

Female waist-to-hip ratio, body mass index and sexual attractiveness in China

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Abstract Men and women at Northwest University ($n=751$), Xi'an, China were asked to judge the attractiveness of photographs of female patients who had undergone micrograft surgery to reduce their waist-to-hip ratios (WHR). Micrograft surgery involves harvesting adipose tissue from the waist and reshaping the buttocks to produce a low WHR and an 'hourglass' female figure. This gynoid distribution of female body fat has been shown to correlate with measures of fertility and health. Significantly larger numbers of subjects, of both sexes, chose post-operative photographs, with lower WHRs, as more attractive than pre-operative photographs of the same women. Some patients had gained, and some had lost weight, post-operatively, with resultant changes in body mass index (BMI). However, these changes in BMI were not related to judgments of attractiveness. These results show that the hourglass female figure is rated as attractive in China, and that WHR, rather than BMI, plays a crucial role in such attractiveness judgments [*Current Zoology* 56 (2): 175–181, 2010].

Key words China, Waist-to-hip ratio, Body mass index, Female attractiveness, Sexual selection

Uniquely among the Primates, adult female human beings have large stores of body fat in their breasts, thighs, hips and buttocks (Dufour and Slather, 2002; Pond, 1997). Body composition is highly sexually dimorphic (Carter and Heath, 1990), so that women typically have 43.6% of their physique comprised of fat in comparison to 28.4% in men (Clarys et al., 1984).

Sexual dimorphism in human body composition is also reflected by sex differences in overall body shape. During adolescent development, secretion of oestrogen promotes storage of fat in the gluteofemoral region and breasts of girls (Merzenich et al., 1993; Boot et al., 1997). This gynoid distribution of body fat can be measured using the waist-to-hip ratio (WHR), which is calculated by dividing the circumference of the waist by the distance around the hips and buttocks. A low WHR, characterized by a slimmer waist in relation to wider hips, fuller thighs and larger buttocks, is linked to the onset of menarche in girls (Lassek and Gaulin, 2007), and the maintenance of regular, ovulatory cycles in adulthood (Moran et al., 1999; Van Hooff et al., 2000). Women with larger breasts and low WHRs have been shown to have higher circulating levels of 17 β -oestradiol and progesterone (Jasienska et al., 2004),

which are predictors of the probability of conception (Lipson and Ellison, 1996). In studies conducted in fertility clinics, women with lower WHRs have higher success rates in artificial insemination (Zaadstra et al., 1993) and in in-vitro fertilization programs (Waas et al., 1997). Women's WHRs increase as they age, possibly due to reduction in estrogen production (Kirschner and Samojlik, 1991). Women with lower WHRs have been found to have a younger age of first coitus and report having had more sexual partners than women with high WHRs (Hughes et al., 2004). The 'hourglass' female body constitution may therefore signal health and reproductive status.

It has been suggested that human morphology that conveys biological information relating to health and fertility was important in mate selection in ancestral environments (Barber, 1995; Symons, 1995; Thornhill and Gangestad, 1996). Evolutionary psychologists have proposed that selection has shaped human psychological faculties to attend to morphological features that honestly signal health and reproductive status (Buss, 2003; Grammer et al., 2003). Thus, it has been hypothesized that sexual selection via male partner preference may have driven the evolution of low WHR in women

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(Singh, 1993; 2006). Cross-culturally, men rate images of women with low WHRs (0.6–0.7) as most attractive in China (Dixson et al., 2007a), the USA and New Zealand (Dixson et al., 2008). Images depicting women with low WHRs are also preferred by men from Germany (Henss, 2000), England (Furnham et al., 1997) and Poland (Rozmus-Wrzesinska and Pawlowski, 2005).

Cross-cultural studies are critical for testing adaptive claims for sexual preferences for traits such as female WHR. Interestingly several studies conducted in less industrialized cultures have questioned whether a low female WHR of 0.7 is universally attractive to men. Among the Shiwiar of the Ecuadorian Upper Amazon, men selected images of women with a high body weight as most attractive (Sugiyama, 2004). However, when body weight was controlled for, images with WHRs of 0.7 and 0.8 were selected as more attractive (Sugiyama, 2004). Amongst the Matsigenka of Peru a WHR of 0.9 was most attractive (Yu and Shepherd, 1998). In Bakosiland, a community of subsistence farmers in rural Southwest Cameroon, a WHR of 0.8 was most attractive for both short and long-term relationships (Dixson et al., 2007b). Initial studies among the Hadza hunter-gatherers of Tanzania found that a WHR of 0.9 was more attractive to Hadza men (Wetsman and Marlowe, 1999). However, in a follow-up study using culturally appropriate images, Hadza men preferred a WHR of 0.6 (Marlowe et al., 2005).

WHR is a measure of body fat distribution and is positively correlated with another anthropometric measure, the body mass index (BMI), which equates to weight scaled for height ($BMI = \text{weight in Kilograms} / (\text{height in meters} \times \text{height in meters})$). It has been suggested that cross-cultural discordance in male preferences for images varying in WHR may be due to the use of stimulus line drawings as they confound the effects of WHR on female BMI (Tovée and Cornallisen, 2001). Women with a BMI of 20 are highly attractive to men in the UK (Tovée et al., 1999). Recently in a series of cross-cultural studies, which employed photographs of women that vary in BMI and WHR, differences in women's BMI were found to exert a greater influence than WHR on male ratings of female attractiveness (Japan: Swami et al., 2006; Malaysia: Swami and Tovée, 2005; Zululand in South Africa: Tovée et al., 2006). Thus, the roles played by BMI and WHR in de-

termining female attractiveness to men remain highly debated (Swami and Furnham, 2007).

As WHR and BMI are positively correlated it is very difficult to tease apart the contribution made by each variable to men's judgments of female attractiveness. A recently developed surgical procedure called micrograft surgery provides such an opportunity, as in this procedure adipose tissue is harvested from the waist and used to re-shape the buttocks of female patients. This surgical procedure reduces female WHR without altering BMI (Roberts et al., 2005¹; Singh and Randall, 2007). If female body fat distribution has been important in the evolution of male mate selection, as a fundamental and perhaps ancient cue to health and fecundity, then images with lower WHRs should be more attractive. To test this hypothesis, men and women from Xi'an, China, completed a questionnaire quantifying their preferences for photographs of women who had undergone micrograft surgery to reduce the waist-to-hip ratio.

1 Materials and methods

1.1 Patients and photographic images

Plastic surgeons obtained preoperative measurements of the waist-to-hip ratio (WHR) and body mass index (BMI) of ten North American women, who had requested micrograft surgery for cosmetic reasons (Singh and Randall, 2007). The measurements were repeated postoperatively, once healing was complete (Table 1). Five patients were of Caucasian and five were of African/Hispanic descent. Pre-operative and post-operative colour photographs were obtained of these same patients, directly from the back, and from an oblique angle (For examples of the images see Dixson et al., 2009; Singh and Randall, 2007). Although the stimulus set varies in ethnicity, if WHR is of importance in mate choice, then images with low WHRs should be more attractive irrespective of ethnicity. Furthermore, low WHR in women should also be attractive when the body is viewed from different angles. As such, two views were taken of each woman in order to control for possible effects of pose upon attractiveness judgments. The post-operative photographs were taken a few months after surgery, in order to allow for healing of any scars. To control for any differences in skin blemishes between the pre and post-operative photographs, the images were scanned into a computer and modeled using Adobe Photoshop version 7.0 in order to remove imperfections.

¹ Roberts R, Weinfeld A, Nguyen K, 2005. "Universal" and ethnic ideals of beautiful buttocks and how to create them surgically. Paper presented at the annual meeting of the American Society for Aesthetic Plastic Surgery, New Orleans, LA: April 30th, 2005.

Table 1 Waist-to-hip ratio (WHR) and body mass index (BMI) measurements of female patients before (pre-op) and after (post-op) micrograft surgery

Patient Patient No, Ethnicity	WHR		BMI	
	Pre-op	Post-op	Pre-op	Post-op
Group A				
1 Caucasian	0.84	0.75	21.13	21.46
2 Caucasian	0.93	0.78	22.84	23.92
3 Hispanic	0.84	0.75	25.06	25.32
4 Caucasian	0.78	0.68	26.31	26.47
5 African American	0.80	0.69	26.36	26.66
Group B				
6 Caucasian	0.74	0.70	25.18	24.05
7 African American	0.76	0.68	22.53	19.99
8 Hispanic	0.78	0.74	23.71	21.44
9 Caucasian	0.77	0.71	25.74	23.51
10 African American	0.80	0.75	21.95	20.82
Mean	0.80	0.72	24.80	23.36
SEM	0.01	0.01	0.60	0.748

All patients have lower post-operative WHRs. Group A have higher post-operative BMI whereas in Group B, BMI decreased slightly.

1.2 Participants

This study was conducted at Northwest University, in the city of Xi'an, Shaanxi Province, China. Students were asked to participate by completing a questionnaire in which they judged the attractiveness of photographs of women before, and after, micrograft surgery. Each questionnaire had a cover sheet (written in Mandarin Chinese) for demographic data, including the respondent's sex, age, and marital status. A total of 376 men (mean age 22.41 ± 3.25 years, range 18–52), none of whom were married, and 375 women (mean age 22.53 ± 3.46 years, range 18–45) completed the same questionnaire. Of these women, only 4% were married. Hence our sample consisted predominantly of unmarried university students, in their late teens and early twenties.

1.3 Procedure

A questionnaire was compiled which contained 20 pairs of images, in colour. Each pair of images was of one patient, showing her pre-operative and post-operative appearance, either in back-pose, or oblique pose. The position of each photograph in a pair was randomized (appearing on either the right or left side of the page) and likewise the order in which the pairs were presented to subjects who judged their attractiveness was randomized. Each subject was asked to view one pair of photographs at a time, and to choose the image that they judged to be more attractive. Subjects had no knowledge of the rationale for the study, or that the pairs of photographs they viewed were of the

same individuals.

1.4 Statistical Analyses

Wilcoxon Signed Rank tests were used to determine whether preferences for pre or post-operative images were statistically significant. Mann-Whitney U tests were conducted to test whether selections for post-operative images were affected by increases (Group A in Table 1) or decreases (Group B in Table 1) in female BMI. Spearman Rank correlation coefficients were calculated in order to test for possible correlations between the magnitude of post-operative changes in female WHR and BMI and judgments of their attractiveness.

2 Results

2.1 Postoperative changes in WHR and BMI

Micrograft surgery resulted in reductions in WHR in all ten women, from an average of 0.8 ± 0.017 to 0.72 ± 0.011 ($t = 7.364$, $df = 9$, $P < 0.001$). However, pre-operative and postoperative measurements of BMI for these same subjects did not differ significantly (Pre-op: Mean \pm SEM 24.8 ± 0.60 ; Post-op: 23.36 ± 0.75 , $t = 1.731$, $df = 9$, $P = 0.118$). Five women increased slightly in weight and five lost weight during the postoperative period (see Groups A and B, in Table 1).

2.2 Judgments of Attractiveness

Judgments of attractiveness were not significantly influenced by the different views of the body (back-posed versus oblique-posed) depicted in the photographs (Men:

$z=1.478$, $P = 0.139$; Women: $z=1.325$, $P = 0.185$). Thus, the data for both views were combined for further analysis. Men and women judged post-operative photographs to be significantly more attractive, as determined by Wilcoxon Signed Rank tests (Men: $z = 3.061$, $P < 0.01$; Women: $z = 3.603$, $P < 0.001$; Fig. 1).

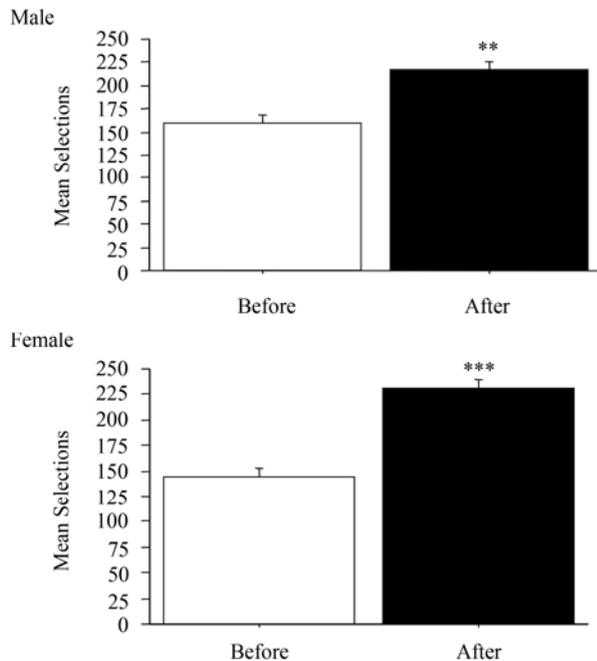


Fig. 1 Male and female preferences for pre- and post-operative images of women who had undergone micrograft surgery

Open histograms = pre-operative data. Black histograms = post-operative data. Data are the mean number of subject (+standard errors). ** $P < 0.01$, *** $P < 0.001$.

Post-operative increases, or decreases, in BMI in the women who were photographed for this study had no significant effect on attractiveness judgments. Thus, five women increased slightly in BMI after micrograph surgery, whilst five showed small decreases (Table 1). Mann-Whitney U tests were conducted to compare the attractiveness judgments of men and women concerning these two groups. A minimum U value of 23 would be required for such comparisons to be significant at the five percent level. However, both U values were well below this minimum (Men, $U = 8$; Women, $U = 6$) and hence were not statistically significant.

2.3 Attractiveness and post-operative changes in WHR and BMI

It is possible that male and female judgments of attractiveness might be affected by the magnitude of changes in post-operative WHR or BMI. Therefore, we tested whether the differences between pre and

post-operative WHR and BMI for each of the 10 patients used in this study correlated with numbers of selections for post-operative images. For WHR, this correlation was not significant for male preferences for either back-posed ($r_s = 0.039$, $P = 0.910$) or oblique-posed photographs ($r_s = 0.227$, $P = 0.495$). Likewise, there was no correlation between female selections for back-posed ($r_s = 0.176$, $P = 0.598$) or oblique-posed images ($r_s = 0.048$, $P = 0.884$). Nor did male preferences for post-operative images correlate with the degree of post-operative changes in BMI (back-posed: $r_s = 0.552$, $P = 0.098$; oblique-posed: $r_s = 0.627$, $P = 0.060$). Women's judgments were not correlated with the magnitude of post-operative changes in BMI for oblique-posed images ($r_s = 0.039$, $P = 0.906$). However, there was a small, significant effect regarding back-posed images ($r_s = 0.670$, $P < 0.05$). Thus, larger numbers of women showed a significant tendency to select back-posed images of patients whose post-operative BMI had increased slightly.

2.4 Female attractiveness as a function of ethnicity

It is possible that selections might be affected by the ethnicity of the patients that were rated for attractiveness. Five women were of African American or Hispanic descent, while the remaining five patients were Caucasian. Mann-Whitney U tests were conducted to compare attractiveness judgments concerning these two groups (i.e. African American/Hispanic versus Caucasian). A minimum U value of 23 would be required for such comparisons to be significant at the five percent level. However, both U values were well below this minimum and hence were not statistically significant (Men, $U = 6.5$; Women, $U = 10$). Thus, it is unlikely that the ethnicity of the patients used in this study affected attractiveness judgments.

2.5 Some variable effects concerning individual images

The current study has shown that Chinese men and women, given the choice of pre-operative and post-operative images if women who undergo micrograft surgery, are more likely to choose the post-operative images. These statistical effects refer to data on all 10 female patients, considered as a group. However, there was considerable variability regarding judgments of certain individual patients. Thus, images of 4 women were not consistently judged to be significantly more attractive post-operatively, by either male or female subjects. Patient no. 8 received 45% of post-operative selections from men and 52% from women. Post-operative images of patient no. 3 received 50% of

selections from men and 58% from women. Similarly, the post-operative image of patient no. 4 was chosen by 52% by men and 51% of women. Finally, the post-operative image of patient no. 9 received 50% of male selections and 54% of female selections. Some possible reasons for these individual variations are considered in the discussion section.

3 Discussion

The current study tested the role of waist-to-hip ratio (WHR) and body mass index (BMI) as possible determinants of female attractiveness, as judged by a sample of young Chinese men and women. In general, post-operative images with low WHRs were preferred over pre-operative images. Post-operative changes in BMI, by contrast, did not affect attractiveness judgments. These results are consistent with the hypothesis that low female WHR is a trait that is preferred as it may signal health, youth and fertility (Singh, 1993; 2006).

The role of WHR in male judgments of female physical attractiveness has been heavily critiqued in recent years (Swami and Tovée, 2005; Tovée et al., 1999). It has been claimed that previous research has confounded the effects of WHR and BMI by using line drawings as stimulus images (Tovée and Cornallisen, 2001). In response, these authors employed as stimuli photographs of women that ranged in BMI from 15 (severely underweight) to 30 (clinically obese), while WHRs fell in a range of 0.68–0.98 (e.g. Tovée et al., 1999). In the current study, photographs of women with a narrower range of BMIs, from 19.99–26.66, and a comparable range of WHRs (0.68–0.93) were used. Thus, the effect of BMI (i.e. the variance that BMI accounted for when measuring male preferences) that has been shown in previous studies may be due to the extreme range of BMIs in the stimulus sets. In the current study, Chinese men's preferences for post-operative images did not correlate with the magnitude of post-operative changes in BMI. Interestingly, larger numbers of women showed a significant tendency to select back-posed images of patients whose post-operative BMI had increased slightly. Thus, when controlling for BMI, men in China show a significantly higher preference for images of women with low WHRs.

These findings agree with results of recent work, conducted using the same questionnaire but with much smaller numbers of subjects, in Samoa, Komodo Island (Indonesia), Cameroon, and in New Zealand (Singh et

al., in press). These effects referred to the overall selections by subjects for pre-operative or post-operative images of the ten women who had chosen to undergo micrograft surgery. Interestingly, Chinese men and women showed considerable variability regarding judgments of certain individual patients. Because the sample sizes in the current study are relatively large (751 men and women) it is possible to examine these individual variations in more detail. Of the four most problematic sets of images (Patients 3, 4, 8 and 9) two are Caucasian (patients 4 and 9) and two are darker-skinned. Thus, ethnicity alone is not likely to provide an explanation for differences in attractiveness judgments, especially as there were no significant differences for such judgments of the 5 Caucasian versus the 5 African American/Hispanic patients. Interestingly, patient No. 8 showed only a very small post-operative reduction in her WHR (from 0.78–0.74). Cross-culturally, men's preferences for the post-operative images of this patient were quite low, ranging from 47% in Samoa to 63% in New Zealand and Cameroon. Thus, in this case, the findings in China are not unexpected. Patient No. 4 showed a larger post-operative decrease in WHR (from 0.78–0.68). This patient was not rated as highly attractive by men in other cultures; post-operative scores ranged from 45% in New Zealand to 67% in Indonesia (Komodo Island). Thus, again, the findings in China, involving much larger numbers of subjects, follow the pattern observed elsewhere. However Patients 3 and 9 present a different picture since their post-operative images were not rated as more attractive in China (50% of choices in both cases) and this was not the case cross-culturally. Patient No. 3 was given ratings of between 69%–85% in Samoa, Cameroon, Komodo Island and New Zealand. Patient No. 9 received ratings of between 78%–88% in these same cultures. Both patients underwent a marked change in body shape as a result of micrograft surgery and achieved an 'hour-glass' figure with low waist-to-hip ratio. Patient 3 showed a post-operative increase in BMI whereas Patient 9 showed a decrease. Thus, at the present time, we can offer no explanation as to why Chinese men and women's attractiveness judgments were evenly distributed between the pre and post-operative images of these patients.

The current study extends previous research (using computer-morphed drawings), showing that a female WHR of 0.6 is rated as most attractive by Chinese men (Dixson et al., 2007a). The use of photographic images of women who have undergone cosmetic micrograft

surgery has made it possible to test the effects of altering WHR on female attractiveness, while controlling for BMI. Significantly larger numbers of Chinese men and women chose as most attractive the post-operative images of women who had undergone micrograft surgery, with resultant reductions in their waist-to-hip ratios.

Some authors have strongly argued that BMI, rather than WHR, plays the critical role in female attractiveness to men (Tovée et al., 1999; Swami and Tovée, 2005). As regards the question of body mass, it is worth noting that among the polygynous anthropoid primates there are marked sex differences in body weight (Martin, Willner and Dettling, 1994). Sexual dimorphism in body weight is much less pronounced in humans, as they exhibit monogamy as well as polygyny in their mating systems (Ford and Beach, 1951; Chapais, 2008; Dixson, 2009). Human beings show greater sexual dimorphism in body composition (percentages of muscle and fat; Clarys et al., 1984) than they do in overall body weight. Singh (1993, 2002, 2006) suggests that women's large stores of body fat, which are essential for reproductive purposes, have also evolved via sexual selection as 'honest signals' of age, health and fecundity to men. The pronounced sexual dimorphism in body fat that occurs in humans is not found to the same extent among non-human primates. It has been suggested that sex differences in body fat composition arose in hominids ancestral to *Homo sapiens*, such as *H. ergaster* and *H. erectus* (Dixson, 2009). While the current study cannot confirm these speculations, it contributes to a large body of scientific evidence indicating that a low female WHR (in the range from 0.6-0.8) is a trait that men find highly attractive throughout a wide range of modern cultures.

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