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The effects of body mass index and waist-to-hip ratio on ratings of female attractiveness, fecundity, and health

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Abstract

This paper examines the effects of body mass index (BMI) and waist-to-hip ratio (WHR) on people's perceptions of female attractiveness and fecundity. One hundred and two participants (51 females) were asked to rate 18 line drawings, varying across three BMI and six WHR levels, on seven different attributes ('healthy', 'fertile', 'youthful', 'intelligent', 'nurturing', 'flirty', and 'attractive'). Line drawings manipulated arm and leg thickness while keeping torso WHR consistent, thus unconfounding previously confounded variables. The data were analysed through a doubly multivariate analysis of variance. Effect sizes were larger for BMI than for WHR. Figures of average weight and a WHR of 0.7 were rated as most attractive and healthy. Overall, the results demonstrate that the effects of BMI and WHR on perceptions of attractiveness and fecundity are interdependent and should be studied concurrently rather than in isolation.

Keywords: Waist-to-hip ratio; Body mass index; Female attractiveness

1. Introduction

Many studies have shown that people ascribe many positive personal qualities and personality traits to physically attractive people (Eagly, Ashmore, Makhijani, & Longo, 1991; Hatfield &

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Sprecher, 1986). For example, attractive individuals are assumed to be more likeable (Miller, 1970) as well as more socially skillful than their unattractive counterparts (Goldman & Lewis, 1977).

A fundamental assumption of evolutionary theories of human mate selection is that physical attractiveness is largely a reflection of reliable cues to a woman's reproductive potential (Buss, 1987; Symons, 1995). Consequently, men place greater emphasis on physical attractiveness than women do (Feingold, 1990). This finding, which has been replicated in many cross-cultural studies (Buss, 1989), has prompted a series of investigations seeking to determine fundamental physical cues that are strongly indicative of female reproductive potential. Recent studies have also underlined the importance of male physical attractiveness, especially when females are considering short-term mating (Hughes & Gallup, 2003; Swaddle & Reierson, 2002).

Singh (1993, 1994, 2002; Singh and Luis, 1995) identified a morphological characteristic strongly suggestive of female reproductive potential, viz., the waist-to-hip ratio (WHR; the ratio of the circumferences of the waist and the hips). The fat distribution in humans depends on both age and sex. WHRs are relatively similar in both sexes during infancy, childhood, and old age. Sex differences are greatest from early adolescence until late middle age (Singh, 1994).

It has also been shown that WHR is a reliable indicator of female reproductive capability (Wass, Waldenstrom, Rossner, & Hellberg, 1997). Furthermore, WHR is an accurate indicator of androgenicity and oestrogenicity (e.g., Evans, Barth, & Burke, 1988; Voracek & Fisher, 2002) and is also related to risk for major diseases, with lower ratios signifying better health.

A number of experiments, based on sets of line drawings of females developed by Singh, have demonstrated that WHR and attractiveness are negatively correlated. This correlation has been replicated in studies that have employed judges of different genders, age groups, social classes, and cultures (Furnham, Lavancy, & McClelland, 2001; Furnham, Tan, & McManus, 1997; Henss, 1995; Singh, 1993; Singh & Luis, 1995). However, there is some concern about the cross cultural replication of these results (Furnham & Alibhai, 1983; Furnham, Moutafi, & Baguma, 2002; Marlow & Wetsman, 2001; Yu & Shephard, 1998).

Tassinary and Hansen (1998) criticized Singh's (1993) stimulus figures, which have been used in numerous studies, on the grounds that they confound WHR with waist size and weight with hip size. Hence, various subsequent studies used Tassinary and Hansen's figures (Furnham, McClelland, & Omer, 2002). However, the Tassinary and Hansen figures have also been criticized for confounding WHR with BMI (Tovée & Cornelissen, 2001). Further, Streeter and McBurney (2003) offered an experimental critique of Tassinary and Hansen and were able to provide support for Singh's claim that WHR predicts attractiveness in females. Bronstad and Singh (1999) also pointed out that figures within the same body categories of light, medium, and heavy appeared to differ widely in body weight. The present study hopes to overcome limitations of previous research by using a new set of stimulus figures that unconfound WHR and BMI and allow for a comparison of the effects of the two variables.

Henss (2000) replicated Singh's findings using photographic images. However, they introduce potential confounding variables. For example, several facial features (e.g., size of eyes and nose) themselves seem to provide cues to potential reproductive success (Symons, 1995; Zebrowitz, 1997).

Tovée, Maisey, Emery, and Cornelissen (1998) suggested that a healthy BMI (between 20 and 24) is a better indicator of attractiveness than WHR and argued that the importance attributed to the latter is an artifact of its covariance with the former. Tovée et al. found that when WHR and BMI are known for images of real women, their effects can be estimated separately, in which case

BMI emerges as a stronger predictor of attractiveness. Tovée et al. also argued that BMI is a more direct indicator of fecundity and reproductive potential because emaciated women (BMI < 15), such as anorexic patients, can be amenorrhoeic and still have a WHR of 0.7, which is considered the most fertile WHR.

Tovée et al.'s (1998) argument may also be applied to BMI, since women with 'healthy' BMIs (20–24) could be menopausal or pregnant. In a similar vein, it is possible for pre-pubertal girls to have a BMI of 20 or 21. As an index of body fat distribution, the WHR must be interpreted with reference to BMI levels. Previous research (Furnham and Lavancy et al., 2001; Furnham and Moutafi et al., 2002; Furnham and Tan et al., 1997; Singh, 1993, 2002) has repeatedly shown that ratings of attractiveness and fecundity are most strongly related to WHR when they are examined within a normal body weight range (excluding anorexic or obese figures). When ratings are collapsed across BMI and WHR levels, the former explains more variance than the latter. However, when weight is controlled for, the effects of WHR on rated attractiveness become salient (Streeter & McBurney, 2003).

Neither BMI nor WHR are singly sufficient predictors of female attractiveness. While women with low WHRs tend to be rated as highly attractive, substantial deviations from average body weight have a negative effect on perceptions of both attractiveness and healthiness (Singh, 1993). In contrast to previous studies that have examined independently either BMI or WHR, the present paper attempts to investigate them concurrently and to compare their relative effects. The study uses Singh's (1993) line drawings, which combine three BMI categories (underweight, average weight, overweight) and six WHR levels (0.6–1.1), to produce a total of 18 different combinations of stimuli. However, those stimuli systematically vary the thickness of the arms and legs of the figures to remove a potential confound introduced by the fact that some line drawings depicting a low WHR also appear to depict a low BMI. This manipulation allowed the creation of average weight figures with similar BMIs, but different WHRs. In this sense, limitations of previous research are overcome, although it could still be argued that limb thickness can itself become a confounding variable.

In addition to attractiveness, the present study also considers six physical and personality attributes, viz., health, fertility, youthfulness, intelligence, nurturing, and flirtatiousness. The inclusion of these attributes provides an opportunity to examine whether the effects of BMI and WHR are largely restricted to perceptions of attractiveness or whether they generalize to perceptions of other characteristics including fecundity. If the influence of BMI and WHR is similar across all attributes, then this could be interpreted as evidence for the existence of particular body types that, either favorably or unfavorably, bias people's overall perceptions of others. On the other hand, if the effects are clearly more relevant to some ratings than others, as reflected in the corresponding effect sizes, it seems reasonable to discount the possibility of strong halo effects.

2. Method

2.1. Participants

Participants were 102 undergraduate students (51 males), with a mean age of 18.66 years. (SD = 3.06 years). All were naïve to the aims of the study and participated as part of a course requirement.

2.2. Materials

The stimuli consisted of 18 line drawings of female figures, depicting six levels of WHR (0.6, 0.7, 0.8, 0.9, 1.0, 1.1) and three levels of body weight (underweight, average weight and overweight). As mentioned above, the arms and legs within each weight category were either thickened or narrowed accordingly. The 18 line drawings are presented in Fig. 1.

Within each body weight category, all facial and bodily features were held constant, with the exception of WHR ratios, which were varied through modifying the waist part of the drawings. Participants were told that all figures represented females of average height (5′6″). Stimuli from the various categories were presented in a pseudo-random order and participants were asked to use a 6-point Likert scale to rate each one on the seven attributes of interest. Participants were also asked to estimate the weight of each figure. These estimates, in combination with the given average height, were subsequently used to derive estimates of BMI scores. A pilot study was carried out on 20 participants to ensure that the task was clear and the seven attribute ratings relevant to the figures.

2.3. Procedure

Participants were tested in a lecture theatre, where the stimulus materials were projected on a large screen. Each slide remained on the screen for 60 s, which provided enough time to record the seven different responses, but did not leave extra time for contemplating the choice and possibly altering first impressions. Participants were debriefed at the end of the study. Ideally, it would be

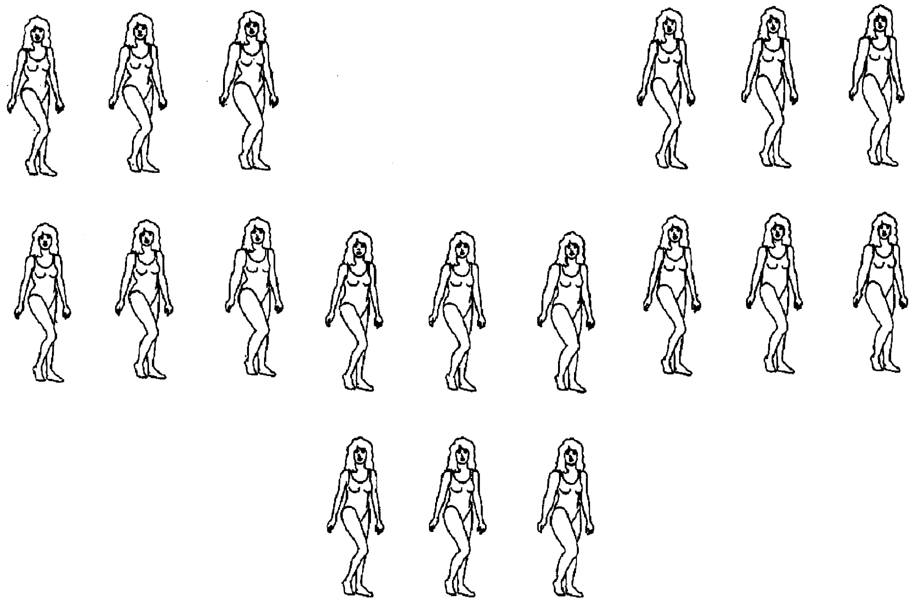

Fig. 1. The 18 line drawings used in the study, with the six overweight figures at the left end, the six average weight figures in the middle, and the six overweight figures at the right end. Within each block of figures, WHRs are increased in five increments of one decimal point (0.1), from 0.6 to 1.1.

preferable to have a fully counterbalanced design whereby the order of the presentation of the slides and the order of the various attributes were systematically varied. However, comparing the results from the pilot study in which both the attributes and the stimuli were presented in a different order to that in the main study, did not reveal any order effects. Similar results have also been reported in other WHR studies using counterbalancing procedures (Furnham and Moutafi et al., 2002).

3. Results

In order to check the effectiveness of the weight manipulation procedure, a one-way repeated measures ANOVA was performed to compare the mean BMIs of the three different weight levels (underweight, average weight, overweight). As expected, the ANOVA was highly significant ($F_{(2,1.33)} = 337.6$, $p < 0.01$). The post-hoc tests indicated that all BMIs were significantly different in the hypothesized direction (overweight > average weight > underweight).

Initially, a 3-way MANOVA (BMI, WHR, sex) was performed to investigate possible main effects and interactions involving participant sex. There was a multivariate main effect of sex, with females rating line drawings higher than males ($F_{(7,93)} = 2.92$, $p < 0.01$; partial $\eta^2 = 0.18$). However, participant sex was not involved in any interactions and the data were collapsed across genders for the subsequent analyses.

A doubly multivariate analysis of variance was performed, with repeated measures on the six WHR levels (0.6, 0.7, 0.8, 0.9, 1.0, 1.1) and the three weight levels (underweight, average weight, overweight), and with the seven traits ('attractive', 'fertile', 'healthy', 'flirty', 'youthful', 'intelligent', and 'nurturing') as the dependent variables. There were multivariate main effects of WHR (Wilks' lambda$_{(35,66)} = 9.68$, $p < 0.01$; partial $\eta^2 = 0.14$) and weight (Wilks' lambda$_{(14,87)} = 40.30$, $p < 0.01$; partial $\eta^2 = 0.52$) as well as a significant interaction between the two (Wilks' lambda$_{(70,31)} = 6.04$, $p < 0.01$; partial $\eta^2 = 0.07$). The results of the follow-up univariate tests are summarized in Table 1, where it can be seen that the main effects of weight (BMI) were consistently stronger than those of WHR. Biggest effect sizes and differences occurred for 'healthy' (0.38 vs 0.27), 'youthful' (0.45 vs 0.27), 'flirty' (0.42 vs 0.27), and 'attractive' (0.53 vs 0.35).

In the presence of strong interactions, main effects were not examined in detail. Exceptions were the main effects of WHR on 'intelligent', and of weight on 'intelligent' and 'nurturing', for which there were no interactions. For the WHR main effect on 'intelligent', Sidak post-hoc tests indicated that figures with WHRs = 1.0 were perceived as more intelligent than all other figures, with the exception of those with WHR = 0.9. For the main effect of weight on 'intelligent', Sidak post-hoc tests indicated that figures of average weight were perceived as more intelligent than either underweight or overweight figures. Last, for the main effect of weight on 'nurturing', Sidak post-hoc tests indicated that overweight figures were judged as more nurturing than either underweight or average weight figures and average weight figures were judged as more nurturing than underweight figures.

The results of the five significant interactions are tabulated in Table 2, where it can be seen that the effects of weight varied considerably across the six WHR levels. For example, overweight figures were generally perceived as less youthful than underweight figures, however, the opposite was the case for WHR = 0.8. Moreover, the pattern of variation itself varied across the dependent

Table 1
ANOVA results with main effects of WHR, BMI, and their interaction

Source	Trait	*Df*[a]	*F*	Effect size
WHR	Healthy	4.56, 456.35	36.96*	0.270
	Fertile	4.51, 451.31	20.46*	0.170
	Youthful	4.58, 458.59	38.68*	0.279
	Intelligent	4.65, 465.63	10.83*	0.098
	Nurturing	3.63, 363.69	1.57	0.015
	Flirty	4.17, 417.62	38.62*	0.279
	Attractive	4.30, 430.35	54.83*	0.354
BMI	Healthy	1.60, 160.73	62.40*	0.384
	Fertile	1.61, 161.45	19.04*	0.160
	Youthful	1.60, 160.79	84.79*	0.459
	Intelligent	1.76, 176.55	14.43*	0.126
	Nurturing	1.45, 145.80	39.21*	0.282
	Flirty	1.78, 178.48	74.18*	0.426
	Attractive	1.84, 184.43	113.70*	0.532
WHR ∗ BMI	Healthy	8.35, 835.57	29.79*	0.230
	Fertile	7.86, 786.84	23.84*	0.193
	Youthful	8.38, 838.70	24.46*	0.197
	Intelligent	8.18, 817.95	1.56	0.015
	Nurturing	5.63, 563.19	0.56	0.006
	Flirty	8.13, 813.91	20.63*	0.171
	Attractive	7.97, 797.23	35.57*	0.262

* $p < 0.01$.
[a] Greenhouse–Geiser corrected.

variables. For example, being overweight, with WHR = 0.6 or WHR = 1.1, seemed to be relatively unimportant for fertility, but not for attractiveness. Fig. 2 presents a graphical depiction of the interactions for 'attractive' and 'fertile'.

As can be seen in Figs. 1 and 2, the ratings of overweight BMI figures with a WHR of 0.8 showed a different pattern to the other ratings and were mainly responsible for the observed interactions. In five of the seven dependent variables, the overweight BMI figure showed a pronounced spike at WHR = 0.8, whereas the average and, especially, the underweight figures showed a clear dip. Close inspection of the 0.8 figures did not reveal any obvious explanation for this finding, which may be the result of the particular set of figures used in this study and which merits further investigation.

4. Discussion

The results suggest that both body fat and its distribution play a critical role in the perception and judgement, not only of female attractiveness, but also of the six other attributes investigated in this study, including the previously unexamined intelligence. However, as in previous studies, it was the ratings of attractiveness and health that consistently showed the most pronounced differ-

Table 2
Means, SDs, and Sidak post-hoc tests for simple main effects analyses

WHR		Mean	Standard deviation	Post-hoc tests
Health				
0.6	Under	4.12	1.14	U > O, A > O
	Average	4.27	0.88	
	Over	3.69	1.10	
0.7	Under	4.24	1.00	U > O, A > O, A > U
	Average	4.93	0.74	
	Over	3.49	1.20	
0.8	Under	3.59	1.08	O > U, A > U
	Average	4.62	0.83	
	Over	4.60	0.81	
0.9	Under	4.30	1.07	U > O, A > O, A > U
	Average	4.73	0.92	
	Over	3.49	1.03	
1.0	Under	3.93	1.12	U > O*, A > U, A > O
	Average	4.75	0.82	
	Over	3.66	0.96	
1.1	Under	3.66	1.03	U > O, A > O
	Average	3.63	1.11	
	Over	3.13	1.07	
Fertility				
0.6	Under	4.09	1.17	A > U*
	Average	4.31	0.93	
	Over	4.09	1.22	
0.7	Under	4.24	1.15	U > O, A > O, A > U*
	Average	4.87	0.86	
	Over	3.88	1.08	
0.8	Under	3.44	1.24	O > U, A > U, O > A
	Average	4.43	0.86	
	Over	4.93	0.85	
0.9	Under	4.10	1.05	A > U, A > O
	Average	4.47	0.89	
	Over	4.06	1.06	
1.0	Under	3.76	1.02	O > U*, A > O, A > U
	Average	4.50	0.83	
	Over	4.04	1.12	
1.1	Under	3.76	1.10	–
	Average	3.63	1.25	
	Over	3.71	1.12	

(*continued on next page*)

Table 2 (*continued*)

WHR		Mean	Standard deviation	Post-hoc tests
Youthful				
0.6	Under	4.34	1.23	U > O, A > O
	Average	4.13	0.98	
	Over	3.35	1.00	
0.7	Under	4.18	1.05	U > O, A > O, A > U
	Average	4.52	0.98	
	Over	3.17	1.08	
0.8	Under	3.47	1.28	O > U, A > U
	Average	4.20	0.98	
	Over	4.07	0.97	
0.9	Under	4.54	1.09	U > O, A > O
	Average	4.69	0.83	
	Over	3.22	0.96	
1.0	Under	4.43	1.13	U > O, A > O
	Average	4.41	1.00	
	Over	3.28	0.95	
1.1	Under	3.46	1.17	U > O, A > O
	Average	3.35	1.08	
	Over	2.85	1.02	
Flirty				
0.6	Under	4.49	1.10	U > O, A > O, A > U
	Average	4.15	1.09	
	Over	3.23	1.16	
0.7	Under	3.95	1.11	U > O, A > O, A > U
	Average	4.63	0.91	
	Over	3.08	1.07	
0.8	Under	3.25	1.28	A > O, A > U
	Average	3.92	1.03	
	Over	3.87	1.21	
0.9	Under	3.95	1.09	U > O, A > U*, A > O
	Average	4.24	0.97	
	Over	2.90	1.03	
1.0	Under	3.89	1.21	U > O, A > O
	Average	3.88	1.06	
	Over	2.97	0.98	
1.1	Under	3.16	1.17	U > O, A > O
	Average	3.11	1.10	
	Over	2.73	1.07	

Table 2 (*continued*)

WHR		Mean	Standard deviation	Post-hoc tests
Attractive				
0.6	Under	4.00	1.27	U > O, A > O
	Average	3.97	1.13	
	Over	2.77	1.14	
0.7	Under	3.83	1.21	U > O, A > O, A > U
	Average	4.61	0.98	
	Over	2.70	1.08	
0.8	Under	2.97	1.22	O > U, A > U, A > O*
	Average	4.08	1.02	
	Over	3.80	1.07	
0.9	Under	3.97	1.23	U > O, A > U, A > O
	Average	4.44	1.05	
	Over	2.62	0.99	
1.0	Under	3.68	1.16	U > O, A > U, A > O
	Average	4.10	1.04	
	Over	2.77	1.04	
1.1	Under	2.87	1.24	U > O, A > O
	Average	2.84	1.11	
	Over	2.35	1.05	

Note: All post-hoc tests were significant at $p < 0.01$ except in cases marked with an asterisk, where $p < 0.05$.

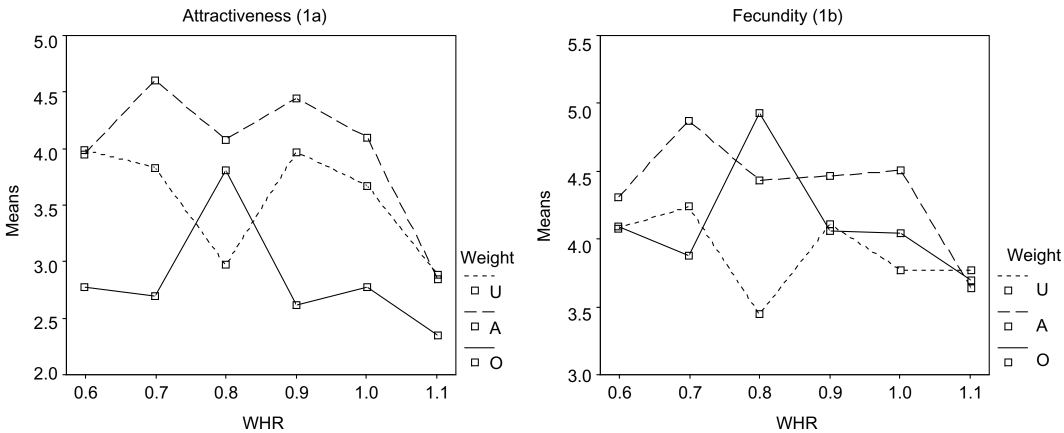

Fig. 2. Underweight (U), average weight (A), and overweight (O) profile plots for ratings of 'attractiveness' (1a) and 'fecundity' (1b) across the six WHR levels.

ences, as the relevant effect sizes indicate. It should be borne in mind that in this study we did not use *actual* BMIs, but rather estimates based on participants' judgments of the weight of the various figures, given an overall average height of 5′6″, a technique that has been used successfully by Streeter and McBurney (2003). As expected, the figure rated most highly for attractiveness was of average weight and a WHR of 0.7. This was also the case in Streeter and McBurney's (2003) study that was based on computer-manipulated photographs. The same figure was also rated highest for health and flirtatiousness and second highest for fertility and youthfulness. With respect to the relative contribution of BMI and WHR in ratings of attractiveness and fecundity, these results confirm that the former indeed accounts for more variance than the latter, as maintained by Tovée and colleagues (Tovée & Cornelissen, 2001; Tovée et al., 1998). Nevertheless, the results also provide support for Singh's position that WHR plays an important role, especially for given weight categories. It is important to recognize that the relative importance of WHR and BMI is inevitably a function of the variances of these two variables (Furnham and Moutafi et al., 2002). Moreover, these two variables seem to have interdependent effects, which is clearly evidenced by the presence of a large number of interactions in the results.

There were considerable differences in the effect sizes of BMI and WHR across the seven traits, with 'intelligent' and 'nurturing' at the low end and 'youthful' and 'attractive' at the high end. In fact, ratings of attractiveness yielded the biggest effect sizes both for the two main effects (weight = 0.53; WHR = 0.35) and for the interaction (0.26). These results indicate that perceptions of attractiveness and youthfulness are more strongly influenced by BMI and WHR than perceptions of intelligence and nurturing, as might be expected.

Despite the fact that the main effect of BMI was stronger than that of WHR, it can be seen in Fig. 2a that perceptions of attractiveness were clearly influenced by both variables, which provides support for Singh's position. Thus, for WHRs of 0.7, 0.8, 0.9, and 1.0, average weight figures were judged overall as more attractive than either underweight or overweight figures. However, there was a decline in ratings for WHRs of 0.6 and, especially, for 1.1. This pattern was roughly similar for underweight and average weight figures, but not for overweight figures, where there was a pronounced increase for WHR = 0.8. This difference is largely responsible for the strong WHR $\times$ BMI interaction in attractiveness ratings. In line with findings from many previous studies, there was a consistent tendency for figures with WHR of 1.1 to be rated as least attractive.

Similar results were obtained for fertility, where there was considerable variation of ratings across BMI and WHR levels (see Fig. 2b). In this case, average weight figures with a WHR of 0.7 received the second highest rating, with the maximum rating given for overweight figures with WHR = 0.8. Again, there was a tendency for ratings to drop as WHR levels exceeded 0.9. These findings very strongly suggest that perceptions of attractiveness and fertility are simultaneously influenced by both BMI and WHR.

This study attempted to overcome some of the problems that beset earlier research, which was largely based on line drawings that confounded BMI and WHR. It also attempted to test the generality of previous findings by incorporating typical attributes like attractiveness and fecundity, but also novel ones, such as intelligence. Overall, BMI seems to explain more variation than WHR in the ratings of the traits examined in this paper, including attractiveness and fecundity. However, the presence of interactions between the two variables strongly suggests that their effects cannot be fully understood in isolation. These interactions are a sign of interdependent influences that diminish the importance of the main effects of both variables. The significant finding is that BMI and WHR affect perceptions not only of attractiveness, but also of health, fecundity, youthfulness, and flirtatiousness.

The limitations of this paper include the fact that the stimulus figures employed attempted to unconfound BMI and WHR at the expense of introducing a possible new confound (limb thickness). It is worth noting that the issue of confounding could extend beyond the objective nature of the line drawings. Because BMI and WHR are positively correlated in humans, it is possible that participants may unconsciously assume that size per se is an indicator of WHR. This may create a tendency to perceive heavier line drawings as having higher WHRs, in spite of the fact that the latter is actually held constant in the line drawings. In other words, one of the reasons why BMI explains more variance than WHR may be because it acts as a cue to it. A final shortcoming worth reiterating, is that the BMI of the stimulus figures was based on participant estimates of each stimulus figure's weight rather than on actual values.

Overall, the findings of this study follow a clear and interpretable pattern that is in line with results from previous studies employing different sets of stimulus materials and procedures. Future research could investigate the ecological validity of these findings and establish the extent to which BMI and WHR contribute incrementally to perceptions of attractiveness and fecundity over other important cues, like, for example, facial features.

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