Available online at www.sciencedirect.com
ScienceDirect
Personality and Individual Differences 43 (2007) 329–340
PERSONALITY AND INDIVIDUAL DIFFERENCES
www.elsevier.com/locate/paid

Beauty is in the eye of the plastic surgeon: Waist–hip ratio (WHR) and women's attractiveness

Devendra Singh [a,*], Patrick K. Randall [b]

[a] *Department of Psychology, 1 University Station, A8000, Austin, TX 78712, USA*
[b] *Institute for Psychiatry, Center for Drug and Alcohol Programs, Medical University of South Carolina, 67 President Street, PO Box 250861, Charleston, SC 29425, USA*

Received 21 August 2006; received in revised form 30 November 2006; accepted 5 December 2006
Available online 31 January 2007

Abstract

Attractiveness conveys reliable information about a woman's age, health, and fertility. Body fat distribution, as measured by waist-to-hip ratio (WHR), is a reliable cue to a woman's age, health, and fertility, and affects judgment of women's attractiveness. WHR is positively correlated with overall body weight or body mass index (BMI). Some researchers have argued that BMI, rather than WHR, affects judgments of female attractiveness. To evaluate the role of WHR, independent of BMI, we secured photographs of pre- and post-operative women who have undergone micro-fat grafting surgery. In this surgery, surgeons harvest fat tissue from the waist region and implant it on the buttocks. Post-operatively, all women have a lower WHR but some gain weight whereas others lose body weight. Results indicate that participants judge post-operative photographs as more attractive than pre-operative photographs, independent of post-operative changes in body weight or BMI. These results indicate that WHR is a key feature of women's attractiveness.
© 2006 Published by Elsevier Ltd.

Keywords: Female attractiveness; BMI; Mate selection; WHR

* Corresponding author. Tel.: +1 512 475 7013.
E-mail address: singh@psy.mail.utexas.edu (D. Singh).

0191-8869/$ - see front matter © 2006 Published by Elsevier Ltd.
doi:10.1016/j.paid.2006.12.003

1. Introduction

A large body of evidence indicates that physical attractiveness is consensual (people agree about who is and is not attractive both within and across cultures) and is an important determinant of interpersonal and romantic relationships (Langlois et al., 2000; Sugiyama, 2005). Evolutionary psychologists offer a clear and testable explanation for the functional significance of attractiveness: physical attractiveness provides reliable cues to a person's health and reproductive potential (Grammer, Fink, Moller, & Thornhill, 2003; Symons, 1979). It is argued that a recurrent adaptive problem ancestral people faced was to assess prospective mates according to "mate value" (attractiveness as a mate relative to available others in local mating market: Buss, 2003). The variables that determine mate value, such as genetic quality, health, and fertility, cannot be directly observed but there are specific observable characteristics of the body that reliably convey this information. Sexual selection thus produces mechanisms of mate selection that extract and process information based on specific observable characteristics of the body, linked to good health and reproductive ability (Symons, 1979).

A straightforward test of this evolutionary explanation would be to identify a feature of the body known to be linked with health and reproductive capability and to demonstrate that the systematic variation in that feature produces systematic changes in judgments of attractiveness. Body fat distribution, as measured by waist-to-hip ratio (WHR), may be an ideal feature. First, WHR, unlike overall body weight, is an unambiguous indicator of age in men and women (Rebuffe-Scrive, 1988). Prior to puberty, the sexes have similar WHR because body fat distribution is essentially similar. However, during puberty, increases in sex hormones induce an increase in pelvic width and regulate the anatomical location of body fat deposits. Estrogen selectively inhibits fat deposition in abdominal and waist regions and facilitates fat deposition in the gluteofemoral (buttocks and thighs) region in the females, whereas testosterone inhibits fat depositions in the gluteofemoral region and facilitates fat deposition on the waist and upper body in the males (Björntorp, 1987). After puberty, healthy women have a WHR between 0.67 and 0.79, whereas healthy men have a WHR between 0.8 and 0.95 (National Academy of Sciences, 1991). As women age and their production of estrogen decreases, their WHR moves into the male range (Kirschner & Samojlik, 1991). WHR, thus, reliably signals a woman's reproductive (pre-, post-pubertal, pre-, post-menopausal) status unlike any other observable body feature. Second, WHR after puberty provides a powerful cue to biological sex, and selecting the correct sex for mating is an adaptive problem that must be solved by every sexually reproducing species (Trivers, 1972).

Third, WHR is a reliable indicator of reproductive capability of pre-menopausal women. Compared to women with high WHR, women with a low WHR have fewer irregular menstrual cycles (Van Hooff et al., 2000), optimal sex hormone profiles (Jasienska, Ziomkiewicz, Ellison, Lipson, & Thune, 2004), ovulate more frequently (Moran et al., 1999), and have lower endocervical pH, which favors sperm penetration (Jenkins, Brook, Sargeant, & Cooke, 1995). Low WHR is also an independent predictor of pregnancy in women attending an artificial insemination clinic (Zaadstra et al., 1993) and in women attempting in vitro embryo fertilization transfer (Waas, Waldenstrom, Rossner, & Hellberg, 1997).

Fourth, women with low WHR have lower risk of heart diseases, stroke, type II diabetes, gallbladder disease, kidney diseases, various cancers (breast, endometrial, ovarian), and premature death. (For a review see Singh, 1993a, 2006.) Women with low WHR also cope with stress (as measured by cortisol release) more efficiently (Epel et al., 2000) and report fewer episodes of

depression than women with higher WHR (Nelson, Palmer, Pedersen, & Miles, 1999). Women less susceptible to health problems would likely have more energy to attend to their family and children, and because many health problems are heritable, their offspring would receive the genetic gift of good health.

Fifth, WHR is a powerful cue to pregnancy status, particularly as pregnancy progresses (Rebuffe-Scrive, 1987). Selection should create a preference in men to mate with fecund, and hence non-pregnant women.

Given that WHR is a signal of youth, health, biological sex, non-pregnancy status, and reproductive capability, do changes in the size of WHR cause changes in judgment of female attractiveness? To investigate this issue, Singh (1993a, 1993b) developed 12 line drawings of female figures representing three body weight categories (underweight, normal, overweight) and two levels of feminine (0.7, 0.8), and two levels of masculine (0.9 and 1.0) WHR within each body weight category. The findings indicate that variations in WHR, in female figures, produce systematic changes in the judgments of attractiveness. Participants rated figures with a lower WHR as more attractive than figures with a higher, more masculine, WHR in each of the weight categories. These findings, using line drawings developed by Singh (1993a), now have been replicated (for exception see Yu & Shepard, 1998; Marlow & Wetsman, 2001) with African–Americans (Markey, Tinsley, Ericksen, Ozer, & Markey, 2002), in Great Britain (Furnham, Tan, & McManus, 1997), Germany (Henss, 1995), Australia (Connolly, Slaughter, & Mealey, 2004), Indonesia (Singh & Luis, 1995), the Azore Island, the African country of Guinea Bissau (Singh, 2004), and in the Shiwiar Tribes of East Ecuador (Sugiyama, 2004).

In the original studies, the relationship between attractiveness and WHR depended on body weight category; the normal weight figure with 0.7 WHR was judged most attractive, followed by the underweight figure, whereas the overweight figure was judged not to be attractive (Singh, 1993a, 1993b). Singh (1993b) concluded that, "... neither body weight, nor WHR alone can explain attractiveness. To be attractive, women must have a low WHR and deviate little from normal weight" (pp. 310–311).

In spite of this reported intricate relationship between WHR and body weight, some researchers have opted to treat body weight or degree of obesity (body mass index – BMI) and WHR as independent variables and have reported that body weight accounts for more variance than WHR in female attractiveness judgments (Tassinary & Hansen, 1998; Tovee, Reinhardt, Emery, & Cornelissen, 1998). Tovee and Cornelissen (1999) have even suggested that an attractiveness judgment based on WHR is an artifact of BMI. They argue that reduction of the size of WHR, for example, from 0.8 to 0.7, reduces BMI regardless of body weight category and that this reduction in BMI is responsible for attractiveness ratings for figures with low WHR.

These arguments are, however, based on misunderstandings about the nature of WHR. WHR describes the nature of body fat distribution, and therefore bodyweight is critical in evaluating the effect of WHR on attractiveness judgments. It is also important to take into account total body fat, or BMI, a feature that people in ancestral environments would have encountered when examining the effects of WHR (the nature of body fat distribution) on attractiveness. Given the cycles of famine, feast, and workload, obesity would have been rare. There would have been some emaciated people suffering from disease or malnutrition and they would not likely have been desirable mates. The selection process would have stabilized the preference for population-typical average body weight.

Additionally, due to seasonally availability of food supply, body weight would have frequently fluctuated in ancestral environments. WHR, unlike total body weight, does not significantly change if weight loss or gain is not greater than 8 kg (Kissebah, Evans, Peiris, & Wilson, 1985). WHR is, therefore, a reliable signal of women's health and fertility, in spite of short-term body weight fluctuation.

Nevertheless, because WHR and BMI are correlated, it can be difficult to conclude that changes in attractiveness judgments are due to WHR alone. One needs to assess the relative contribution of WHR and BMI to attractiveness ratings. Some researchers have used *post-hoc* "variance accounted" for methods to assess the relative contribution of WHR and BMI (Tovee et al., 1998). However, these methods are overly sensitive to the range of the independent variable in the stimulus set. The optimal solution is to use stimulus for which BMI and WHR are independent. A recent surgical technique provides a means to examine the role of different sizes of WHR on attractiveness, independent of BMI. The surgical procedure includes liposuction of the circumference of the waist and then using purified fat cells to graft to the buttocks (Roberts, III, Weinfeld, & Nguyen, 2005). This procedure both narrows the waist and enhances the buttocks (without affecting pelvic morphology), having a synergetic effect on WHR without altering BMI. In his practice, aesthetic plastic surgeon Roberts measures pre- and post-operative waist and buttocks circumferences and records pre- and post-operative BMI. Post-operative measurements and photographs are taken about two to three months after surgery to allow for healing and scar disappearance. Although all patients have a lower post-operative WHR, some patients gain weight and other patients lose weight post-operatively. These patients provide a unique opportunity to examine the independent effects of WHR and body weight, or BMI on attractiveness. Furthermore, because pre- and post-operative photographs of the same woman are evaluated, the contributions of other factors (e.g., skin complexion, dimples, and moles) are controlled. The current research tests the hypothesis that if WHR, more than BMI, affects attractiveness, participants will judge post-operative photographs as more attractive regardless of any change in BMI.

2. Method

2.1. Participants

A total of 66 Caucasian males (mean age = 30.7 years; range = 20–68 years) and 47 females (mean age = 28.2 years; range = 18–53 years) were tested. A packet containing photographs and an attractiveness rating scale was given to various professional and semi-skilled workers (lawyers, doctors, accountants, computer data processors). Each participant individually rated the photographic material and placed the rating scale in an envelope that was collected by the researchers.

2.2. Photographic material

Pre- and post-operative photographs of the plastic surgery patients were used. This surgical procedure does not reduce the body weight or BMI but redistributes the body fat. Plastic surgeons photographed the patient and obtained information about height, body weight, age, and

measured the patients' hip and waist circumferences prior to surgery and after surgery. We obtained 15 pre- and post-operative photographs (9 Caucasian, 4 Asian–American, and 2 African–American) showing a back or oblique view of their lower torso, including upper thighs. Post-operative photographs were taken two to three months after surgery. Ten patients had a higher BMI and five patients had a lower BMI after surgery. Permission to use these photographs for research was obtained from the patients.

2.3. Procedure

Participants rated the attractiveness of the pre- and post-operative photographs (reproduced on $8'' \times 11''$ white sheets of paper) either individually (single presentation) or a paired and presented together (pair presentation). In the single presentation condition (36 males and 21 females), the packet contained randomly arranged pre- and post-operative photographs of 15 patients. Participants were asked to assign attractiveness ratings to each person on a scale of 0–9 (0 = *not attractive at all*; 9 = *very attractive*). The participants were asked to complete their rating of each photograph before looking at the next photograph and not to change the attractiveness ratings once assigned. In the pair presentation condition (30 males and 26 females), each participant viewed the pair of pre- and post-operative photographs of the patient presented together and rated each photograph for attractiveness using the same 0–9 scale. Participants were not told that both photos in the pair were of the same woman.

3. Results

Table 1 shows pre-operative BMI and WHR, pre- to post-operative changes in BMI and WHR and differences in pre- to post-operative attractiveness ratings for paired and single presentation for all surgical patients. As expected, there was a dramatic pre- versus post-operative difference in WHR ($F(1,14) = 65.73$, $p < 0.0001$). BMI remained unchanged ($F(1,14) = p > 0.12$, $p = 0.73$). Patients were as likely to gain slightly in BMI as they were to lose. As evident from Table 1, post-operative photographs of all patients, regardless of whether post-operative BMI was higher or lower, were judged to be more attractive than their pre-operative photographs ($p < 0.001$, Wilcoxon signed rank test).

The two presentation methods produced similar results with correlations between the pre- and post-operative ratings and difference scores being 0.96, 0.97 and 0.92, respectively. All further results are based on the single presentation, although all conclusions are the same with pair presentation. The average intraclass correlation (random stimuli and random raters) was high, 0.95, suggesting high rater reliability. A multilevel model did not generate evidence ($p > 0.5$) of individual differences in level 1 regression coefficients (linear for BMI and quadratic for WHR) suggesting that all raters used similar judgments "styles".

An ANOVA revealed that mean attractiveness ratings were strongly affected by surgery ($F(1,14) = 148.7$, $p < 0.001$, d(relative to the pre-operative standard deviation) = 1.76). The slope of the line, relating pre-operative to post-operative ratings, was close to 1.0 ($b = 0.92$, not statistically different from 1.0). It is as if the surgery increased everyone's attractiveness rating by a constant amount around the intercept value of 2.6 ($t(14) = 4.55$, $p = 0.001$, versus 0). BMI in this

Table 1
Pre-operative BMI and WHR, pre-to-post operative changes in BMI and WHR and differences in pre-to-post-operative attractiveness ratings for paired and single presentation for all surgical patients

Pair #	Pre-operative		Pre–post-operative change			
			ΔAttractiveness rating			
	BMI	WHR	ΔBMI	ΔWHR	Pair presentation	Single presentation
1	21.13	0.84	0.33	−0.09	3.10	3.05
2	22.84	0.93	1.08	−0.15	1.21	1.79
3	22.53	0.76	−2.54	−0.08	1.72	1.16
4	23.71	0.78	−2.27	−0.04	4.09	3.70
5	26.36	0.80	0.30	−0.11	2.79	2.72
6	25.18	0.74	−1.13	−0.04	3.03	2.58
7	25.06	0.84	0.26	−0.09	2.31	2.33
8	26.31	0.78	0.16	−0.10	1.47	1.65
9	21.71	0.79	2.65	−0.18	0.53	0.98
10	21.28	0.91	0.09	−0.14	2.10	2.51
11	25.39	0.90	0.76	−0.12	2.10	1.82
12	25.37	0.83	0.94	−0.20	3.21	2.82
13	25.39	0.90	0.76	−0.20	2.64	2.86
14	25.74	0.77	−2.23	−0.06	2.07	2.47
15	21.95	0.80	−1.13	−0.05	3.36	3.07

sample did not predict attractiveness ratings in any combination (i.e. pre-operative BMI versus pre-operative ratings, pre-operative BMI versus post-operative BMI, and post-operative BMI versus post-operative ratings). Thus, alterations of WHR produce substantial changes in attractiveness ratings, regardless of whether there was an increase or decrease in post-operative BMI. There was, however, substantial variance in both pre- and post-operative ratings, but in each case, post-operative photographs, regardless of whether post-operative BMI was higher or lower, were judged to be more attractive that pre-operative photographs (see Fig. 1). This is strikingly obvious when pre- and post-operative photographs of a patient are observed (see Fig. 2). In spite of an increase in post-operative BMI, the post-operative photograph is judged to be more attractive than the lower BMI pre-operative photograph.

Clearly, many factors affect the relationship between WHR and attractiveness as evidenced from differences in post-operative ratings among patients. For example, post-operative, but not the pre-operative, ratings were a systematic quadratic function of the contemporaneous WHR. BMI entered alone or together with WHR showed no relationship with either pre- or post-operative ratings of attractiveness suggesting that pre-operative values of both parameters were outside the range in which these relationships can be demonstrated. Pre-operative ratings are highly predictive of post-operative ratings ($r = 0.808$, $r^2 = 0.653$, $p = 0.0003$). Thus, a number of factors (skin color, texture, etc.) may account for substantial variance in attractiveness rating (65%), in addition to WHR and BMI. Examination of post-operative attractiveness ratings controlling for pre-operative ratings (i.e. pre-operative ratings entered as the first block and WHR as the second block), in a non-linear regression or dummy-coded linear regression provides an uncontaminated assessment of the WHR/attractiveness relationship. This relationship is shown in Fig. 3. The pre-operative rating was a significant predictor ($B = 0.864$, $\mathrm{WE} = 0.147$, $t(11) = 5.861$, $p < 0.001$) of post-surgical attractiveness explaining 65% of the post-operative

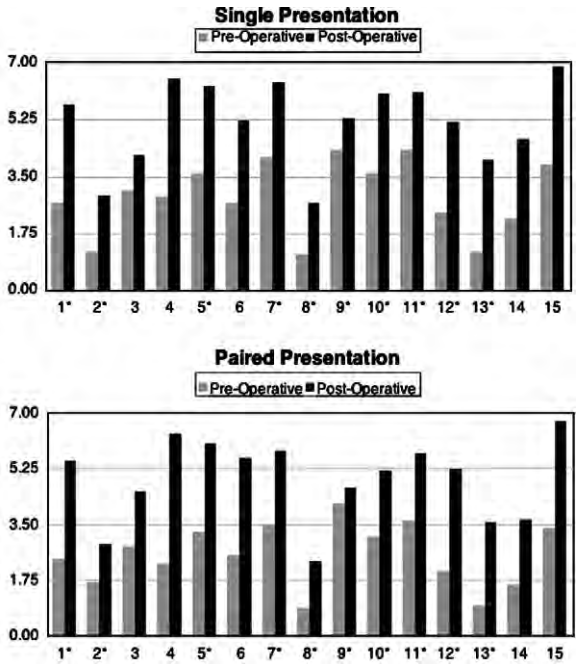

Fig. 1. Mean pre- and post-operative ratings for 15 patients using single and paired presentation of photographs. Asterisks (*) under the pair represent photographs of women who gained BMI post-operatively.

ratings. Additionally, WHR (centered quadratic) to the model explains an additional 17.9% (or) about half of the remaining variance, ($t(11) = 3.5$, $p = 0.005$). Maximum attractiveness occurs at a WHR of 0.732.

4. Discussion

Post-operative attractiveness ratings, corrected for the pre-operative ratings, are highly predicted by WHR. BMI, in the range investigated in this study, does not significantly predict attractiveness. Thus, the argument that previously reported affects of WHR on attractiveness are due to minor changes in BMI, is not supported. Furthermore, maximum attractiveness was found to be close to 0.7 (0.73), similar to findings of previous reports using line drawings (Singh, 1993a, 1993b). Similar effects of WHR on attractiveness has been reported by Roberts in more than 200 patients. "It has been my experience ... that body weight has a negligible effect on how attractive the body looks post-surgically or the judgment of attractiveness of their own by the patient. Rather, the critical variable in attractiveness is the proportionality of the shape and the size of the waist and buttocks ... A review of our data shows the best results have a waist-to-hip ratio of approximately 0.7 (their pre-operative WHR averaged 0.85)" (Personal communication, April, 28, 2005).

The summarized research provides additional empirical support for an evolutionary mate selection theory, according to which attractiveness is an indicator of phenotypical and genotypical

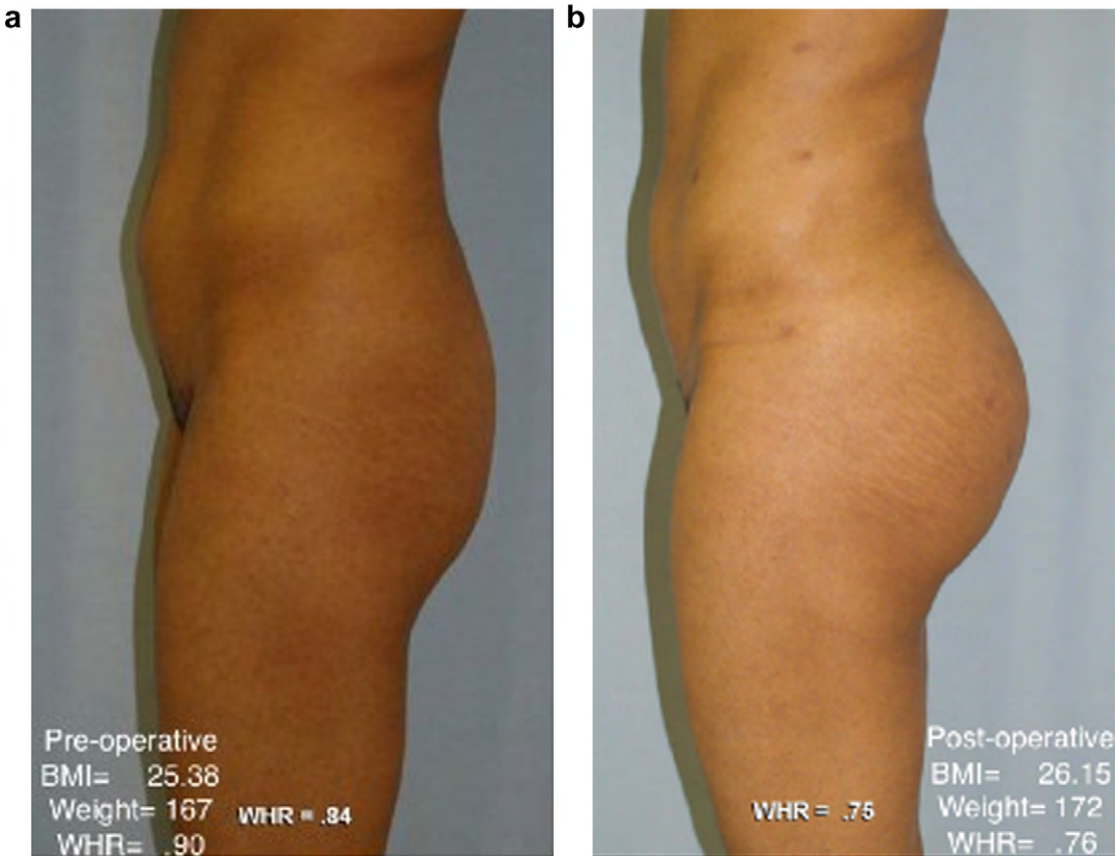

Fig. 2. Sample of a representative pre- and post-photograph. The pre-operative photograph (left) has lower BMI than post-operative photograph (right) and has a higher BMI and low WHR. Post-operative photograph is rated more attractive than pre-operative photograph, in spite of higher BMI.

qualities. First, there is accumulating evidence suggesting that WHR has a large heritable component, that cannot be accounted for by parent–child resemblance in total body weight or environmental condition (Donahue, Prineas, Gomez, & Hong, 1990; Nelson et al., 1999). Segregation analysis has provided evidence for the presence of genes for age and BMI adjusted WHR (Feitosa et al., 2000). Offspring of women with lower, more feminine, WHR would have inherited good health and would have been physically attractive to potential mates. Second, WHR is the only known body feature that tracks, in lock step, sex hormone and thus fertility in women. Women with low WHR have higher estrogen and progesterone levels during the ovulatory phase of the menstrual cycle than do body weight matched women with a high WHR (Jasienska et al., 2004). Kirchengast and Gartner (2002) report that during fertile phases of the menstrual cycle, there is a reduction in WHR, even in women with a low WHR. Finally, as pointed out before, WHR is an independent predictor of pregnancy (see Section 1).

If WHR is an important cue for mate choice, then it is important to show that variation in WHR leads to variation in mating success due to competition among rivals through contest, mate choice, or any other mechanisms of sexual selection. Women with low WHR flirt more often

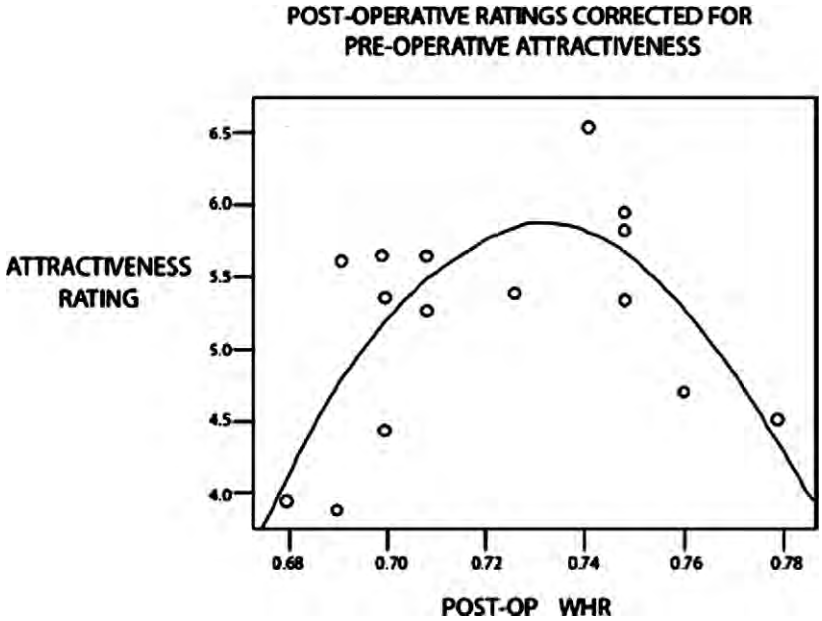

Fig. 3. Best-fitting quadratic relationship between post-operative WHR and post-operative attractiveness rating, controlling for pre-operative attractiveness ratings.

(Singh, 2004) and have more sex partners (Mikash & Bailey, 1999). Hughes and Gallup (2003) were the first to demonstrate the effect of WHR on female sexual behavior, independent of BMI. These investigators found that a woman with lower WHR reported earlier age of first sexual intercourse, had more sex partners, and engaged more often in sexual intercourse with men involved in other relationships. No such relationship was evident for BMI, except in predicting delay in age of first sexual intercourse. In another study, Hughes, Dispenza, and Gallup (2004) found that lower WHR was correlated with higher opposite sex rating of voice attractiveness, but there was no correlation between BMI and the voice attractiveness. Jamaican men with high genotypical and phenotypical quality (as measured by the degree of bilateral body part symmetry) prefer women with low WHR as a romantic mate (Jacobson, 2005).

Historical and modern manipulation by women to increase or decrease attractiveness are testaments to the importance of WHR. The popularity of corsets during the Victorian era (despite internal injuries caused to women) and fashionable clothing that highlights tiny waists and exaggerated hips cannot be explained by arguing that women were trying to decrease their body weight. Clothing and fashion can be made to make a political or personal statement (or may be designed for comfort), rather than for attracting the mating attention of prospective mates. When women attempt to convey that they are not sexually available they often deemphasize the body form (e.g., nun's habit, business suit, and the chador to hide the female body in Iran and some Arab countries). When the objective is to make oneself sexually alluring, a persistent method has been to emphasize the narrow waist, as it is historically evident in early Greek paintings and presently evident in Western female fashion using corsets, bustle, and other devices (Shorter, 1982). In a recent study, Rozmus-Wrzesinska and Pawlowski (2005) found that female

attractiveness judgments are influenced more by a change in female waist size, compared with changes in hip size. Women are aware of and seem to manipulate this evolved preference. For instance, when asked what they do to make themselves attractive to potential mates, young women most often report "sucking stomach in" as tactic after make-up application (Tooke & Camire, 1991). Taken together, it seems that the current trend of defining and assessing women's attractiveness solely according to bodyweight or BMI (e.g., Tovee et al., 1998) provides an incomplete and perhaps inaccurate picture of female attractiveness.

One limitation of the current study is that attractiveness judgments were made by white Caucasian men and women. It could be that, in some ethnic groups, the relative role of BMI and WHR may be different. The current study has certain methodological strengths. First, unlike most studies on attractiveness, we used photographs of ethnically diverse groups and used two different methods (single and paired photographs) to assess attractiveness: none of these variables significantly affect the results. Finally, we employed a technique, which allowed us to evaluate the relative contribution of BMI and WHR to attractiveness. This methodology allowed us to demonstrate that WHR is a key determinant of female attractiveness, independent of BMI.

Acknowledgements

We would like to thank Jeffrey Fletcher, Bobbie Lanier, Adam Webb, Valerie Foster and Adrian Singh for help in collecting data and to Sean Conlan and Todd Shackelford for comments on the draft of this paper.

References

Björntorp, P. (1987). Fat cell distribution and metabolism. In R. J. Wurtman & J. J. Wurtman (Eds.). *Human obesity* (pp. 66–72). New York: New York Academy of Sciences.

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

Connolly, J., Slaughter, V., & Mealey, L. (2004). The development of preferences for specific body shapes. *Journal of Sex Research, 41*(1), 5–15.

Donahue, R. P., Prineas, R. J., Gomez, O., & Hong, C. (1990). Familial resemblance of body fat distribution. The Minneapolis Children's Blood Pressure Study. *International Journal of Obesity, 16*, 161–167.

Epel, E. S., McEwen, B., Seeman, T., Matthews, K., Castellazo, G., Brownell, K. D., et al. (2000). Stress and body shape: stress-induced cortisol secretion is consistently greater among women with central fat. *Psychosomatic Medicine, 62*, 623–632.

Feitosa, M. F., Borecki, I., Hunt, S. C., Arnett, D. K., Rao, D. C., & Province, M. (2000). Inheritance of the waist-to-hip ratio in the national heart, lung, and blood institute family heart study. *Obesity Research, 8*, 294–301.

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

Grammer, K., Fink, B., Moller, A. P., & Thornhill, R. (2003). Darwinian aesthetics: sexual selection and the biology of beauty. *Biological Review, 78*, 385–407.

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

Hughes, S. M., Dispenza, F., & Gallup, G. G. Jr., (2004). Ratings of voice attractiveness predicts sexual behavior and body configuration. *Evolution and Human Behavior, 25*, 294–304.

Hughes, S. M., & Gallup, G. G. Jr., (2003). Sex differences in morphological predictors of sexual behavior: shoulder to hip and waist to hip ratios. *Evolution and Human Behavior, 24*, 173–178.

Jacobson, A. S. (2005). The effect of fluctuating asymmetry on attractiveness on self-perception, self-deception, and preference for others in rural Jamaica. *Dissertation Abstract: International Section A: Humanities and Social Sciences, 66*, 1839.

Jasienska, G., Ziomkiewicz, A., Ellison, P. T., Lipson, S. F., & Thune, I. (2004). Large breasts and narrow waists indicate high reproductive potential. *Proceedings of the Royal Society of London, series B, Biological Sciences, 271*, 1213–1217.

Jenkins, J. M., Brook, P. F., Sargeant, S., & Cooke, I. D. (1995). Endocervical mucus pH is inversely related to serum androgen levels and waist-to-hip ratio. *Fertility Sterility, 63*, 1005–1008.

Kirchengast, S., & Gartner, M. (2002). Changes in fat distribution (WHR) and body weight across the menstrual cycle. *Collegium Antropologicum, 26*, 47–57.

Kirschner, M. A., & Samojlik, E. (1991). Sex hormone metabolism in upper and lower body obesity. *International Journal of Obesity, 15*, 101–108.

Kissebah, A. H., Evans, D. J., Peiris, A., & Wilson, C. R. (1985). Endocrine characteristics in regional obesities: role of sex steroids. In J. Vague, P. Björntorp, B. Guy-Grand, M. Refuffe-Scrive, & P. Vague (Eds.). *Metabolic complications of human obesities* (pp. 115–130). Amsterdam: Excerpta Medica.

Langlois, J. H., Kalakanis, L., Rubenstein, A. J., Larson, A., Hailam, M., & Smoot, M. (2000). Maxims or myths of beauty? A meta-analytic and theoretical review. *Psychological Bulletin, 126*, 390–423.

Markey, C. N., Tinsley, B., Ericksen, A. J., Ozer, D. J., & Markey, P. M. (2002). Preadolescent's perception of female's body size and shape: evolutionary and social learning perspective. *Journal of Youth and Adolescents, 31*, 137–147.

Marlow, F., & Wetsman, A. (2001). Preferred waist-to-hip-ratio and ecology. *Personality and Individual Differences, 30*, 481–489.

Mikash, S. H., & Bailey, J. M. (1999). What distinguishes women with high number of sex partners? *Evolution in Human Behavior, 20*, 141–150.

Moran, C., Hernandez, E., Ruiz, I. E., Fonseca, M. E., Bermubez, J. A., & Zarate, A. (1999). Upper body obesity and hyperinsulinemia are associated with anovulation. *Gynecological and Obstetric Investigations, 47*, 1–5.

National Academy of Sciences (1991). *Diet and health*. Washington, DC: National Academy of Sciences.

Nelson, T. L., Palmer, R. F., Pedersen, N. L., & Miles, T. P. (1999). Psychological and behavioral predictor of body fat distribution: age and gender effect. *Obesity Research, 7*, 199–207.

Rebuffe-Scrive, M. (1987). Regional adipose tissue metabolism in men and women during menstrual cycle, pregnancy, lactation, and menopause. *International Journal of Obesity, 11*, 347–355.

Rebuffe-Scrive, M. (1988). Metabolic differences in fat deposits. In C. Bouchard & F. E. Johnston (Eds.). *Fat distribution during growth and later health outcome* (pp. 163–173). New York: Alan R. Liss.

Roberts, III, R. L., Weinfeld, A. B., & Nguyen, K. (2005). "Universal" and ethnic ideals of beautiful buttocks and how to create them surgically. Paper presented at the annual meeting of American society for aesthetic plastic surgery, New Orleans, LA, April, 30.

Rozmus-Wrzesinska, M., & Pawlowski, B. (2005). Men's ratings of female attractiveness are influenced more by changes in female waist size compared with change in hip size. *Biological Psychology, 68*, 299–308.

Shorter, E. (1982). *A history of women's body*. New York: Basic Books.

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

Singh, D. (1993b). Body shape and women's attractiveness. The critical role of waist-to-hip ratio. *Human Nature, 4*, 297–321.

Singh, D. (2004). Mating strategies of young women: role of physical attractiveness. *The Journal of Sex Research, 41*, 43–54.

Singh, D. (2006). Universal allure of the hour glass figure: an evolutionary theory of female physical attractiveness. *Clinics in Plastic Surgery, 33*, 359–370.

Singh, D., & Luis, S. (1995). Ethnic and gender consensus for the effect of Waist-to-Hip Ratio in judgments of women's attractiveness. *Human Nature, 6*, 51–65.

Sugiyama, L. F. (2004). Is beauty in the context-sensitive adaptations of the beholder? shiwiar views of waist-to-hip-ratio in assessments of female mate value. *Evolutionary and Human Behavior, 25*, 51–62.

Sugiyama, L. S. (2005). Physical attractiveness in adaptationist perspective. In D. M. Buss (Ed.). *The handbook of evolutionary psychology* (pp. 292–343). New York: Wiley.

Symons, D. (1979). *The evolution of human sexuality*. New York: Oxford University Press.

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.

Tooke, W., & Camire, L. (1991). Pattern of deception in intrasexual and intersexual mating strategies. *Ethology and Sociobiology, 12*, 345–364.

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

Tovee, M. J., Reinhardt, S., Emery, J. L., & Cornelissen, P. L. (1998). Optimal BMI and maximum sexual attractiveness. *Lancet, 352*, 548.

Trivers, R. L. (1972). Parental investment and sexual selection. In B. Campbell (Ed.). *Sexual selection and the descent of man: 1871–1971* (pp. 136–179). Chicago: Aldine.

Van Hooff, M. H., Voorhorst, F. J., Kaptein, M. B., Hirasing, R. A., Koppenaal, C., & Schoemaker, J. (2000). Insulin, androgen, and gonadotropin concentration, body mass index, and waist to hip ratio in the first years after menarche in girls with regular menstrual cycle, irregular menstrual cycles, or oligomenorrhea. *Journal of Clinical Endocrinology and Metabolism, 85*, 1394–1400.

Waas, P., Waldenstrom, V., 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.

Yu, D., & Shepard, G. H. (1998). Is beauty in the eyes of the beholder? *Nature, 396*, 321–322.

Zaadstra, B. M., Seidell, J. C., Van Noord, P. A. H., Te Velde, E. R., Habbema, J. D. F., Vrieswijk, B., et al. (1993). Fat and female fecundity: prospective study of body fat distribution in conception rates. *British Medical Journal, 306*, 484–487.