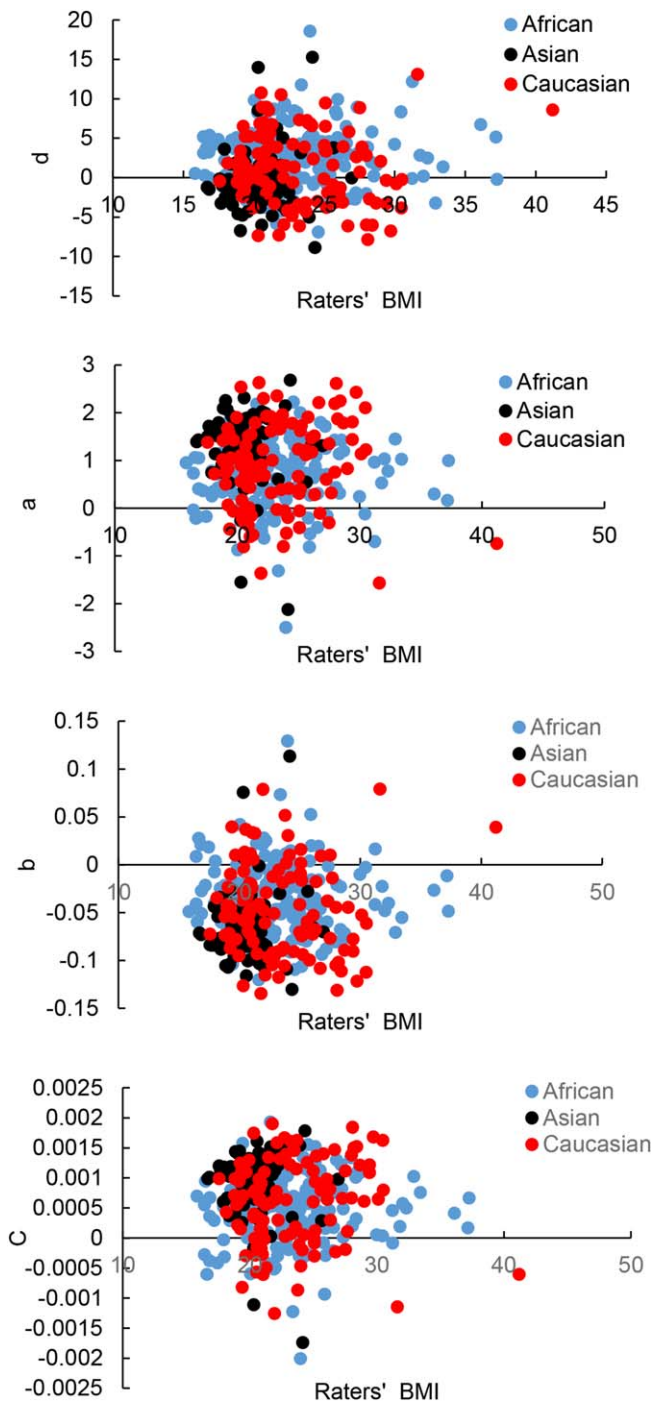


Figure 6 Relationship between rater BMI and coefficients of male attractiveness from the fitted third-order polynomial models (fitted as $y = d + ax + bx^2 + cx^3$). The x-axis refers to the rater BMI, and the y-axis refers to the fitted coefficients (d, a, b, and c) separately. There was no significant relationship between female rater BMI and any of these coefficients. [Color figure can be viewed at wileyonlinelibrary.com]

Particularly hard to understand from these evolutionary perspectives is why some individuals (of both sexes) were indifferent to cues of body fatness, with some considering the images of subjects with obesity, and hence lower fitness, as more attractive. In terms of

evolutionary fitness, it is better for an individual to have a mate, and reproduce, than not. Decisions about whom to attempt to mate with are, to an extent, independent of the most attractive potential partner. Individuals of both sexes may routinely pursue, and ultimately mate with, partners whom they do not consider the most attractive. This is because, due to their own levels of attractiveness, the most attractive individuals of the opposite sex would be unlikely to accept them as partners (attractiveness matching (32)). Ultimately, it is better to have somebody than nobody. However, in this latter scenario the ratings of physical attractiveness in relation to putative fitness are unaffected (33). Individuals who pursue and mate with individuals who are not the most attractive simply accept less than “the best” to achieve a nonnegative result. Supporting this viewpoint, men with a higher BMI are less likely to approach women whom they rate as “attractive” (34).

Why some individuals are indifferent to adiposity, or even perceive the less-fit alternative as most attractive, is unclear. For female attractiveness, 12 of 41 males who were indifferent to adiposity (pattern 3) used WHR to judge attractiveness. There has been a long debate about the relative importance of body fatness and WHR as indicators of female attractiveness. Body features may indicate reproductive values (35). In the 1990s, it was suggested that WHR is the main driver of attractiveness (36). This view was challenged when it was shown that adiposity explains more of the variance in attractiveness than WHR (12,14-17,32). The present work shows that this is probably because the majority of the male population used adiposity as a key signal (18). However, a small percentage based their ratings on WHR and were indifferent to adiposity. In practice, WHR and adiposity covary, so someone using WHR as a marker of attractiveness would indirectly maximize fitness in their ratings. In contrast to the males, we did not find that any of the 43 females who were indifferent to adiposity were using SWR to gauge attractiveness.

These factors cannot, however, explain why some individual raters found the subjects with obesity more attractive than the lean ones. One hypothesis might be that, in some situations, obesity may be a proxy for wealth (38,39). This association is well established in undeveloped countries preceding the economic transition. Some evidence suggests that this association is stronger in females rating males (40,41), and hence we might anticipate a greater proportion of females rating males to show this trend. However, 11 of 559 (2%) males rated females with obesity as most attractive and 7 of 340 (2%) females rated males with obesity as most attractive (Pearson $\chi^2 = 0.009$, $P = 0.925$). So this result remains an enigma.

In summary, individual variations in ratings of physical attractiveness are large. There was little support for the idea of mutual attraction as a driver for assortative mating. Our data suggest that despite overall trends favoring leaner phenotypes of both sexes as most attractive, everyone is beautiful to somebody of the opposite sex. ○

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References

- World Health Organization. *Global Status Report on Noncommunicable Diseases 2014*. Geneva: World Health Organization; 2014.
- Allison DB, Kaprio J, Korkeila M, Koskenvuo M, Neale MC, Hayakawa K. The heritability of body mass index among an international sample of monozygotic twins reared apart. *Int J Obes Relat Metab Disord* 1996;20:501-506.
- Allison DB, Neale MC, Kezis MI, Alfonso VC, Heshka S, Heymsfield SB. Assortative mating for relative weight: genetic implications. *Behav Genet* 1996;26:103-111.
- Dawson JA, Dhurandhar EJ, Vazquez AI, Peng B, Allison DB. Propagation of obesity across generations: the roles of differential realized fertility and assortative mating by body mass index. *Hum Hered* 2013;75:204-212.
- Hebebrand J, Wulfthange H, Goerg T, et al. Epidemic obesity: are genetic factors involved via increased rates of assortative mating? *Int J Obes Relat Metab Disord* 2000;24:345-353.
- Schafer RB, Keith PM. Matching by weight in married couples: a life cycle perspective. *J Soc Psychol* 1990;130:657-664.
- Silventoinen K, Kaprio J, Lahelma E, Viken RJ, Rose RJ. Assortative mating by body height and BMI: Finnish twins and their spouses. *AM J Hum Biol* 2003;15:620-627.
- Speakman JR, Djafarian K, Stewart J, Jackson DM. Assortative mating for obesity. *Am J Clin Nutr* 2007;86:316-323.
- Fisher CL, Fincher CL, Hahn AC, Little AC, DeBruine LM, Jones BC. Do assortative preferences contribute to assortative mating for adiposity? *Br J Psychol* 2014;105:474-485.
- Di Castelnuovo A, Quacquarello G, Donati MB, De Gaetano G, Iacoviello L. Spousal concordance for major coronary risk factors: a systematic review and meta-analysis. *Am J Epidemiol* 2009;169:1-8.
- Wilson EO. *On Human Nature*. Cambridge, MA: Harvard University Press; 2012.
- Fan J, Liu F, Wu J, Dai W. Visual perception of female physical attractiveness. *Proc Biol Sci* 2004;271:347-352.
- Faries MD, Bartholomew JB. The role of body fat in female attractiveness. *Evol Hum Behav* 2012;33:672-681.
- Tovée MJ, Cornelissen PL. The mystery of female beauty. *Nature* 1999;399:215-216.
- Tovée MJ, Cornelissen PL. Female and male perceptions of female physical attractiveness in front-view and profile. *Br J Psychol* 2001;92:391-402.
- Tovée MJ, Hancock PJ, Mahmoodi S, Singleton BR, Cornelissen PL. Human female attractiveness: waveform analysis of body shape. *Proc Biol Sci* 2002;269:2205-2213.
- Tovée MJ, Swami V, Furnham A, Mangalparsad R. Changing perceptions of attractiveness as observers are exposed to a different culture. *Evol Hum Behav* 2006;27:443-456.
- Wang G, Djafarian K, Egedigwe CA, et al. The relationship of female physical attractiveness to body fatness. *PeerJ* 2015;3:e1155. doi:10.7717/peerj.1155
- Fan J, Dai W, Liu F, Wu J. Visual perception of male body attractiveness. *Proc Biol Sci* 2005;272:219-226.
- Furnham A, Radley S. Sex differences in the perception of male and female body shapes. *Pers Individ Dif* 1989;10:653-662.
- Swami V, Smith J, Tsiokris A, et al. Male physical attractiveness in Britain and Greece: a cross-cultural study. *J Soc Psychol* 2007;147:15-26.
- Kalick SM, Hamilton TE. The matching hypothesis reexamined. *J Pers Soc Psychol* 1986;51:673. doi:10.1037/0022-3514.51.4.673
- Cawley J, Joyner K, Sobal J. Size matters: the influence of adolescents' weight and height on dating and sex. *Rationality and Society* 2006;18:67-94.
- Kark M, Karnehed N. Weight status at age 18 influences marriage prospects. A population-based study of Swedish men. *BMC Public Health* 2012;12:833. doi:10.1186/1471-2458-12-833
- Spencer EA, Appleby PN, Davey GK, Key TJ. Validity of self-reported height and weight in 4808 EPIC-Oxford participants. *Public Health Nutr* 2002;5:561-565.
- Dekkers JC, van Wier MF, Hendriksen IJ, Twisk JW, van Mechelen W. Accuracy of self-reported body weight, height and waist circumference in a Dutch overweight working population. *BMC Med Res Methodol* 2008;8:69. doi:10.1186/1471-2288-8-69
- Ortiz-Panozo E, Yunes-Díaz E, Lajous M, Romieu I, Monge A, López-Ridaura R. Validity of self-reported anthropometry in adult Mexican women. *Salud Publica Mex* 2017;59:266-275.
- Emery JL, Cohen-Tovée EM. The estimation of body mass index and physical attractiveness is dependent on the observer's own body mass index. *Proc Biol Sci* 2000;267:1987-1997.
- Pawlowski B, Jasienska G. Women's body morphology and preferences for sexual partners' characteristics. *Evol Hum Behav* 2008;29:19-25.
- Hanson RL, McCance DR, Jacobsson LT, et al. The U-shaped association between body mass index and mortality: relationship with weight gain in a Native American population. *J Clin Epidemiol* 1995;48:903-916.
- Yuan J-M, Ross RK, Gao Y-T, Yu MC. Body weight and mortality: a prospective evaluation in a cohort of middle-aged men in Shanghai, China. *Int J Epidemiol* 1998;27:824-832.
- Taylor LS, Fiore AT, Mendelsohn G, Cheshire C. "Out of my league": a real-world test of the matching hypothesis. *Pers Soc Psychol Bull* 2011;37:942-954.
- Lee L, Loewenstein G, Ariely D, Hong J, Young J. If I'm not hot, are you hot or not? Physical-attractiveness evaluations and dating preferences as a function of one's own attractiveness. *Psychol Sci* 2008;19:669-677.
- Clayton DE, Klassen ML. Perception of attractiveness by obesity and hair color. *Percept Mot Skills* 1989;68:199-202.
- Andrews TM, Lukaszewski AW, Simmons ZL, Bleske-Rechek A. Cue-based estimates of reproductive value explain women's body attractiveness. *Evol Hum Behav* 2017;38:461-467.
- Singh D. Female judgment of male attractiveness and desirability for relationships: role of waist-to-hip ratio and financial status. *J Pers Soc Psychol* 1995;69:1089-1101.
- Anson D, Moist P, Przywara M, Wells H, Saylor H, Maxime H. The effects of word completion and word prediction on typing rates using on-screen keyboards. *Assist Technol* 2006;18:146-154.
- Sobal J, Stunkard AJ. Socioeconomic status and obesity: a review of the literature. *Psychol Bull* 1989;105:260-275.
- Stringhini S, Forrester TE, Plange-Rhule J, et al. The social patterning of risk factors for noncommunicable diseases in five countries: evidence from the modeling the epidemiologic transition study (METS). *BMC Public Health* 2016;16:956. doi:10.1186/s12889-016-3589-5
- Addo J, Smeeth L, Leon D. Obesity in urban civil servants in Ghana: association with pre-adult wealth and adult socio-economic status. *Public Health* 2009;123:365-370.
- McLaren L. Socioeconomic status and obesity. *Epidemiol Rev* 2007;29:29-48.