Article

Perceptions of Female Body Size and Shape in China, Hong Kong, and the United Kingdom

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Abstract

Photographs of 50 women were rated for attractiveness, health, and fertility recorded by four sets of participants—Rural-Chinese (n = 50), Chinese participants in Hong Kong (n = 50), Chinese participants living in the United Kingdom (n = 50), and participants self-identifying as "Caucasian" living in the United Kingdom. The results suggest that a polynomial function of Body Mass Index (kg/m^2) is the best predictor of all three judgments in all four observer groups. In contrast, shape cues, such as the waist-to-hip ratio (WHR), seem to play a relatively small role. Shape cues do consistently account for a greater proportion of the variance in all three Chinese groups than for the Caucasian participants, implying a greater role for shape in the Chinese participants' judgments. This result may reflect the competing pressures between the healthy range for shape and body mass in the Chinese populations versus the role of visual diet in influencing body preferences in different cultural environments.

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Introduction

From an evolutionary perspective, mate selection is a fundamental adaptive problem for an individual (for reviews, see Buss, 1998; Miller, 1998). Every person needs to be sensitive to the physical cues that honestly signal that one individual is more desirable (i.e., fitter and with a better reproductive potential) than another, and use these cues to choose the partner who is most likely to enhance their chances of successful reproduction (Buss, 2003). In the context of mate selection, beauty or attractiveness can be viewed as a "certificate" of health and reproductive potential (Thornhill & Gangestad, 1999). Research into physical attractiveness (i.e., the attractiveness of the body excluding the face) has focused on overall body mass as measured by the Body Mass index (BMI; kg/m^2) and torso shape as indexed by the waist-to-hip ratio (WHR) and the waist-to-chest ratio (WCR). For women in Western Europe and the United States, a low WHR and WCR (i.e., a curvaceous body) is suggested to correspond to the optimal fat distribution for high fertility (Jasienska, Ziomkiewicz, Ellison, Lipson, & Thune, 2004; Wass, Waldenstrom, Rossner, & Hellberg, 1997; Zaadstra et al., 1993). Hence, this shape should be highly attractive within these cultures (Furnham, Tan, & McManus, 1997; Henss, 2000; Singh, 1993, 1994). A BMI of around 20 to 22 also appears to be a strong predictor of attractiveness throughout Western countries (Tovée, Edmonds & Vuong, 2012; Fan, Liu, Wu, & Dai, 2004; Puhl & Boland, 2001; Thornhill & Grammer, 1999; Tovée, Hancock, Mahmoodi, Singleton, & Cornelissen, 2002; Tovée, Maisey, Emery, & Cornelissen, 1999; Tovée, Reinhardt, Emery, & Cornelissen, 1998). There are advantages of using BMI as a basis for mate selection, because it appears to be a reliable cue to female health (Manson et al., 1995; Willet et al., 1995) and reproductive potential (Frisch, 1988; Lake, Power, & Cole, 1997; Reid & van Vugt, 1987; Wang, Davies, & Norman, 2000).

Although some authors have argued for universal values for the perceived attractiveness of features such as WHR or WCR, which transcend cultural and social categories (on the basis that cues to fertility and health should be attractive everywhere; for example, Dixson, Dixson, Li, & Anderson, 2007; Singh, 1993, 1994), several studies have shown substantial cross-cultural differences (see Cashdan, 2008). For example, the preferred WHR for the female body has been suggested to vary from 0.7 in U.K. self-identified "Caucasians" (U.K. Caucasians) to 0.80 and 0.90 in African and native South American cultures (Sugiyama, 2004; Tovée, Swami, Furnham, &

Mangalparsad, 2006). Likewise, the preferred BMI varies from 20.8 in U.K. Caucasians to 26.5 in South Africa (Tovée et al., 2006). Why should this variation in size and shape preference exist? Two potential factors, which could alter body preferences, are socioeconomic status (SES) and visual diet.

SES and resource availability have been suggested to play a key role for the observed variation in preferences as the optimal size and shape of bodies. A number of studies have suggested that people with limited access to resources tend to prefer a heavier and less curvaceous female body than in more economically developed countries or people of high SES (Anderson, Crawford, Nadeau, & Lindberg, 1992; Brown & Konner, 1987; Furnham, Swami, & Shah, 2006). For example, studies in Malaysia have shown an inverse relationship between SES and body size ideals in same ethnic group, and the same body ideals in different ethnic groups of the same SES (Swami & Tovée, 2005, 2006).

Alternatively, the visual diet hypothesis suggests that we recognize faces and bodies by comparison with an internal template, which is based on the weighted average of the faces and bodies we encounter on a daily basis (e.g., Leopold, O'Toole, Vetter, & Blanz, 2001; Winkler & Rhodes, 2005). This visual diet also seems to influence our perception of what is a normal body toward this averaged body size (Winkler & Rhodes, 2005). This "visual diet mechanism" would allow us to normalize our perception of body size and shape for a particular environment. Sensitivity to visual diet potentially also allows us to modify our internal representation of a normal or attractive body as our environment changes or we move between environments (Scott et al., 2007; Tovée et al., 2007; Tovée et al., 2006). This modification can happen comparatively rapidly, with significant changes in preferences occurring in the order of months rather than years (Tovée et al., 2007; Tovée et al., 2006). This creates a potential problem in Western societies whose media contains bodies whose size and shape are unrepresentative of the general population. They tend to be significantly thinner (e.g., Tovée, Mason, Emery, McClusky, & Cohen-Tovée, 1997; Voracek & Fisher, 2002) and this shifts the representation of a "normal" body significantly below the population average and may lead to dissatisfaction with an individual's own body size (for a detailed review, see Grabe, Ward, & Hyde, 2008)

The relative importance of these two explanations in determining our body preferences is unclear. We will test their relative importance in Chinese participants spread across three different environments. We will measure the perception of attractiveness, health, and fertility in four groups: Chinese participants in Rural China, Hong Kong (HK) and the United Kingdom, as well as a Caucasian U.K. observer group. The visual diet hypothesis would predict that as Rural-Chinese participants see predominantly Chinese people whose

weight and shape is smaller than Caucasians (Health Survey for England, 2008; Lin, Wang, & Wang, 2004) and have little or no access to the Western media, they will have a preference for lower weight bodies. While the U.K. Chinese, although exposed to the relatively thin body shapes in the media, will meet and interact with Caucasians in the general population who are significantly bigger and heavier than their Chinese counterparts, which should bias them toward preferring a heavier body (Health Survey for England, 2008; Lin et al., 2004). The HK participants should show intermediate preferences as they see a mixture of both Chinese and Caucasian body types. Alternatively, an SES explanation would predict that the relatively poor Rural-Chinese population would prefer a heavier body type, and the Chinese group in the more affluent United Kingdom would prefer lighter figures. The HK participants would again be intermediate. The Caucasian group provides a baseline measure to compare against the Chinese groups (particularly the U.K.-Chinese group). Our data should thus allow us to test these two alternative explanations to determine the relative importance of visual diet and socioeconomic pressures in shaping body preferences.

Method

Participants

The 200 participants in this study were recruited by opportunity sampling in three countries, each with a different socioeconomic background, from industrialized United Kingdom and HK to Rural China (Chen Been Village, Guangdong Province). The Rural-China group consisted of 50 participants (20 females and 30 males), with a mean age of 32.54 years (*SD* = 9.96 years). Most participants in this group had very little education, with the majority of participants having only an elementary school qualification or no qualifications. The average annual household income in Guangdong is equivalent to £1,523.43 in U.K. currency. The mean annual income of the China participants studied is equivalent to £1,829.29 (*SD* = £2,033.33) in U.K. currency, with the major source of income being from arable farming. Access to Internet and digital media in this village is extremely limited. Similarly, access to magazines and newspapers covering Western body preferences is fairly restricted

The 50 HK participants (25 females, 25 males) had a mean age of 23.88 years (*SD* = 8.63 years). Participants either had or were studying for undergraduate degrees. The average annual household income in HK is equivalent to £16,286.76 in U.K. currency. The mean annual income of all the participants studied in this group is equivalent to £6,533.18 (*SD* = £11,639.27), with

most of this coming from the service sector. The lower than average income reflects both the youth of the participants and the high proportion of students in our sample. Access to Internet and media coverage is widespread, with most households having access to both Internet and television. Magazines and newspapers documenting body preferences in the West are easily accessible.

In the United Kingdom, two groups were studied. The 50 U.K.-Chinese participants (25 females and 25 males) had a mean age of 24.4 years (*SD* = 9.27 years). These were participants who had, or their families had, migrated from HK or China and are now living in Britain (i.e., first- and second-generation migrants). The mean annual income of this group was £12,427.56 (*SD* = £22,233.96), compared with the average annual household income of £31,323 in the United Kingdom, according to the Office for National Statistics (2009). The 50 Caucasian participants (25 females and 25 males) had a mean age of 24.4 years (*SD* = 9.27 years). The mean annual income of this group was £12,427.56 (*SD* = £22,233.96). These participants were born, raised, and educated in the United Kingdom. Both groups were recruited by opportunity sampling via the Internet and were predominantly students.

Materials

The participants in all four groups were asked to rate fifty 24-bit color digital photographs of real women. To generate the images, consenting women were photographed standing in a set pose at a standard distance, wearing tight gray leotards and leggings (Tovée et al., 1999). The use of high-resolution, color photographic images is a more realistic way of testing preferences than the line drawings often used (see, for example, Dixson et al., 2007; Furnham et al., 1997; Henss, 1995; Singh, 1993). The photographs of the women were shown in front view with their faces obscured so identities could be kept anonymous and facial attractiveness would not be a confounding factor. The photographs were taken from a previous study by Tovée et al. (1999) and have been used extensively to test attractiveness and body size preferences (e.g., Scott et al., 2007; Swami, Caprario, Tovée, & Furnham, 2006; Swami, Knight, et al., 2007; Swami & Tovée, 2005; Tovée, Emery, & Cohen-Tovée, 2000; Tovée et al., 2007; Tovée et al., 2002; Tovée et al., 2006). The stimulus set contained 10 photographs of women from each of the BMI categories: emaciated, underweight, normal, overweight, or obese. The women in the photographs varied in WHR from 0.68 to 0.98 and in WCR from 0.69 to 0.95. Rating data were collected in two ways: by an online survey and through printed paper copies. The online survey was generated using the Qualtrics software (www.qualtrics.com). The online questionnaire presented images

individually to the participants on a computer screen with three sliding rating scales (unattractive-attractive, unhealthy-healthy, infertile-fertile) below the image (ranging from 0 to 100). For the paper-based version, the images were presented on separate sheets of A4-size paper, and the participants rated the images by marking their preferences on line scales identical to those of the online questionnaire. An instruction section and debrief sheet were also included at the beginning and end of both questionnaires. The paper-based questionnaire was used for the Rural-Chinese participants as access to the Internet was limited and it proved to be easier to recruit via direct testing rather than online. The collection of the Rural-Chinese data was handled by the first author (J.J.Y.M.), and was collected by opportunistic sampling of adults in the village market place and associated buildings. The U.K. Caucasians all completed their data on the online version. These were predominantly students at Newcastle University completing the questionnaire for course credit. For the other groups, 31 HK-Chinese participants and the 30 U.K.-Chinese participants completed the online version. Participants were recruited primarily through email of friends and contacts of the first author and through a Facebook site. But as further participant recruitment was proving challenging, the remaining HK and U.K.-Chinese participants were recruited through opportunistic sampling of people on the street and were tested through direct face-to-face testing, using the paper version (again by J.J.Y.M.).

The questionnaire also asked for demographic details such as age, gender, height, and their education levels. There were also a set of acculturation questions measuring their exposure to Western culture and media. The acculturation scale was originally produced by Marin, Sabogal, Marin, Otero-Sabogal, and Perez-Stable (1987) for use in Hispanic populations in South America to determine the relative acculturation of Spanish speakers to the English Language and associated culture. In the modified version, Chinese was substituted for references to Spanish—a Chinese language version used in Rural China, and this was translated by the first author of this paper (J.J.Y.M.) who is a bilingual Chinese-English speaker. An English-language version was used in the other three groups.

Procedure

All participants completed the questionnaires individually. The only difference between the groups was the language in which the questionnaires were presented. The questionnaire was in English for the HK-Chinese, U.K.-Chinese, and Caucasian groups and in traditional Chinese for the Rural-Chinese group. They were all given instructions as to what they needed to do

prior to beginning the questionnaire. The whole procedure took approximately 25 to 30 min to complete for each individual participant. The procedure for this study was approved by the University Ethics Committee.

Results

Demographic Data

The use of the Chinese version of the acculturation scale has not been validated, but it provides a broad general measure of the exposure of our different populations to English speakers and Western culture. All the participants in the Rural-Chinese group scored the minimum possible on the questionnaire (a score of 12), indicating having no significant links with English speakers or the English-Language culture. The HK-Chinese group scored 24.0 (SD = 6.3), the U.K.-Chinese group scored 30.8 (SD = 9.9), and the U.K. Caucasians scored 52.9 (SD = 8.9). The maximum possible score on the scale is 60. The results for the Caucasians provide a baseline to compare against the three Chinese groups. The acculturation scores in the other three groups are significantly different, one-way ANOVA, $F(2, 148) = 156.21$, $p < .0001$; all post hoc ps < .05.

The BMI of the Rural-Chinese group (M = 20.9, SD = 2.2), the HK-Chinese group (M = 19.9, SD = 5.0), and the U.K.-Chinese group is very similar (M = 20.7, SD = 2.8). The U.K. Caucasians have a slightly heavier BMI (M = 22.9, SD = 3.5). A one-way ANOVA shows a significant difference in BMI between the groups, $F(3, 197) = 6.525$, $p < .0001$, and post hoc tests (Tukey's honestly significant difference [HSD]) show that U.K. Caucasian group is on average significantly heavier than the other three groups (all ps < .05).

Gender Differences

To explore whether there were any differences between the two genders in our observer groups, we carried out Spearman Rank correlations. We found very high correlations between the male and female participants within each group, suggesting they were ranking the images in the same way (all Spearman's r: $.85 < r < .95$). This result is consistent with the correlations between attractiveness ratings by male and female participants found in previous studies (e.g., Tovée & Cornelissen, 2001; Tovée et al., 2002). We therefore amalgamated the male and female ratings together and calculated Cronbach's alpha for each cultural group. The intraclass reliability was very high across groups (see Table 1), which suggests that all the participants within each of the groups are rating the images in the same way, and that there are no subgroups within each of the observer groups.

Table 1. Table Summarizing the Response Characteristics of the Four Observer Groups.

	Group	Cronbach's α	BMI r-sq	WHR r-sq	WCR r-sq	BMI AIC	WHR AIC	WCR AIC	BMI Peaks (s.d.)	WHR Gradient (s.d.)	WCR Gradient (s.d.)
Attractiveness	**Rural Chinese**	0.99	78.2	11.2	8.3	260.4	321.8	323.3	20.74 (0.66)	-18.72 (6.39)	-17.43 (5.96)
	Hong Kong	0.98	72.7	11.8	9.8	205.1	249.4	249.3	20.82 (3.05)	-5.31 (6.85)	-5.31 (6.85)
	British - Chinese	0.95	74.5	18.7	19.4	192.5	242.3	241.9	21.14 (3.77)	-7.25 (6.92)	-5.27 (6.22)
	UK Caucasians	0.99	83.7	6.6	2.9	197.2	274.6	276.4	20.86 (1.51)	-7.77 (6.00)	-5.24 (9.56)
Health	**Rural Chinese**	0.99	83.7	11.1	9.3	277.5	341.7	342.7	20.28 (1.63)	-22.13 (6.61)	-20.57 (5.81)
	Hong Kong	0.98	75	10.9	7.5	200.2	240.7	264.6	21.00 (2.20)	-5.41 (6.64)	-4.35 (4.89)
	British - Chinese	0.95	77.7	12	9.7	191.2	251	252.1	21.29 (3.48)	-4.21 (6.92)	-4.15 (5.79)
	UK Caucasians	0.98	81.7	2.6	1.1	199.6	273.5	274.2	21.04 (1.89)	-5.03 (7.71)	-3.19 (9.12)
Fertility	**Rural Chinese**	0.99	79.2	10	8.1	260.4	321.8	323.3	20.64 (0.72)	-24.84 (6.69)	-23.31 (7.33)
	Hong Kong	0.96	75	10.7	7.7	169.7	240.7	238.1	22.62 (4.35)	-0.04 (8.28)	0.47 (6.16)
	British - Chinese	0.9	79	12.2	9.4	170.1	238.8	237.1	24.45 (5.40)	2.35 (9.16)	0.58 (7.16)
	UK Caucasians	0.98	82.7	0	1	188.1	265.8	265.4	23.09 (3.48)	-0.56 (7.41)	2.82 (9.69)

Note. This includes Cronbach's alpha, the amount of variance (r^2) that BMI, WHR, and WCR accounted for in the regression equations, the AIC, along with the average ideal BMI values, and the gradient of the relationship between attractiveness and WHR or WCR. BMI = Body Mass Index, WHR = waist-to-hip ratio; WCR = waist-to-chest ratio; AIC = Akaike's Information Criterion.

Methodological Differences

Some of the data were collected online and some by direct testing by the experimenter (as described above). To test whether between-group differences could have arisen due to this difference in methodology, we compared the data in the U.K.-Chinese and HK groups, which had been collected by different techniques. The ratings were highly correlated (Spearman rank correlations: U.K. Chinese, $r = .92$, $p < .0001$ [attractiveness], $r = .93$, $p < .0001$ [health], $r = .90$, $p < .0001$ [fertility]; HK, $r = .93$, $p < .0001$ [attractiveness], $r = .90$, $p = .0001$ [health], $r = .85$, $p < .0001$ [fertility]).This suggests that the there are little differences between way participants rate the images in the two methodologies, a result consistent with the high scores on Cronbach's alpha for these groups, indicating little within-group variability in rating behavior.

Multiple Regression Results

Figure 1 shows plots of attractiveness, health, and fertility ratings as a function of BMI for all the observer groups, with all the ratings being significantly explained by BMI (all cases: $p < .001$). It is clear from these figures that the relationship between BMI and the ratings is nonlinear. That is, increases or decreases in BMI either side of the peak of the curve reduce the ratings in attractiveness, health, and fertility.

Figure 2 shows the corresponding relationship between the three sets of ratings and WHR, and Figure 3 shows the relationship between the three sets of ratings and WCR. As in previous studies (e.g., Swami et al., 2006; Swami, Neto, et al., 2007; Swami & Tovée, 2005), the relationship between shape cues as indexed by WHR and WCR and judgments of physical attractiveness, health, and fertility is comparatively weak as compared with their relationship with BMI. However, it does seem that for all four groups, the ratings are higher for the more curvy bodies, with the strongest effect being observed for the Rural-Chinese group.

There are a large number of nonlinear functions that could be used to model these data. Following Tovée et al. (1999), we chose the simplest approach possible, which was to include second- and third-order terms in a multiple regression model (see Altman, 1991), to estimate the variance of the ratings explained by BMI, WHR, and WCR. There appears little justification in the psychological literature for fitting a more complex function.

The total variance explained by the different body features is shown in Table 1. The effect sizes for the relationship between BMI and the ratings are much greater than for either WHR or WCR and the ratings, suggesting that a nonlinear function of BMI is a considerably stronger determinant of rating

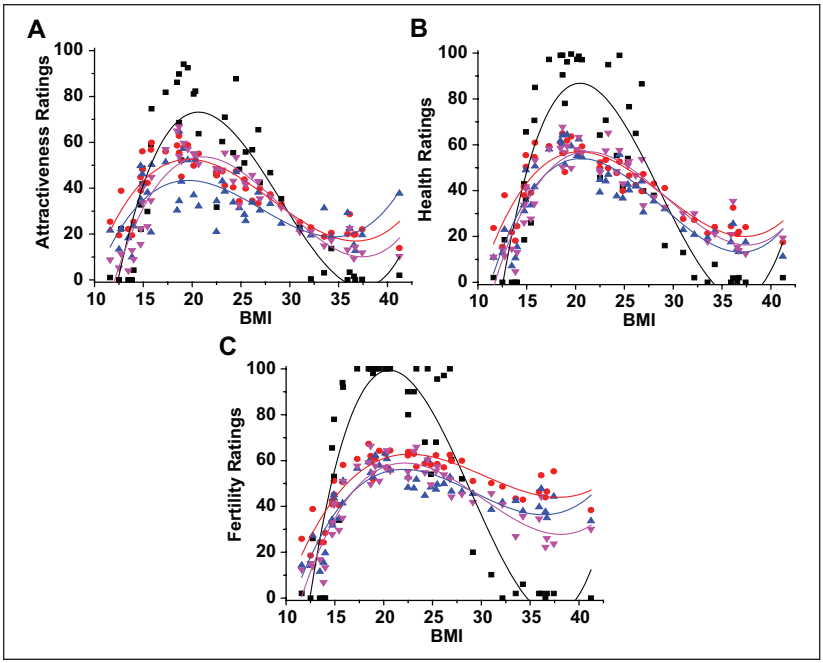

Figure 1. Plots of (A) attractiveness, (B) health, and (C) fertility as functions of BMI.

Note. Each point represents the mean rating by the participants in each participant group for each of the female bodies. Superimposed over the data are third-order polynomial regression lines. The Rural Chinese are represented by black squares and lines, the HK Chinese by blue triangles and lines, the U.K. Chinese by red circles and lines, and the U.K. Caucasians by inverted magenta triangles and lines. BMI = Body Mass Index; HK = Hong Kong.

for bodily attractiveness, health, and fertility than these indices of torso shape. An alternative way of analyzing the relative importance of the three predictors is an information theoretic approach, for example, by use of Akaike's Information Criterion (AIC; Motulsky & Christopoulos, 2004). Including a squared or cubic term in a regression analysis could artificially inflate R^2, but this is less of an issue with AIC, as it takes into account the number of parameters within the model, as well as measuring the goodness of fit for the model. For each set of predictors (BMI, WHR, and WCR), we ran separate models to calculate AIC. The model for BMI included squared and cubed terms. When comparing between competing models, the preferred option has the lowest AIC value. The AIC results corroborate the R^2 findings (Table 1). Within each group the AIC overwhelmingly supports the BMI

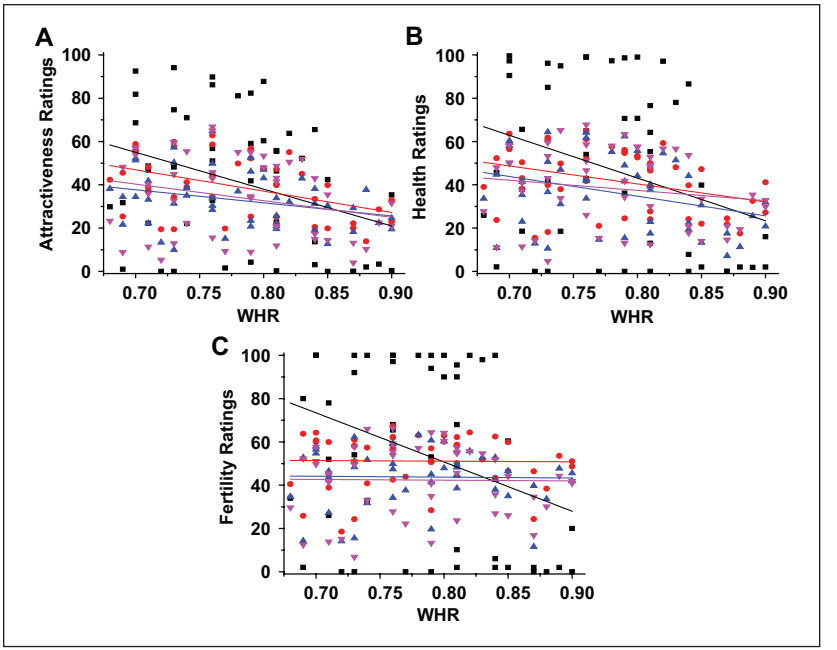

Figure 2. Plots of (A) attractiveness, (B) health, and (C) fertility as functions of WHR.

Note. Each point represents the 50 attractiveness judgments made by participants. Superimposed over the data are third-order polynomial regression lines. The Rural Chinese are represented by black squares and lines, the HK Chinese by blue triangles and lines, the U.K. Chinese by red circles and lines, and the U.K. Caucasians by inverted magenta triangles and lines. WHR = waist-to-hip ratio; HK = Hong Kong.

model as the preferred option. Generally a difference of 10 units (or more) means a large difference in support for one model versus another (Burnham & Anderson, 2002). This is the case for every single comparison, thus strongly suggesting that the models with nonlinear functions of BMI are the closest fit to the body judgments made.

Between-Group Differences

Although the shape of the attractiveness, health, fertility judgments as a function of BMI is very similar across all the groups, it is possible the function may have been shifted in some groups (i.e., the peak or "ideal" BMI value may differ across the groups). To explore this possibility, third-order

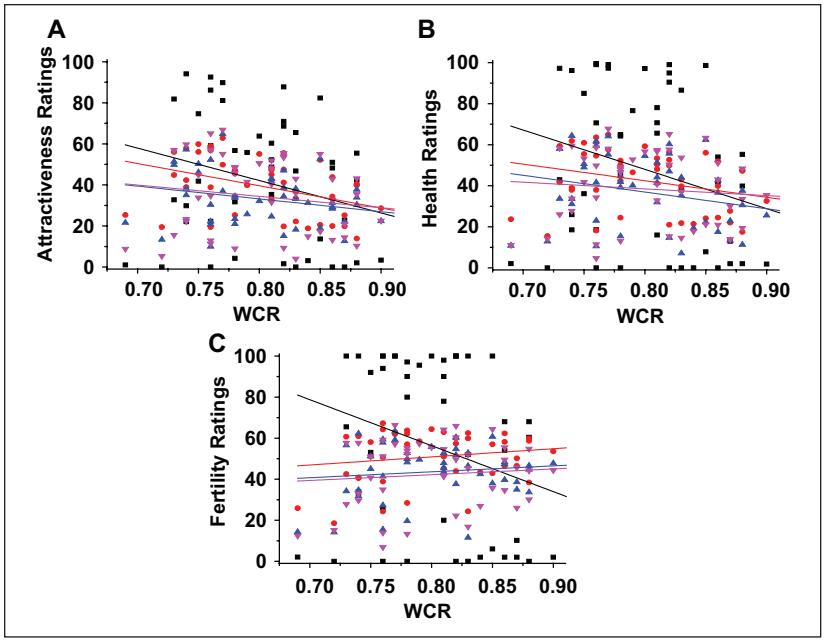

Figure 3. Plots of (A) attractiveness, (B) health, and (C) fertility as functions of WCR.

Note. Each point represents the 50 attractiveness judgments made by participants. Superimposed over the data are third-order polynomial regression lines. The Rural Chinese are represented by black squares and lines, the HK Chinese by blue triangles and lines, the U.K. Chinese by red circles and lines, and the U.K. Caucasians by inverted magenta triangles and lines. WCR = waist-to-chest ratio; HK = Hong Kong.

polynomials for BMI were fitted to the ratings made by all participants in each group, allowing the BMI at the peak of the curve to be calculated for each participant for each of the three judgments (attractiveness, health, fertility). The average peak BMI (the "ideal" BMI for a particular judgment) for each group is shown in Figure 1.

The peak BMI values tended to be lower for all three judgments by the Rural-Chinese group. However, ANOVAs show no significant differences between the peak BMI values for all four groups for attractiveness and health judgments (both $p > .1$). However, there were significant differences between the four groups for the fertility condition, one-way ANOVA, $F(3, 197) = 8.59$, $p < .001$. To see where these differences lay, a post hoc Tukey HSD was carried out on the data. The peak BMI values from the Rural-Chinese group

were significantly different from the other three groups (all *p*s < .05). There was also a significant correlation between peak BMI values for fertility and the acculturation scores (Pearson correlation, $r = .19$, $p < .01$).

As the rural group is older than the other groups, it may be that the preference in the fertility condition reflects age-related preferences rather than socioeconomic or visual diet differences. To test for this possibility, we correlated age with the peak BMI values for fertility across all the participants in all four groups. There was no evidence for a significant association between age and fertility ratings (Pearson correlation, $r = -.12$, $p = .92$). This is consistent with a previous study by George et al. (2008), which found no age-related difference in body preferences based on age in a large set of Caucasian participants. We also correlated the fertility peak BMI values with the BMI of the participants, and again found no significant correlation (Pearson correlation, $r = -.18$, $p = .80$).

As in previous studies, the proportion of the variance accounted for by WHR and WCR in the regression analyses was considerably lower than that for BMI. It is interesting to note that the proportion of variance accounted by shape cues in all the Chinese groups was much higher than those reported in the U.K. Caucasian participants. The gradient of the relationship between averaged ratings and WHR or WCR for each group seems similar in all of the groups except the Rural Chinese, which is consistently sharper. To explore whether this difference was statistically significant, we carried out a series of standard dummy regressions (Tukey, 1977). The Rural-Chinese group's judgments were significantly different from all the other groups ($p < .05$). Moreover, there was also a significant correlation between acculturation score and the gradient for WCR (Pearson correlation, $r = .36$, $p < .001$) and WHR ($r = .26$, $p < .004$) for fertility. That is, as the acculturation score rises, the gradient between the rating score and WCR or WHR becomes less negative (i.e., higher acculturation scores are correlated with a smaller effect on fertility ratings by WCR or WHR).

Discussion

The results suggest that BMI is the best predictor of all three judgments in all four observer groups, which is consistent with previous studies (e.g., Fan et al., 2004; Swami et al., 2006; Swami, Knight, et al., 2007; Swami & Tovée, 2005; Tovée et al., 2002). Shape cues, such as WHR and WCR, seem to play a relatively small role in these behavioral judgments. In all three judgments, the Rural-Chinese participants tend to prefer a lower ideal BMI than the other three observer groups, though not significantly so. However, in the ratings of fertility, the ideal BMI by the Rural Chinese is statistically significantly

different from the other three groups. This significant difference is not because the ideal value for the Rural-Chinese participants is markedly different from their attractiveness and health judgments, but rather because the ideal BMI for fertility preferred by the other three groups has risen relative to their other sets of judgments.

The relative importance of BMI and WHR in body judgments has been explored in a number of studies, most of which have found BMI to be a stronger predictor than WHR in attractiveness ratings (e.g., Fan et al., 2004; Puhl & Boland, 2001; Rilling, Kaufman, Smith, Patel, & Worthman, 2009; Scott et al., 2007; Smith, Cornelissen, & Tovée, 2007; Smith, Tovée, et al., 2007; Swami et al., 2006, Swami, Knight, et al., 2007; Swami, Neto, et al., 2007; Swami & Tovée, 2005, 2007a, 2007b; Tovée et al., 2002; Tovée et al., 1999; Tovée et al., 1998). Although Singh (1993) initially reported that WHR was the primary predictor of body judgments, he used line drawings which covaried WHR and apparent body mass. As a result, it was not possible to differentiate between the importance of these two features—changes in body ratings could be due to changing WHR, BMI, or a mixture of both (Tassinary & Hansen, 1998; Tovée & Cornelissen, 1999). The use of large numbers of digital photographs of real bodies, in which there is not an absolute correlation between BMI and WHR, has allowed an assessment of the relative importance of the two features, which suggests that BMI is a stronger predictor of attractiveness and health judgments (e.g., Fan et al., 2004; Rilling et al., 2009; Tovée et al., 2002; Tovée et al., 1999; Tovée et al., 1998). This is true of silhouettes (e.g., Puhl & Boland, 2001), digital photographs (e.g., Tovée & Cornelissen, 2001; Tovée et al., 2000; Tovée et al., 1999), video clips (Rilling et al., 2009; Smith, Cornelissen, et al., 2007), and three-dimensional (3D) laser scanned bodies (Fan, Dai, Qian, Chau, & Liu, 2007; Fan et al., 2004). This also seems to be true cross-culturally, as supported by data from Bangladesh, Malaysia, Thailand, Indonesia, India, Japan, Samoa, Africa, and a variety of European countries (e.g., Scott et al., 2007; Swami et al., 2006; Swami, Knight, et al., 2007; Swami, Neto, et al., 2007; Swami et al., 2008; Swami & Tovée, 2005, 2007a, 2007b). However, none of these studies tell us directly which body features predict peoples' attractiveness judgments. A recent study recorded the eye movements of three groups of observers when they rated photographs of female bodies (Cornelissen, Hancock, et al., 2009). The first group rated the images for attractiveness, the second group rated for BMI and the third group for WHR. If either WHR and/or BMI is used to judge attractiveness, then observers rating attractiveness should have looked at those areas of the body which allow assessment of these features, and they should have looked in the same areas when they were directly asked to estimate WHR and BMI. So Cornelissen, Hancock, et al. (2009) were able to

compare the fixation patterns for the WHR and BMI judgments with those for attractiveness judgments and infer which features were used for attractiveness. The pattern of fixations for attractiveness ratings was very similar to the fixation patterns for BMI judgments, but the fixations for WHR ratings were significantly different from those for attractiveness and BMI. This suggested that BMI and not WHR was used to judge attractiveness. (Cornelissen, Hancock, et al., 2009).

Varying the relative ranges of BMI and WHR in the bodies used also does not seem to significantly alter the relative importance of BMI and WHR (e.g., Smith, Cornelissen, et al., 2007; Tovée et al., 2002; Tovée et al., 1999). Of course, WHR itself is not a perfect measure of lower body shape. It is essentially trying to capture a complex, changing shape by sampling at only two points. This might be why it does not seem to be a strong predictor of attractiveness judgments. To better capture lower body shape change, waveform analysis has been used to quantify torso shape, but even using this analysis technique, BMI is still a stronger predictor of attractiveness judgments than the shape components of a principal components analysis (Smith, Tovée, et al., 2007; Tovée et al., 2002). Another possible reason that BMI overshadows WHR is that there is a degree of covariation between the two features, but even statistically partialing out this effect, WHR still plays a minimal role in attractiveness judgments (Cornelissen, Tovée, et al., 2009).

An alternative method of looking at the relative importance of BMI and WHR was tried by Singh and Randall (2007), who used before and after photographs of the lower torsos (from the bottom of the ribcage to halfway down the thigh) of 15 women who had undergone a cosmetic surgical procedure, which took adipose tissue from their stomach and added it to their thighs and buttocks. However, there are potential problems with these images. The photographs were not standardized and vary in viewing angle (varying between a profile view and a viewpoint behind the body) and illumination in the before and after conditions, which complicates comparison of a body in the two conditions. Moreover, it is important to note that both behavioral and eye-movement studies suggest that the degree of stomach depth (i.e., the degree to which the stomach protrudes) is used as a key cue to judge BMI (e.g., Cornelissen, Tovée, et al., 2009; Rilling et al., 2009; Tovée et al., 1999). The cosmetic surgical intervention, which artificially alters this part of the body, may lead observers to perceive a difference in BMI in the before and after condition. This is important because the observers have only the visual image to go on, and if the image appears to vary in BMI (even if there is no significant change in the actual BMI of participants in the photographs), then the observers will react to the images as though they do alter in BMI (Holliday, Longe, Thai, Hancock, & Tovée, 2011). Thus, the *apparent* BMI and WHR

of the pictures may covary, and it is not clear whether the reported changes in the attractiveness judgments were due to changes in WHR, apparent BMI, or some mixture of the two. The obvious control experiment for this image set is to ask a set of observers to estimate the BMI or body mass of the figures to see whether their *perception* of the body's BMI changes before and after the surgical procedure.

This is not to say that WHR plays no role in attractiveness judgments. For example, the waveform deconstruction of body shape can be used as the basis of creating artificial body shape, where shape or weight can be held constant and, in this case, shape could be made to play a role in attractiveness judgments (Smith, Tovée, et al., 2007). In addition, in a recent study with interactive software program, which allowed female participants to create their ideal body, they produced low BMI bodies, which were also curvaceous with a low WHR (Crossley et al., 2012). So body shape probably does play a role in attractiveness judgments, but it seems to play a weaker role than overall body fat. This same result is found in our study using four groups—for all groups, BMI is a better predictor of ratings than WHR.

Our results further suggest that male and female observers rank female bodies for attractiveness in a very similar way. This finding is consistent with mate selection theory (e.g., Buss, 2003), which postulates not only that an individual will be able to judge the attractiveness of members of the opposite sex but also that he or she will know his or her attractiveness, mate value, relative to other members of the same sex. This finding is also consistent with previous attractiveness studies using these images that have shown a close correlation in the ranking of female attractiveness and health by male and female observers in other countries in the region, including Japan, Thailand, Indonesia, and Malaysia (e.g., Swami et al., 2006; Swami et al., 2008; Swami & Tovée, 2005, 2007a, 2007b).

The Rural-Chinese population seem to prefer a subtly different body shape (i.e., more curvy), and this is again most obvious in the fertility condition. This may partially be a secondary effect for a preference of a lower body weight (a body with a lower BMI also tends to be more curvy), but the size of the difference particularly for the fertility condition suggests a real preference for a more curvy shape. It is also clear that although the shape cues play a relatively small role in determining the behavioral judgments, they are consistently accounting for a greater proportion of the variance in all three Chinese groups than for the Caucasian participants. This implies a greater role for shape in the Chinese participants' judgments than for Caucasian participants.

One methodological difference between the Rural-Chinese group and the other three groups is that this group's data were collected on paper rather than

partially or completely online, and it is possible that this might lead to a difference in the rating behavior of this group. However, a large proportion of the U.K.-Chinese and HK-Chinese participants were also collected by paper as insufficient numbers were recruited online, and there was no significant difference in the way the image set was rated between the two techniques within each participant group. In addition, a previous study measured the preferences of Malaysian-Chinese participants in Kuala Lumpur using the same paper-based methodology and the same image set (Swami & Tovée, 2005). Their preferences were extremely similar to the HK-Chinese group with whom they share a similar socioeconomic environment. This implies that the differences in results between the Rural-Chinese participants and the other three groups are likely to reflect a real difference in preferences rather than methodological differences.

The preferences of the HK participants are consistent with other studies. A previous study using 3D "wire frames" of 31 Caucasian women found a preference for a low BMI in HK-Chinese men (Fan et al., 2004), and a study of HK beauty pageant data also suggest a preference for a low BMI and a relatively curvy body (Leung, Lam, & Sze, 2001). A previous study in a Mainland Chinese city using line drawings of female bodies seen from behind also showed a preference for a low body weight and a curvy shape (Dixson et al., 2007), but as these drawings covaried body weight and shape, it is not possible to say whether these preferences are based on body weight, shape, or a mixture of the two. The use of photographs of real women, which do not have this absolute covariation, as we have used here, allows for the relative importance of the different physical features in determining attractiveness preferences to be assessed. Using the same image set, a preference for a low BMI body has also been reported for urban groups in the region, including Japan, Thailand, Indonesia, and Malaysia (Swami et al., 2006; Swami et al., 2008; Swami & Tovée, 2005, 2007a, 2007b). However, these studies do not show the slightly enhanced importance of WHR in attractiveness judgments that is shown by the Chinese participants in this study relative to Caucasian participants.

An interesting feature of the data is that the peak BMI for attractiveness and health does not significantly alter between the Chinese groups, although both the SES and the visual diet explanations would predict changes should occur. The SES explanation would predict a preference for a higher ideal BMI because their absolute income and standard of living is the lowest of the four groups tested, living as they do in a rural environment and making their living predominantly through farming. It has been argued that in such environments, body fat is believed to be an indicator of wealth and prosperity (e.g., McGarvey, 1991), with obesity as a symbol of economic

success, femininity, and sexual capacity (Ghannam, 1997; Nasser, 2006). In less affluent societies, there is a positive relationship between increased SES and body weight (e.g., Scott et al., 2007; Swami & Tovée, 2005, 2007a; Tovée et al., 2006). Only high-status individuals would have the resources to have been able to put on body weight, which would explain why many of the world's cultures had or have ideals of feminine beauty that include plumpness (Anderson et al., 1992; Brown & Konner, 1987; Swami & Furnham, 2007), as it would have been advantageous for women to be able to store excess food as fat reserves in times of food surplus. Conversely, with the food abundance in many industrialized nations, fatty foods are easily available, and it is those with higher SES who are more able to keep their weight down (e.g., Furnham & Alibhai, 1983). In Western societies, fatness became associated with poverty, poor diet, and lack of slimming activities and exercise. Several previous studies, which have tested this hypothesis, have suggested that groups who have relatively low incomes and living standards do indeed prefer heavier, less curvy bodies, a result not replicated here (e.g., Swami & Tovée, 2005, 2007a; Tovée et al., 2007; Tovée et al., 2006).

By comparison, a visual diet explanation would predict that the Rural Chinese would prefer the lowest BMI body (as they see predominantly lower BMI bodies), and the U.K. Chinese (who see a larger number of heavier Caucasian bodies) would prefer a heavier BMI body (i.e., there would be a shift toward a preference for a heavier body type in our participants with increasing exposure to heavier bodies in their everyday life). The average BMI of Chinese people in rural Southern China is lower than that in urban areas (Folsom et al., 1994) and is significantly lower than in the HK or the United Kingdom (e.g., Health Survey for England, 2008; Chow, 2008). So the difference in the BMI of the bodies the different groups are exposed to seems to be real. In addition, there is a clear progression in the degree of acculturation in our participant groups. If we take this as an index of the degree of contact our participants are having with heavier, English-speaking Europeans, the visual diet hypothesis would predict a stepped shift in the BMI preferences between Chinese participants in the three visual environments as the degree of exposure to the heavier Western body type increases. The U.K.-Chinese participants with the most contact with heavier Europeans should prefer the heaviest body, and the Rural Chinese with no contact with Europeans would prefer the least, with the HK Chinese being intermediate between these two extremes. However, the predicted change in BMI is only a significant in the fertility judgments. This may be because although participants in HK and the United Kingdom will encounter more heavily built non-Chinese bodies, this effect may be offset by the influence of the Western media. The Western media constantly show thin, low BMI bodies as being

more healthy and attractive (e.g., Tovée et al., 1997; Voracek & Fisher, 2002), which tends to shift preferences toward a lower BMI (Grabe, Ward, & Hyde, 2008; Spettigue & Henderson, 2004) and may counteract the simple visual diet effect. A positive association of desired traits with bodies of different sizes and shapes has been shown to influence the judgments of participants (Boothroyd, Tovée, & Pollet, 2012) and this "valence learning" effect may serve to anchor the preferred body size to a lower BMI. Only for fertility, which is not generally linked to a specific body type in the media, does the simple visual diet effect show up in our participants and move the preferred BMI upward.

In addition, the relatively constant BMI preference for attractiveness and health judgments may also be partially due to differences in fat deposition and the associated health risks in Chinese populations. It has been suggested that what we perceive to be attractive is what we believe to be healthy and fertile (Buss, 2003; Thornhill & Grammer, 1999). The healthy BMI range for Caucasians is between 18.5 and 24.9, but for Chinese people it is between 18.5 and 22.9 (e.g., Choo, 2002; Deurenberg, Deurenberg-Yap, & Guricci, 2002; Shiwaku, Anuurad, Enkhmaa, Kitajima, & Yamane, 2004). This is a much narrower range in which body mass can fluctuate without running a high risk of type 2 diabetes, hypertension, and cardiovascular disease. In addition, the reason for this narrowing of BMI categories in Chinese people is that for a given BMI, Chinese and South Asian people have a significantly higher proportion of their mass made up from body fat, and most importantly, a significantly higher proportion of it is stored as visceral adipose tissue in the intra-abdominal cavity (Choo, 2002; Deurenberg et al., 2002; Shiwaku et al., 2004). This is a crucial and independent risk factor for cardiovascular disease. This is reflected in the risk factors associated with waist circumference. Caucasian women with a waist circumference of 88 cm (35 inches), or greater, are at high risk of developing cardiovascular disease and other related health problems. Whereas the corresponding waist circumference is significantly lower for Chinese women at 80 cm (31.5 inches; Lear, James, Ko, & Kumanyika, 2010; Wildman, Gu, Reynolds, Duan, & He, 2004; World Health Organization Expert Consultation, 2004). Thus, one might expect both a preference for a relatively low BMI, and a greater sensitivity to relative waist width (as indexed by WHR and WCR) in our Chinese participants. This seems to be the case in the Rural-Chinese sample with a consistent preference for a low BMI, and body shape cues do seem to have a greater role in the judgments of all the Chinese participants relative to our Caucasian participants.

The preference for a curvy body shape is most marked in the Rural-Chinese group. This may be explained by socioeconomic explanation factors.

The rural population is part of a farming community with significant amounts of manual labor. Manual labor in women reduces estrogen levels and increases WHR (i.e., they become less curvy; Cashdan, 2008). In such conditions, a curvy body could potentially signal a wealthy, high-status individual who does not need to carry out manual labor to make a living, which could make that individual attractive. Although Cashdan has argued the opposite. She proposes that the higher androgen to estrogen balance in women with a higher WHR suggests that they are better suited to manual labor and thus should be more attractive as potential partners. Our results seem to run contrary to her argument and suggests that an alternative explanation, such as a perceived higher SES with a higher WHR, as a potential basis for the judgments.

To summarize, the preferences for ideal BMI attractiveness and health are not significantly different between the three of our Chinese participants, despite the fact that they have both different socioeconomic environments and different visual diets. This may reflect the media influence in promoting thin bodies with high-status (visual valence effect) acting to maintain a thin ideal in the Chinese participants who have moved from a visual environment with a high proportion of thin ideals in Rural China. However, the results do show changes in ideal BMI preferences for fertility, which seems to reflect exposure to the larger Caucasian bodies (visual diet)—a tendency, which is not ameliorated by media influences.

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References

Altman, D. G. (1991). *Practical statistics for medical research*. London, England: Chapman & Hall.

Anderson, J. L., Crawford, C. E., Nadeau, J., & Lindberg, T. (1992). Was the Duchess of Windsor right? A cross-cultural view of the socio-biology of ideals of female body shape. *Ethology and Sociobiology*, *13*, 197-227.

Boothroyd, L. G., Tovée, M. J., & Pollet, T. V. (2012). Visual diet versus associative learning as mechanisms of change in body size preferences. *PLoS One*, *7*, e48691.

Brown, P. J., & Konner, M. (1987). An anthropological perspective on obesity. *Annals of New York Academy of Sciences*, *499*, 29-46.

Burnham, K. P., & Anderson, D. R. (2002). *Model selection and multimodel inference: A practical information-theoretic approach* (2nd ed.). New York, NY: Springer-Verlag.

Buss, D. M. (1998). The psychology of human mate selection: Exploring the complexity of the strategic repertoire. In C. Crawford & D. L. Krebs (Eds.), *Handbook of evolutionary psychology: Ideas, issues, and applications* (pp. 405-429). Mahwah, NJ: Erlbaum.

Buss, D. M. (2003). *The evolution of desire* (2nd ed.). New York, NY: Basic Books.

Cashdan, E. (2008). Waist-to-hip ratio across cultures: Trade-offs between androgen- and estrogen-dependent traits. *Current Anthropology*, *49*, 1099-1107

Choo, V. (2002). WHO reassesses appropriate body-mass index for Asian populations. *The Lancet*, *36*, 235.

Chow, C. C. (2008). Dietary habits, physical activity and obesity in Hong Kong residents. *Obesity Reviews*, *9* (Suppl. 1), 104–106

Cornelissen, P. L., Hancock, P. J. B., Kiviniemi, V. W., George, H. R., & Tovée, M. J. (2009). Patterns of eye-movements when male and female observers judge female attractiveness, body fat and waist-to-hip ratio. *Evolution and Human Behavior*, *30*, 417-428.

Cornelissen, P. L., Tovée, M. J., & Bateson, M. (2009). Patterns of subcutaneous fat deposition and the relationship between body mass index and waist-to-hip ratio: Implications for models of physical attractiveness. *Journal of Theoretical Biology*, *256*, 343-350.

Crossley, K. L., Cornelissen, P. L., & Tovée, M. J. (2012). What is an attractive body? Using an interactive 3D program to create the ideal body for you and your partner. *PLoS One*, *7*, e50601.

Deurenberg, P., Deurenberg-Yap, M., & Guricci, S. (2002). Asians are different from Caucasians and from each other in their body mass index/body fat per cent relationship. *Obesity Reviews*, *3*, 141-146.

Dixson, B. J., Dixson, A. F., Li, B., & Anderson, M. J. (2007). Studies of human physique and sexual attractiveness: Sexual preferences of men and women in China. *American Journal of Human Biology*, *19*, 88-95.

Fan, J., Dai, W., Qian, X., Chau, K. P., & Liu, Q. (2007). Effects of shape parameters on the attractiveness of a female body. *Perceptual and Motor Skills*, *105*, 117-132.

Fan, J., Liu, F., Wu, J., & Dai, W. (2004). Visual perception of female physical attractiveness. *Proceedings of the Royal Society of London. Series B*, *271*, 347-352.

Folsom, A. R., Yihe, L., Rao, X., Cen, R., Zhang, K., Liu, X., . . . Dennis, B. H. (1994). Body mass, fat distribution and cardiovascular risk factors in a lean population of south China. *Journal of Clinical Epidemiology*, *47*, 173-181.

Frisch, R. E. (1988). Fatness and fertility. *Scientific American*, *258*, 88-95.

Furnham, A., & Alibhai, N. (1983). Cross-cultural differences in the perception of female body-shapes. *Psychological Medicine*, *13*, 829-837.

Furnham, A., Swami, V., & Shah, K. (2006). Female body correlates with attractiveness and other ratings. *Personality and Individual Differences*, *41*, 443-454.

Furnham, A., Tan, T., & McManus, C. (1997). Waist-to-hip ratio and preferences for body shape: A replication and extension. *Personality and Individual Differences*, *22*, 539-549.

George, H. R., Swami, V., Cornelissen, P. L., & Tovée, M. J. (2008). Preferences for body mass index and waist-to-hip ratio do not vary with observer age. *Journal of Evolutionary Psychology*, *6*, 207–218

Ghannam, F. (1997). *Fertile, plump and strong: The social construction of female body in low income* (Monographs in Reproductive Health Number No. 3). Cairo, Egypt: Population Council Regional Office for West Asia and North Africa.

Grabe, S., Ward, L. M., & Hyde, J. S. (2008). The role of the media in body image concerns among women: A meta-analysis of experimental and correlational studies. *Psychological Bulletin*, *134*, 460-476.

Health Survey for England, 2008. National Centre for Social Research and University College London. Department of Epidemiology and Public Health. UK Data Archive, Colchester, Essex.

Henss, R. (1995). Waist-to-hip ratio and attractiveness: A replication and extension. *Personality and Individual Differences*, *19*, 479–488

Henss, R. (2000). Waist-to-hip ratio and female attractiveness. Evidence from photographic stimuli and methodological considerations. *Personality and Individual Differences*, *28*, 501-513.

Holliday, I. E., Longe, O. A., Thai, N. J., Hancock, P. J. B., & Tovée, M. J. (2011). BMI not WHR modulates BOLD fMRI responses in a sub-cortical reward network when participants judge the attractiveness of human female bodies. *PLoS One*, *6*, e27255.

Jasienska, G., Ziomkiewicz, A., Ellison, P., Lipson, S., & Thune, I. (2004). Large breasts and narrow waists indicate high reproductive potential in women. *Proceedings of the Royal Society of London. Series B*, *271*, 1213-1217.

Lake, J. K., Power, C., & Cole, T. J. (1997). Women's reproductive health: The role of body mass index in early and adult life. *International Journal of Obesity*, *21*, 432-438.

Lear, S. A., James, P. T., Ko, G. T., & Kumanyika, S. (2010). Appropriateness of waist circumference and waist-to-hip ratio cut-offs for different ethnic groups. *European Journal of Clinical Nutrition*, *64*, 42-61.

Leopold, D. A., O'Toole, A. J., Vetter, T., & Blanz, V. (2001). Prototype-referenced shape encoding revealed by high-level after effects. *Nature Neuroscience*, *4*, 89-94.

Leung, F., Lam, S., & Sze, S. (2001). Cultural expectations of thinness in Chinese women. *Eating Disorders*, *9*, 339-350.

Lin, Y.-C., Wang, M. J., & Wang, E. M. (2004). The comparisons of anthropometric characteristics among four peoples in East Asia. *Applied Ergonomics*, *35*, 173-178.

Manson, J. E., Willet, W. C., Stampfer, M. J., Colditz, G. A., Hunter, D. J., Hankinson, S. E., . . . Speizer, F. E. (1995). Body weight and mortality among women. *New England Journal of Medicine*, *333*, 677-685.

Marin, G., Sabogal, F., Marin, B. V., Otero-Sabogal, R., & Perez-Stable, E. J. (1987). Development of a short acculturation scale for Hispanics. *Hispanic Journal of Behavioral Science*, *9*, 183-205.

McGarvey, S. (1991). Obesity in Samoans and a perspective in its aetiology in Polynesians. *American Journal of Clinical Nutrition*, *53*, 86-94.

Miller, G. F. (1998). How mate choice shaped human nature: A review of sexual selection and human evolution. In C. Crawford & D. Krebs (Eds.), *Handbook of evolutionary psychology: Ideas, issues, and applications* (pp. 87-129). Mahwah, NJ: Lawrence Erlbaum.

Motulsky, H. J., & Christopoulos, A. (2004). *Fitting models to biological data using linear and nonlinear regression*. New York, NY: Oxford University Press.

Nasser, M. (2006). Eating disorders across cultures. *Psychiatry*, *5*, 392-395.

Office for National Statistics. (2009). *Labour market earnings*. Retrieved from http://www.statistics.gov.uk/cci/nugget.asp?id=285

Puhl, R. M., & Boland, F. J. (2001). Predicting female physical attractiveness: Waist-to-hip ratio versus thinness. *Psychology, Evolution & Gender*, *3*, 27-46.

Reid, R. L., & van Vugt, D. A. (1987). Weight related changes in reproductive function. *Fertility and Sterility*, *48*, 905-913.

Rilling, J. K., Kaufman, T. L., Smith, E. O., Patel, R., & Worthman, C. M. (2009). Abdominal depth and waist circumference as influential determinants of human female attractiveness. *Evolution and Human Behavior*, *30*, 21-31.

Scott, I., Bentley, G. R., Tovée, M. J., Ahamed, F. U., Magid, K., & Sharmeen, T. (2007). An evolutionary perspective on male preferences for female body shape. In A. Furnham & V. Swami (Eds.), *The body beautiful: Evolutionary and sociocultural perspectives* (pp. 65-87). Basingstoke, UK: Palgrave Macmillan.

Shiwaku, K., Anuurad, E., Enkhmaa, B., Kitajima, K., & Yamane, Y. (2004). Appropriate BMI for Asian populations. *The Lancet*, *363*, 1077.

Singh, D. (1993). Adaptive significance of female physical attractiveness: Role of waist-to-hip ratio. *Journal of Personality and Social Psychology*, *65*, 292-307.

Singh, D. (1994). Is thin really beautiful and good? Relationship between waist-to-hip ratio (WHR) and female attractiveness. *Personality and Individual Differences*, *16*, 123-132.

Singh, D., & Randall, P. K. (2007). Beauty is in the eye of the plastic surgeon: Waist-hip ratio (WHR) and women's attractiveness. *Personality and Individual Differences*, *43*, 329-340.

Smith, K. L., Cornelissen, P. L., & Tovée, M. J. (2007). Color 3D bodies and judgments of human female attractiveness. *Evolution and Human Behavior*, *28*, 48-54.

Smith, K. L., Tovée, M. J., Hancock, P., Bateson, M., Cox, M. A. A., & Cornelissen, P. L. (2007). An analysis of body shape attractiveness based on image statistics: Evidence for a dissociation between expressions of preference and shape discrimination. *Visual Cognition*, *15*, 1-27.

Spettigue, W., & Henderson, K. A. (2004). Eating disorders and the role of the media. *Canadian Child Adolescent Psychiatry Review*, *13*, 16-19.

Sugiyama, L. S. (2004). Is beauty in the context-sensitive adaptations of the beholder? Shiwiar use of waist-to-hip ratio in assessment of female mate value. *Evolution and Human Behavior*, *25*, 51-62.

Swami, V., Caprario, C., Tovée, M. J., & Furnham, A. (2006). Female physical attractiveness in Britain and Japan: A cross-cultural study. *European Journal of Personality*, *20*, 69-81.

Swami, V., & Furnham, A. (2007). *The body beautiful: Evolutionary and socio-cultural perspectives*. Basingstoke, UK: Palgrave Macmillan.

Swami, V., Knight, D., Tovée, M. J., Davies, P., & Furnham, A. (2007). Preferences for female body size in Britain and the South Pacific. *Body Image*, *4*, 219-223.

Swami, V., Neto, F., Tovée, M. J., & Furnham, A. (2007). Preferences for female body weight and shape in three European countries. *European Psychologist*, *12*, 220-228.

Swami, V., & Tovée, M. J. (2005). Female physical attractiveness in Britain and Malaysia: A cross-cultural study. *Body Image*, *2*, 115-128.

Swami, V., & Tovée, M. J. (2006). Does hunger influence judgments of female physical attractiveness? *British Journal of Psychology*, *97*, 353-363.

Swami, V., & Tovée, M. J. (2007a). Differences in attractiveness preferences between observers in low- and high-resource environments in Thailand. *Journal of Evolutionary Psychology*, *5*, 149-160.

Swami, V., & Tovée, M. J. (2007b). The relative contribution of profile body shape and weight to judgements of women's physical attractiveness in Britain and Malaysia. *Body Image*, *4*, 391-396.

Tassinary, L. G., & Hansen, K. A. (1998). A critical test of the waist-to-hip ratio hypothesis of female physical attractiveness. *Psychological Science*, *9*, 150-155.

Thornhill, R., & Gangestad, S. W. (1999). Facial attractiveness. *Trends in Cognitive Sciences*, *3*, 452-460.

Thornhill, R., & Grammer, K. (1999). The body and face of woman: One ornament that signals quality? *Evolution and Human Behavior*, *20*, 105-120.

Tovée, M. J., & Cornelissen, P. L. (1999). The mystery of female beauty. *Nature*, *399*, 215-216.

Tovée, M. J., & Cornelissen, P. L. (2001). Female and male perceptions of female physical attractiveness in front-view and profile. *British Journal of Psychology*, *92*, 391-402.

Tovée, M. J., Edmonds, L., & Vuong, Q.C. (2012). Categorical perception of human female physical attractiveness and health. *Evolution and Human Behavior*, 33, 85-93.

Tovée, M. J., Emery, J. L., & Cohen-Tovée, E. M. (2000). The estimation of body mass index and physical attractiveness is dependent on the observer's own body mass index. *Proceedings of the Royal Society of London, Series B*, *267*, 1987-1997.

Tovée, M. J., Furnham, A., & Swami, V. (2007). Healthy body equals beautiful body? Changing perceptions of health and attractiveness with shifting socioeconomic status. In V. Swami & A. Furnham (Eds.), *Body beautiful: Evolutionary and sociocultural perspectives* (pp. 108-128). Basingstoke, UK: Palgrave Macmillan.

Tovée, M. J., Hancock, P. J. B., Mahmoodi, S., Singleton, B. R. R., & Cornelissen, P. L. (2002). Human female attractiveness: Waveform analysis of body shape. *Proceedings of the Royal Society of London, Series B*, *269*, 2205-2213.

Tovée, M. J., Maisey, D. S., Emery, J. L., & Cornelissen, P. L. (1999). Visual cues to female physical attractiveness. *Proceedings of the Royal Society of London, Series B*, *266*, 211-218.

Tovée, M. J., Mason, S., Emery, J. L., McClusky, S. E., & Cohen-Tovée, E. M. (1997). Super models: Stick insects or hour glasses. *The Lancet*, *350*, 1474-1475.

Tovée, M. J., Reinhardt, S., Emery, J. L., & Cornelissen, P. L. (1998). Optimum body-mass index and maximum sexual attractiveness. *The Lancet*, *352*, 548.

Tovée, M. J., Swami, V., Furnham, A., & Mangalparsad, R. (2006). Changing perceptions of attractiveness as observers are exposed to a different culture. *Evolution and Human Behavior*, *27*, 443-456.

Tukey, J. W. (1977). *Exploratory data analysis*. Reading, MA: Addison-Wesley.

Voracek, M., & Fisher, M. L. (2002). Shapely centrefolds? Temporal change in body measures: Trend analysis. *British Medical Journal*, *325*, 1447-1448.

Wang, J. X., Davies, M., & Norman, R. J. (2000). Body mass and probability of pregnancy during assisted reproduction to treatment: Retrospective study. *The Lancet*, *321*, 1320-1321.

Wass, P., Waldenstrom, U., Rossner, S., & Hellberg, D. (1997). An android body fat distribution in females impairs the pregnancy rate of in vitro fertilization-embryo transfer. *Human Reproduction*, *12*, 2057-2060.

Wildman, R. P., Gu, D., Reynolds, K., Duan, X., & He, J. (2004). Appropriate body mass index and waist circumference cutoffs for categorization of overweight and central adiposity among Chinese adults. *American Journal of Clinical Nutrition*, *80*, 1129-1136.

Willet, W. C., Manson, J. E., Stampfer, M. J., Colditz, G. A., Rosner, B., Speizer, F. E., & Hennekens, C. H. (1995). Weight, weight change and coronary heart disease in women: Risk within the normal weight range. *Journal of the American Medical Association*, *273*, 461-465.

Winkler, C., & Rhodes, G. (2005). Perceptual adaptation affects attractiveness of female bodies. *British Journal of Psychology*, *96*, 141-154.

World Health Organization Expert Consultation. (2004). Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *The Lancet*, *363*, 157-163.

Zaadstra, B. M., Seidell, J. C., Van Noord, P. A., te Velde, E. R., Habbema, J. D., Vrieswijk, B., & Karbaat, J. (1993). Fat and female fecundity: Prospective study of body fat distribution on conception rates. *British Medical Journal*, *306*, 484-487.

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