Female Mate Value at a Glance: Relationship of Waist-to-Hip Ratio to Health, Fecundity and Attractiveness

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Abstract A fundamental assumption of adaptive explanations of female attractiveness is that bodily features that males judge as attractive reliably signal youthfulness, healthiness, and fertility or female mate value. One of the bodily features, waist-to-hip ratio (WHR), is a reliable indicator of a female's reproductive age, sex hormone profile, parity and risk for various diseases. Systematic variation in the size of WHR also systematically affects the judgment of female attractiveness, healthiness, and youthfulness. This article summarizes recent findings about the relationship between female's WHR and various factors affecting reproductive capability and risk for diseases. Research on the relationship between attractiveness and WHR is discussed in light of some methodological objections to previous research. Finally, cross-cultural and historical data are presented that suggest that the relationship between WHR and female attractiveness is not culture-specific and not inculcated by modern Western fashion dictates or media.

According to evolution based theories of mate selection, one of the adaptive problems faced by human ancestral males was to assess a woman's mate value, or the degree to which she would enhance his reproductive success. Women's mate value is determined by numerous variables such as hormone profile, reproductive age, fecundity, parity and resistance to diseases, none of which can be directly observed. It has been proposed that information about some of these variables was reliably conveyed by specific characteristics of female bodies and that selection therefore produced psychological mechanisms in men to attend to bodily features in assessing a woman's mate value [1,2]. It is the fundamental assumption of evolutionary mate selection theories that physical attractiveness is largely reflective of reliable cues to a woman's mate value [3–5].

Two different research approaches have been used to demonstrate the link between physical attractiveness and mate value. First are the studies in which people identify those features they find attractive; it is then ascertained whether such features are correlated with variables comprising mate value. Early research of categorizing various facial features that people find attractive [6], recent research by Johnston and his associates on computer generated beautiful faces [7,8] and research by Perrett

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and his associates on composite faces [9,10] illustrate this approach. The second approach is to identify bodily features that are known to be related to components of fitness or genetic quality and capacity to cope with environmental stress or health and then to investigate whether people judge such features as attractive. The research of Thornhill, Gangestad and their associates on fluctuating asymmetry (FA) – a marker of developmental stability – and its effect on judgments of attractiveness exemplify this approach [4,11,12].

Another bodily feature that reliably signals hormonal status, susceptibility to endocrinological disorders and fertility is sex-specific fat distribution as measured by the ratio of waist to hip circumference (WHR) [13,14]. This link between health and fertility and WHR should affect the judgment of attractiveness, which should in turn reinforce the assumption that attractiveness conveys information about mate value.

In this paper I will review and summarize the evidence that WHR is a sexually dimorphic feature which reliably tracks women's reproductive capabilities and is related to risks from various diseases. The link between WHR and reproductive capability and healthiness is so precise that minor variations in the size of WHR reflect significant changes in these components of fitness. Most of such research, however, has appeared in highly specialized journals, so many readers may not be familiar with this literature. Next, I will summarize research studies which demonstrate as well as those that dispute that systematic variations of the size of female WHR also systematically affect the judgment of women's attractiveness. Finally, I will present historical and cross-cultural data which suggest that the link between WHR and female attractiveness is due to adaptive design rather than caused by the cultural influence of modern Western societies.

General Characteristics of WHR

Overall body weight gain is the most noticeable change caused by pubertal onset in women. The most popular technique for estimating body weight is body mass index [BMI (weight in kilograms divided by height in meters squared)]. The increase in BMI observed in women during puberty does not take into account the sex-dependent anatomical distribution of fat deposits [15,16]. The deposit and utilization of fat from various anatomical areas is regulated by sex hormones. Simply stated, estrogen inhibits fat deposit in the abdominal region and maximally stimulates fat deposit in the gluteofemoral region (buttocks and thighs) more in than any other region of the body. Testosterone, in contrast, stimulates fat deposit in the abdominal region and inhibits deposits in the gluteofemoral region [17]. It is this sexually dimorphic body fat distribution which primarily sculpts typical body shape differences between the sexes that becomes noticeable after pubertal onset; women have greater amounts of body fat in the lower part of the body (gynoid body fat, or pear shape), whereas men have greater amounts of fat in the upper body (android body fat, or apple shape). This sexually dimorphic body fat distribution is most commonly quantified by measuring and computing the ratio of the waist to hips (WHR) circumference.

WHR has a bimodal distribution with relatively little overlap between the sexes [18]. The range of WHR for the healthy premenopausal Caucasian women has been shown to be .67–.80 and in the range of .85–.95 for healthy Caucasian men [19]. Women typically maintain a lower WHR than men throughout adulthood, although after menopause WHR approaches the masculine range [20,21]. The increase in the size of WHR in menopausal women is due to the reduction of estrogen levels [22]. This interpretation is justified by the observation that premenopausal women suffering from polycystic ovary syndrome (PCOS), which is marked by impaired estrogen production, have higher WHRs than age-matched non-patients [23,24], Additionally, when women suffering from PCOS are administered an estrogen-progestagen compound, their WHRs become lower over time in the absence of any reduction of their BMI [23]. There is no other visible morphological feature which so reliably tracks the level of estrogen.

The size of WHR also has a genetic-heritable component. Data on identical female twins show that additive genetic effects account for 48% of variance, unique environmental effects for 46% and 6% by the effect of age [25]. Recently, segregation analysis has provided evidence for the presence of a major gene for age and BMI adjusted WHR [26]. This interplay of genetic and lifestyle variables may be responsible for population-specific variations in the size of WHR in both men and women [18]. However, it is notable that despite such variations, average male WHR is found to be greater than average female WHR in all the populations studied so far.

WHR and Health Status

There is accumulating clinical and epidemiological evidence that risk for various diseases depends not only on the degree of obesity as commonly measured by BMI, but on anatomical location of fat deposits as well [27–29]. Sex hormones and glucocorticoids regulate adipose (fat) tissue differentiation, function and distribution, but in excess, they cause abdominal or central obesity [30]. Abdominal fat or central obesity is commonly measured by WHR and recently by the size of waist circumference [31,32]. WHR is an independent predictor for cardiovascular disorders, adult-onset diabetes, elevated plasma lipids, hypertension, cancer (endometrial, ovarian and breast), gall bladder disease and premature mortality [13,33]. The clearest support for the relationship between WHR and health is provided by a recent study which conducted forensic autopsies on premenopausal women and found the highest coronary lesions in women with 0.87 or greater WHR after controlling for age and BMI [34].

WHR also significantly predicts poor stress-coping skills and prevalence of various personality disorders. For example, women with higher WHR perform poorly in stressful situations and lack habituation to stress (defined as significantly greater secretion of cortisol) than women with low WHR [35]. Women with a high WHR compared to those with lower WHR score higher on Cluster c (characterized by anxiety and fear) as determined by the structured clinical interview schedule [36]. A longitudinal study reports that women with high WHR exhibit greater cynicism, anxiety and depression than women with low WHR [37]. Thus susceptibility to various major physical diseases and psychological disorders is reliably conveyed by the size of WHR.

It should, however, be noted that while WHR and BMI are positively correlated, they measure overlapping, yet distinctly different aspects of body fat deposits. BMI reflects the degree of thinness/fatness without differentiating whether fat is centrally located or peripherally located (on the limbs), whereas WHR measures upper central (android) and lower (gynoid) body obesity. Although BMI is most frequently used by epidemiologists because of the ease of this measure, there is considerable variability in body composition for any BMI; some individuals with low BMI have as much fat as those with higher BMIs [38]. Additionally, BMI is not appreciably affected by certain parasitic infestations, whereas WHR is. For example, schistosomiasis and Leishmania (Kala-Azar), which are quite prevalent in non-industrialized, non-western countries (and undoubtedly prevalent in the environment of evolutionary adaptiveness, or EEA), affect liver function and induce large bellies in infected individuals. The pathogen infestation does not cause immediate mortality and infected individuals remain asymptomatic and survive 10–15 years, but have low energy levels. The enlargement in the belly size would affect the size of WHR without any readily noticeable change in BMI [39].

The degree of overall obesity, as measured by BMI ,does affect the size of WHR especially in instances of very low and high BMI. For example, low BMI leads to typical gynoid pattern of fat distribution (i.e., low WHR), whereas excess weight or high BMI results in android (high WHR) pattern of fat distribution in women [40]. It is, therefore, common practice in clinical research to measure both BMI and WHR if the subject population represents a wide range of BMI. For accurately evaluating the role of WHR, BMI is divided into lower, middle and upper terciles [15]. The World Health Organization (WHO) defines BMI of 18.5 as thin, or underweight, 19–24 as normal weight, 25–29.9 as overweight and 30 or greater as obese. Frequently, the effect of WHR size on risk for diseases is found to be significant for normal weight range; BMIs representing overweight and obesity overshadows the impact of WHR [41].

The relevant issue from a mate selection perspective is whether people can accurately judge differences in the health of women who differ from each other only in the size of WHR and BMI. To explore this issue, male and female physicians (health experts) were given 12 line drawings of women representing three levels of BMI (all figures had identical height, but different depictions of body weight – underweight, normal and overweight) and within each BMI group four levels of WHR (0.7, 0.8, 0.9, 1.0). Both male and female physicians rated the 0.7 WHR figure in the normal weight category as most healthy and attractive; the underweight figure with low WHR (0.7) was not judged to be healthy or attractive but was judged as younger than normal weight low WHR figure. Body weight did affect the judgment of healthiness as the overweight figure even with low WHR was judged to be less healthy, less attractive and older than underweight and normal weight figures of the same WHR [42]. When young and older laymen and women were asked to rate the same 12 figures, their judgments of healthiness, attractiveness and youthfulness were practically identical to those of the physicians. It should be stressed that ***within** each body weight category*, physician and lay people both judged the figures with lower WHR as more attractive, healthy and youthful [14].

This inverse relationship between WHR and judgments of healthiness and youthfulness has now been replicated using silhouette photographs of women with known BMIs and WHRs [41]. Silhouettes with low BMI and low WHR were judged as more likely to be healthy and to live longer than silhouettes of the same BMI but higher WHR, independent of the observers' own BMI, age or sex. When high BMI silhouettes (BMI of 29) were used, the size of WHR was less influential in the judgment of health and age. Women with high BMI, independent of WHR, were judged to be 15–18 years older than figures with low WHR and low BMI.

Thus, it is this interaction between WHR and BMI that affects health status and healthiness, and no valid conclusion can therefore be drawn if the interaction between BMI and WHR is ignored.

WHR and Reproductive Capability

WHR reliably signals practically all the conditions that affect women's reproductive status. Prior to puberty and again after menopause, females have WHR which is quite similar to that of males; only during reproductive age do women maintain a WHR lower than that of men [20]. The onset of puberty and resultant activation of the menstrual cycle is related to the size of WHR. Females with a high WHR have more irregular cycles [43] and have significantly fewer ovulatory cycles than women with a low WHR [44]. Changes in the size of WHR also track ovulatory phases; WHR becomes significantly lower during ovulation compared to the non-ovulatory phases of the menstrual cycle [45]. Thus, WHR is a reliable indicator of a woman's fecundability. For successful conception, however, it is essential that the chemical environment within the reproductive track facilitate sperm viability. After sperm insemination, the endocervical mucus pH determines viability of sperm; if endocervical mucus has high pH it impairs mucus-sperm interaction and reduces fertility. Endocervical mucus pH has been shown to be inversely related to serum androgen levels and WHR in women who have a BMI in the normal range [46]. The probability of successful pregnancy induction is also affected by WHR. Women participating in a donor insemination program have a lower probability of conception if their WHR is greater than 0.8, after controlling for age, BMI and parity [47].

The failure to conceive during artificial insemination could be due either to deficits in gonadotropin hormone release or some variable associated with embryo implantation. The pregnancy rate of *in-vitro* fertilization embryo transfer, however, bypasses this problem, as gonadotropin hormones are regulated prior to embryo transfer. Women with high WHR (0.80 or higher) have significantly lower pregnancy rates than women with lower WHRs (0.70–0.79), independent of their BMIs [48]. Therefore, it appears that the lower pregnancy rate in women with high WHR, compared to women with low WHR, is due to a problem with embryo development and its viability. Currently, there is no information available about the incidence or frequency of spontaneous abortion and WHR.

One of the significant problems affecting the reproductive success of ancestral population males would have been to assess whether a potential mate was nulliparous or not, and more critically (due to paternal uncertainty), whether the woman was in the early stage of a pregnancy induced by another male. WHR provides reliable information about both of these conditions. The fat deposits in early pregnancy are primarily localized in the pelvic girdle regions and, hence, an increase in WHR in the absence of any significant weight gain is one of the first signs of pregnancy [49]. Reproductive history such as parity or lactation can also increase the size of a woman's WHR, independent of age and BMI. Nulliparous Dutch women have a mean WHR of 0.74 but it increases to 0.76 after two births and to 0.79 after seven births [50]. The increase in the size of the WHR related to parity cannot be explained by abdominal muscle stretching caused by pregnancy. Indeed, magnetic resonance studies have shown that successive pregnancies tend to localize more adipose tissue in the abdominal area [51].

WHR and Attractiveness Judgments

To establish that WHR allows males to solve the adaptive problem of identifying a female's mate value, it needs to be demonstrated that males possess perceptual mechanisms to detect and use information conveyed by WHR in determining a woman's attractiveness as a potential mate. If this is so, it should be possible to systematically change men's evaluations of women's attractiveness by manipulating the size of WHR alone.

To investigate this issue, I developed 12 drawings of female figures, differing solely in the size of their WHR. As there is a positive relationship between BMI and WHR, I used three levels of BMI (underweight, normal and overweight). Within each weight category, line drawings represented four levels of WHR [two typical gynoid WHR (0.7 and 0.8) and two android (0.9 and 1.0) by changing waist size only. The choice to represent various WHRs by changing the size of the waist was based on findings that of all body parts, waist size is clearly positively correlated with altered sex hormonal profile. For instance, postmenopausal women on hormone replacement therapy loose fat selectively from the waist without any significant change in fat deposit on the hip, buttocks or overall body fat [52,53].

Judgments of attractiveness, healthiness and youthfulness were obtained for these 12 figures from men and women of diverse age (18–85 years old), professional (white collar workers, lawyers, physicians), educational (undergraduates and postgraduate degree), and ethnic (Afro-American, Mexican American, Euroamerican) backgrounds [13,14,54]. To summarize the findings:

a) there was a high degree of consensus across sex, educational and ethnic background for the judgment of attractiveness, healthiness and youthfulness;
b) participants judged figures with gynoid WHRs (0.7 and 0.8) as more attractive, healthy, and youthful than figures with android WHRs (0.9 and 1.0); and
c) attractiveness ratings along with ratings of healthiness and youthfulness show a linear drop from WHR of 0.7, followed by 0.8, then 0.9 and then 1.0 in each body weight category.

However, there was a significant interaction between BMI and WHR; within each underweight, normal and overweight category, figures with low WHR were judged as more attractive than figures with high WHR, but across body weight categories, the normal weight figure with low WHR (0.7) had the highest attractiveness rating. Underweight figures with similar WHRs were not judged to be as attractive as normal weight figures with low WHR, and overweight figures, in spite of low WHRs were judged to be less attractive, less healthy and older. Thus, the relationship between WHR and attractiveness was most clearly evident with figures of normal body weight. The impact of WHR on attractiveness judgments is obscured by body weight deviation from the average weight, regardless of whether the weight is extremely low (underweight) or high (overweight). Many researchers have erroneously assumed that WHR and attractiveness hypotheses do not assign any role to BMI, although I had clearly stated the interaction between body weight and WHR in 1993, Viz, "Neither body weight nor WHR alone can explain attractiveness. To be attractive, women must have a low WHR and deviate little from normal weight" [14].

The findings that normal weight female figures with low (0.7) WHR are judged most attractive has been replicated with participants in the U.S., U.K., Germany and Australia using the 12 line drawings developed for the initial study [55–57]. Obviously, the use of line drawings to depict variations in WHR lacks ecological validity. While it allows systematic variation of WHR and holds other bodily features constant, one cannot determine from this if such a manipulation causes people to pay more attention to WHR than usual or how WHR might affect the judgment of female attractiveness when other bodily features, such as breast and facial attractiveness, can also be observed. I have replicated the line drawing findings using photographs of women with altered WHR, but the photographs did not show face or breasts [58]. Now, Henss has used full frontal photographs that include the face and breasts of different women with computer altered WHR and replicated the findings of the inverse relationship between WHR and attractiveness [59]. This is an exceptionally methodologically sound study as Henss used photographs of six different women and used a between-subjects design, whereas most of the previous studies in this field have used a within-subjects design.

Tovee and his associates [60] have correctly objected to previous research that indicated a relationship between WHR and attractiveness, because none of the previous studies used women with known WHR; it could be that such a relationship may not generalize to an actual population. These researchers, however, incorrectly insist that previous research on WHR and attractiveness did not explore the role of BMI and did not acknowledge the reported interaction between WHR and BMI. To demonstrate that BMI is the more important variable determining female attractiveness, Tovee *et al*. in their first study asked subjects to rate attractiveness of female photographs depicting women with BMI at the 5th percentile (emaciated) to the 95th percentile (morbidly obese) to determine the relative impact of BMI and WHR on attractiveness rating. The results show that when such a BMI range is used, BMI accounts for the majority of the variance, while WHR accounts for very little variance. It should be stressed that *in spite* of the well-established relationship between BMI and WHR, these investigators treated BMI and WHR as independent variables and did not examine their interaction [61,62]. The most appropriate analysis of their data would have been to divide BMI into terciles and to examine the role of WHR within each BMI tercile. Recently, Thornhill and Grammer have examined the effect of BMI and WHR on attractiveness as part of a larger study investigating the relationship of facial attractiveness to BMI and WHR based attractiveness [63]. These investigators used nude full body photographs of young women with known BMI and WHR, but the BMI of these women ranged from 15 to 24. Thornhill and Grammer found a weak effect of WHR and a significant effect of BMI on attractiveness ratings. However, they also did not

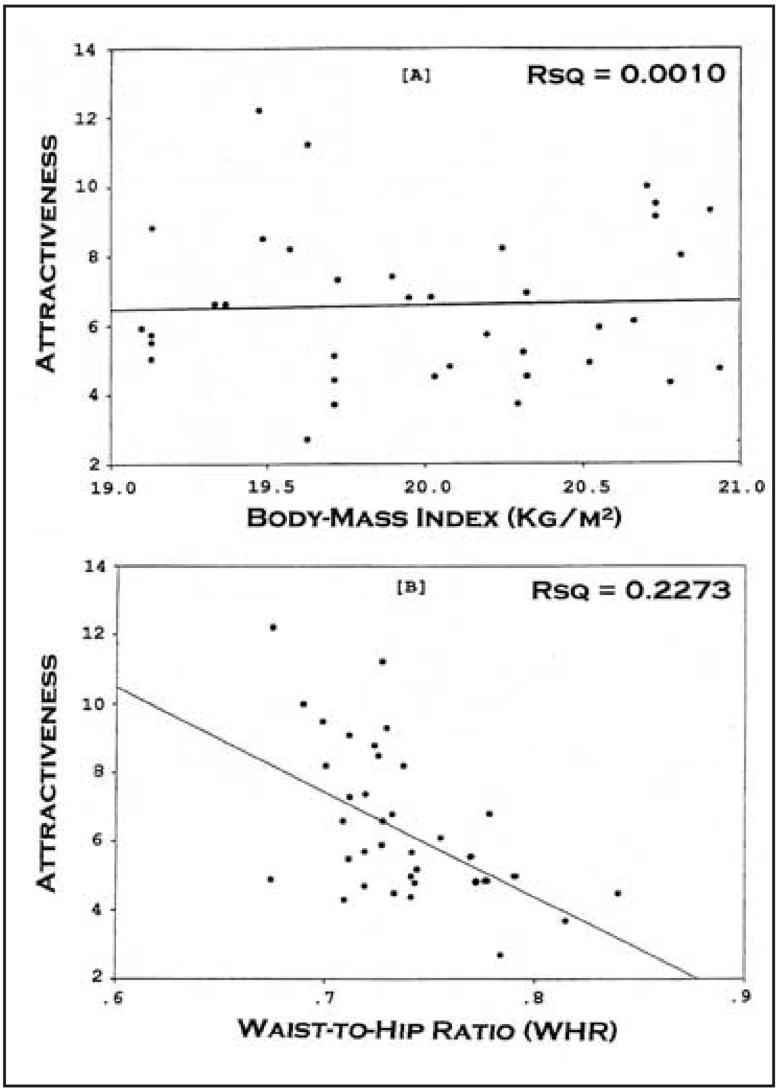

Figure 1. Variance of attractiveness ratings explained by BMI (A) and WHR (B) for data of U.S. and Austrian men analyzed for normal weight BMI range (n=43). When data for the entire sample (n=92) representing BMI range from 15–24 was analyzed, BMI accounts for 23% of variance while WHR accounts for 5% of variance.

examine the role of BMI for the normal population range. Normative data shows that 21 is the 50th percentile for BMI for Caucasian women in the age range of 20–24 [64].

We have recently reanalyzed Thornhill and Grammer's attractiveness data for the photographs showing only the back of the women, head to calf (so as to eliminate any contributions of breast size or facial attractiveness), from the BMI range of 19–22 which represents 50% (n=43) of their sample [65]. Examining the bivariate linear relationships between attractiveness and BMI (in the range of 19–22), and attractiveness and WHR, we found that BMI accounts for virtually no variance, whereas WHR accounts for more than 20% of the variance (Figure 1 here). Clearly, in this BMI range, which represents the majority of normal weight women, WHR is by far the most important for judgment of attractiveness. However, by selecting a greater range of values, BMI can be shown to be more important than WHR in attractiveness. For example, when we use the entire sample of BMI (15–24) used by Thornhill and Grammer, BMI accounts for 23% of the variance in attractiveness, whereas WHR accounts for only 5%. Differences among different BMI ranges account for huge variance overall, but BMI is much less important within a normal weight range. Needless to say, BMI and WHR interact in determining female attractiveness, and treating these two variables as independent would lead to erroneous inferences.

Studies attempting to treat hips or breasts as independent and non-interacting components determining attractiveness face similar problems. For example, in one study, 27 line drawings were developed to systematically represent WHR from 0.5 to 0.9 by either manipulating the size of the waist or the size of the hips within three (underweight, normal and overweight) body weight categories [66]. Results showed that U.S. undergraduate students judge figures with higher WHR as more attractive than figures with low WHR and that body weight and hip size explain more variance than WHR. The authors, however, did not check whether they were successful in changing the size of WHR without affecting perceived body weight. This becomes especially problematic because within any combination of weight category and waist size, a lower WHR can only result from larger hips [59], which makes figures look heavier.

Another recent study [67] has failed to replicate the positive relationship between WHR and attractiveness in U.S. undergraduates reported by Tassinary and Hansen [66]. In this study, color photographs of women were used in which a range of 0.5 to 1.0 WHRs was created by modifying the waist size. These investigators obtained attractiveness ratings and asked participants to estimate the body weight of women in the photographs. Results show that perceived body weight affects attractiveness judgments, and when perceived body weight is statistically controlled, an inverse relationship between WHR and attractiveness is still found to be significant.

It is obvious that isolated changes in different bodily features do not cause independent and isolated changes. The body is perceived as a whole unitary entity (Gestalt) and any morphological trait manipulated beyond a certain point would make the body appear grotesque or unattractive.

Cross-cultural Evidence

The inverse relationship between WHR and female attractiveness has been replicated in various societies, such as the island of Azore, Australia, England, Guinea-Bissau, Greece, Hong Kong, Kenya, India, Indonesia, and Uganda [39,68,69]. These findings are open to the possibility that such a relationship is due to exposure to Western media. Although one would still need to explain why such a relationship exists in Western societies and why Asian and African societies, which are reported to associate fatness with female attractiveness in spite of exposure to Western media, nevertheless attend to and are influenced by WHR.

Obviously, better evidence for a cross-cultural consensus reflective of WHR as an adaptive trait would be to find preferences for low WHR in tribal people who are least exposed to Western influence. There are a few studies that have used this approach. Yu and Shepard [70] report that Peruvian tribe men (n=18, age range 14 – 60 years) living in a reservation and not exposed to European tourists (Gombato group) judge line depicting females of depicting high WHR as more attractive than those with low WHR. However, when these figures were shown to Peruvian tribe men (Shipetiari and Alto Madre groups), who have been exposed to Western tourists for 20–30 years, they judged figures with low WHR as more attractive than figures with high WHR. Preference of the tribes exposed to Western media was identical to that found in Western societies. These investigators therefore concluded that attractiveness of low WHR is a Western phenomenon copied by tribal people in defining their own idea of feminine beauty.

Wetsman and Marlowe [71] tested a hunter gatherer tribe (Hadza) of Tanzania and found that the size of WHR does not affect judgments of attractiveness; Hadza judged heavier figures as more attractive than normal and underweight figures, regardless of their WHRs. These investigators suggest that ecological conditions shape the notion of female attractiveness. They propose that in subsistence-oriented societies, such as hunter-gatherers, women with a greater amount of fat are preferred by men, but in agricultural societies where there is a predictable surplus food supply, preference for lower BMI and low WHR develops.

Another variable that may shape the nature of preferences is the population-typical range of body weight and WHR distribution. As pointed out by Symons [2], psychological mechanisms could instantiate a rule to "prefer WHR somewhat lower than the local female average." As there are population-specific variations in the size of the WHR, it could be that female attractiveness is defined on the basis of being "somewhat lower than the local female average," rather than some absolute size of WHR. Sugiyama [72] has used this type of logic to investigate the nature of the relationship between WHR and attractiveness and mate preference in the hunter-gatherer Shiwiar tribe of Eastern Ecuador. Sugiyama measured WHRs of Shiwiar men and women and found that the average female WHR was not as low as typically found in Western societies, although average female WHR was significantly lower than average male WHR. Sugiyama used WHR lower and higher than the population average and found that Shiwiar men find female figures depicting lower WHRs attractive and desirable as potential mates. It is worth noting that women of child-bearing age of the Gombato group of Peru have a "high WHR even before final pregnancy and post-childbearing women are thin and have a low WHR" [70]. Therefore, Yu and Shephard should have measured the population average of WHR and investigated if the preferred female WHR was lower than average male WHR, rather than the absolute number of 0.7.

Taking into account the role of population-specific sexual dimorphism in the size of WHR, I and my associates measured the WHRs of isolated herder-gatherer tribes (Sugali and Yanadi) in Southern India as well as those of tribal people (Yanadi) who had moved to the city to work as laborers and would have been exposed to Western media [73]. The argument of Yu and Shephard [70] is that "access to television, cinema and advertising posters displaying exceptionally gynoid females draped over desirable products such as cars and beer" changes the ideals of beauty, and therefore one would expect that a tribe who had moved to the city would have very different notions of what constituted a beautiful woman. The first step was to ascertain the population-specific WHR. Results indicated that all three tribal groups had an average male and female WHR within the range as reported for Caucasian men and women, respectively. Adult males belonging to these three tribes were shown 12 nude female photographs (showing the back side of the body) selected from the set of photographs used by Thornhill and Grammer. As all tribal men were illiterate, they were asked to draw a line (long line for very attractive, and short line for less attractive) on a regular (8.5x11 inch) piece of paper for each figure. This technique allowed us to obtain a score for each photograph rather than obtaining ranking based on the "select the most attractive" technique which generates only nominal data but has been used by two other studies [70,71] of isolated tribes. Results showed that the attractiveness rating was jointly determined by BMI and WHR (Figure 2 here). Photographs were judged to be attractive only if they had normal BMI and a low WHR. There was no difference in the judgment of attractiveness between the tribal group that had moved to the city and the tribal group that had not. As a matter of fact, their judgments were practically identical to those of U.S. participants. To my knowledge, this is the only attractiveness study conducted with a tribal population using photographs of women with known BMI and WHR.

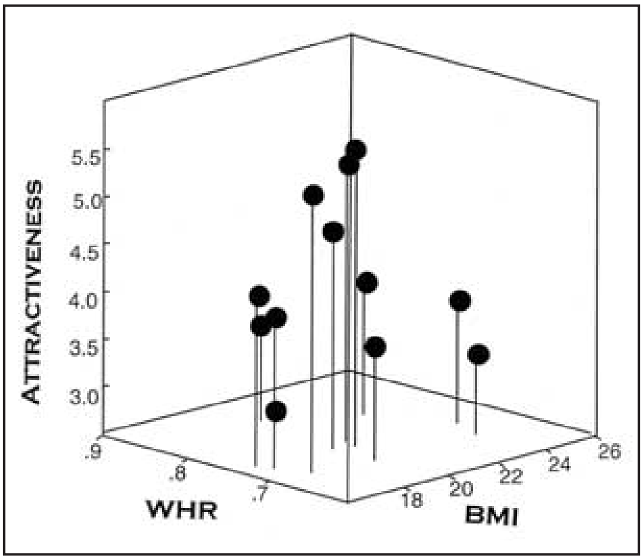

Figure 2. Attractiveness ratings of three groups of adult tribal men (Sugali, rural Yanadi and urban Yanadi) of Southern India (n=103]. It should be stressed that the range of sexual dimorphic difference in size of WHR in these tribal populations is comparable to the range reported for Caucasian populations. There was no significant tribal membership effect and ratings of tribal members who lived in the city responded in the same manner as rural members. Note that, similar to Western men (63], the attractiveness of these tribal men are jointly determined by BMI and WHR.

Cross-generational (historical) Evidence

There is a widespread belief among lay people and many social scientists that people's aesthetic choices are shaped solely by their cultural influences. In the absence of any precise formulation of variables regulating culture and (now) media effect, any similarity across cultures is explained by exposure to a dominant culture media, and lack of similarity is taken as evidence for the uniqueness of culture. Accordingly, Yu and Shepard [70] have argued that culturally isolated indigenous Peruvian men find women with high WHR most attractive, whereas men from the same population exposed to Western media for 20–30 years judge women with low WHR as most attractive. Arguing that even exposure of brief duration (20–30 years) can change the beauty ideals of a culture makes it practically impossible to refute their explanation. Presently, one cannot locate a cultural group in the world for which it can be claimed they have not been exposed to the Western media. Therefore, the issue that a cross-cultural consensus for female attractiveness is due to the design of the psychological mechanism cannot be explored.

One way to assess the role of cultural diffusion versus adaptive design for cross-cultural consensus in attractiveness is to examine the ancient sculptures of various cultures. Artists use naturally occurring responses to biologically significant stimuli. Thus, artistic representations of the female body should invariably be in accord with biological facts. This inference is supported by the evidence that ancient female

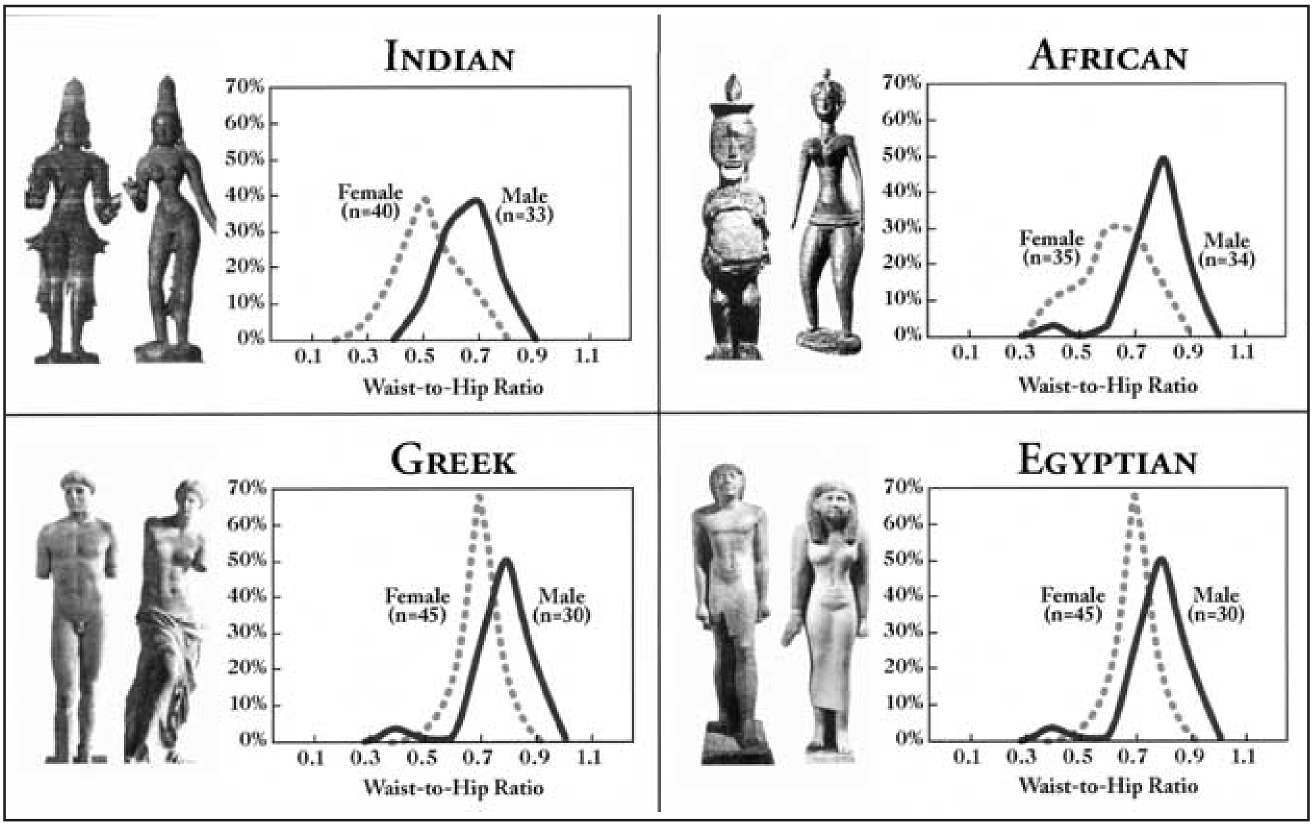

Figure 3. Distribution of male and female WHR in ancient sculptures of three societies and statuettes of African tribes. The source book of these measurements were suggested by art history professors unfamiliar with the WHR hypothesis and contained a broad spectrum from various time periods. All sculptures, whether of mythological or real people, were measured if they were depicted in a frontal (standing or kneeling) pose, unobscured by shadows or objects and with minimal or body hugging clothing. Note that sexual dimorphism is evident in all four groups.

statuettes of venuses of Central Europe and Turkey share a markedly emphasized concentration of lower body fat [74]. Fertility and age related changes in the WHR of a woman would have been observed by artists universally, so the sexual dimorphism in the size of WHR should be evident in artists' depictions of male and female body shapes, in spite of local cannons of aesthetic representation. Consider the ancient sculptures of Rome and India. The archetypical female body form epitomized by Aphrodite, the goddess of beauty and fertility, is, in spite of the difference in representational style remarkably similar to the ancient erotic female sculptures of India. The continued representations of sexual dimorphism among sculptures from Greece, India, and Egypt suggest an almost obsessive and universal interest in specific body parts that depict an alluring body form. Haywood (Personal communication), an art historian, points out that the body form epitomized by Aphrodite was the "ideal" body, whereas the body form of Hera, the goddess of the home and wifely virtues, was sexually less alluring. A cursory examination of these sculptures reveals that the narrow waist of Aphrodite is highlighted, whereas clothing hides the waist and lower body parts of Hera.

If it can be demonstrated that ancient Greek (Greco-Roman), Indian and Egyptian sculptures depict a sexually dimorphic WHR, such a consensus cannot be explained by the influence of modern Western culture. To explore this possibility, I measured WHRs in 286 ancient sculptures from India, Egypt, Greece (Greco-Roman) and some African tribes [73]. In all four cultural groups, distributions of WHR vary but the mean female WHR was significantly lower than the mean male WHR, despite cultural variability (Figure 3 here). Hence, it follows that evolved preferences for female WHR may not be for any absolute size, but rather for lower than average male WHR size evident in a given population.

In a remarkably ambitious study, worldwide WHRs in female depictions dating from the Upper Paleolithic to modern times were analyzed [75]. Measurements of female WHR were obtained from 330 photographs of artworks dating from 32,000 years (B.P.) to 1999 A.D. from Europe, Asia, America and Africa. Results show that, most frequently, WHR was depicted in the range of 0.6 to 0.7. The most important finding of this investigation is that female WHR depictions have remained relatively unchanged from the Upper Paleolithic to the present day. Taken together, this historical cross-cultural information affirms the claim that preference for low WHR is an adaptive design feature rather than an artifact of cultural influence.

General Discussion and Conclusions

The research summarized in this article validates the assertion that selection designed psychological mechanisms in humans to attend to bodily features that convey reliable information about phenotypic and genetic quality and to judge such bodily features as attractive. WHR is a reliable indicator of a woman's various aspects of reproductive capacity (postpubertal premenopausal status, hormonal status and probability of conception and parity), early sign of pregnancy, potential parasite infestation and risk for various diseases. Given that WHR is a heritable trait, an ancestral man selecting a mate with low WHR would have assured his offspring of high quality maternal care (lower risk for diseases) and the genetic gift of good health.

It could be the link between phenotypic quality and WHR that explains the appeal of an hour-glass figure with full breasts and wider hips set against a narrow waist. Women seem to know that the hour-glass figure is sexually appealing to men and attempt to highlight it by manipulating their waist size. When asked how they embellish their appearance around men, young women in the U.S. report "sucking in" their stomachs as the most frequently used tactic after facial makeup and clothing [76]. Similarly, the past popularity of the corset, in spite of the internal injury it caused women, and the currently popularity of abdominoplasty (tummy tuck) are testimonials of the importance of waist size in defining a sexually attractive body. Alternately, women who wish to conceal their sexual attractiveness, such as executive businesswomen, choose clothing that hides rather than highlights their body shape. Nuns' habits, for example, disguise WHR and send a message to males that the women inside the costume are not potential sexual mates.

Women's body shape is affected by both WHR and degree of thinness and fatness (BMI). The amount of body fat is affected by regular availability of food, duration and nature of physical work and certain chronic diseases. In an ancestral hunter-gatherer population, an extremely thin woman (low BMI) would signal malnutrition or sickness; such a woman would have been excluded as a potential mate without any further examination of her WHR. Similarly, an obese woman (high BMI) would arguably be uncommon (due to an unpredictable food supply and physical work) and hence obesity would be a sign of a pathological condition; such a woman would have also been excluded as a potential mate without any further examination of her WHR. From an evolutionary perspective, attractiveness indicators should be examined within the context of an evolutionarily relevant range of occurrence. If the majority of women were within the range of normal weight and if the occurrence extreme thinness or obesity was rare, attending to WHR would have allowed our male ancestors to reliably infer the health and fertility of their potential mates. Moreover, people in ancestral populations would have faced seasons of feast and famine, leading to fluctuations in BMI; however, WHR is not significantly altered until the weight loss or gain exceeds 16.2 pounds [77]. Therefore, small deviations from average body weight (8–10 pounds) would have affected BMI, but such a change would not have been evolutionarily relevant, as such change would have been transitory and tied to feast and famine cycles. However, even a small deviation in WHR would have been indicative of either early pregnancy, pathogen infestation, or parity. It should also be stressed that information about BMI alone, unlike WHR, does not provide any reliable information about the reproductive age of a woman; postmenopausal and prepubertal women can all have an identical BMIs.

Obviously, females with identical WHRs can vary in total body fat, and a maximally attractive amount of total fat may vary from society to society. Human males may have psychological mechanisms designed to adjust certain determinants of attractiveness to local conditions or ecology [2]. Human societies that face frequent food shortage, or must depend on hard labor to acquire and store food, may find strong legs and arms or overall plumpness of body more attractive than narrow waists [71]. Population-specific distribution of BMI and WHR may also influence the size of WHR which is maximally attractive [72]. In some societies where the majority of women have high WHR (e.g. Eskimos of Alaska), men may judge women with high WHR as quite attractive. What is important, however, is the sexually dimorphic size of the WHR rather than the size of women's WHR alone. WHR and attractiveness hypotheses would predict that the maximally attractive size of female WHR should be *lower* rather than equal to or greater than that of men in a population. Cross-cultural studies examining the role of fatness and WHR in determining female attractiveness must obtain information about society-specific distributions of male and female WHR.

Finally, the issue that human females have multiple secondary sexual features of the face and body that affect attractiveness must be addressed. Thornhill and Grammer [63] provide research evidence that suggests that features of a woman's face and body "collectively comprise a single ornament that honestly signals hormonal health and associated variables, such as immunocompetence and possible development health as well" [63, p. 115]. However, the components that constitute a single ornament can convey many overlapping and yet slightly different messages about phenotypic and genetic quality. Facial secondary sexual characteristics convey information about hormonal condition prior to and during puberty and age. These facial characteristics, however, do not provide any readily observable, reliable information about ovulation or early stage of pregnancy. Facial and body asymmetry can be indicative of past parasite infestation or developmental stress on the immune system, but may not be sensitive to current hormone levels and reproductive history. Manning [78] has suggested that developmental stability is signaled by fixed traits such as teeth and other skeletal features, as asymmetry in these traits results from a slow incremental accumulation. Physiological status is signaled by those dynamic soft-tissue traits that are related to some aspect of fertility or metabolic efficiency. For example, Manning and his associates [79] found that women's breasts become more symmetrical during ovulation; WHR also becomes smaller during ovulation [45], so attending to breast shape and the size of WHR can provide information about the fecundability of women. Although not yet incorporated into attractiveness literature, the 2nd and 4th digit (2D:4D) ratio is a reliable signal of sex hormone levels and the fertility of a woman [78]. It may very well be that the 2D:4D ratio influences mate choice to some degree. The main point which I wish to make is that the single but complex ornament of the face and body may contain correlated components that provide overlapping but still different messages about the attractiveness and mate value of a woman.

Thornhill and Grammar [63] have provided a way to integrate the role of face and body in determining attractiveness. A better understanding of the interrelationship between various sexual characteristics (facial, breast, BMI, WHR) that constitute attractiveness and female mate quality could emerge from an examination of these sexual characteristics simultaneously.

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