Waist-to-Hip Ratio across Cultures: Trade-Offs between Androgen- and Estrogen-Dependent Traits

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Why ?

(a)most women have a larger WHR than would seem to be optimal,
(b)there is a lot of variation in the trait, which may reflect environmental conditions, and
(c) WHR in women rises with age and parity.

Summary. A gynoid pattern of fat distribution, with small waist and large hips (low waist-to-hip ratio, or WHR) holds significant fitness benefits for women: women with a low WHR of about 0.7 are more fecund, are less prone to chronic disease, and (in most cultures) are considered more attractive. Why, then, do nearly all women have a WHR higher than this putative optimum? Is the marked variation in this trait adaptive? This paper first documents the conundrum by showing that female WHR, especially in non-Western populations, is higher than the putative optimum even among samples that are young, lean, and dependent on traditional diets. The paper then proposes compensating benefits to a high WHR that can explain both its prevalence and variation in the trait. The evidence indicates that the hormonal profile associated with high WHR (high androgen and cortisol levels, low estrogens) favors success in resource competition, particularly under stressful and difficult circumstances, even though this carries fitness costs in fecundity and health. Adrenal androgens, in particular, may play an important role in enabling women to respond to stressful challenges.

1. Average WHR is larger than the putative optimum
    1-1. What is the optimum WHR?
    1-2. Average values of WHR
    1-3. Is it a consequence of variation in weight?
    1-4. Compensating advantages to a high WHR
    1-5. Women need more than fecundity
2. Hormonal effects on WHR and behavior
    2-1. Cortisol effects
    2-2. Androgen effects
3. Is it facultive?
    3-1. Introduction
    3-2. Cortisol: environmental influences
    3-3. Estrogen: environmental influences
    3-4. Adrenal androgens: environmental influences
4. Explaining Variation in WHR
    4-1. Effects of age and parity
    4-2. Population differences
5. Conclusion

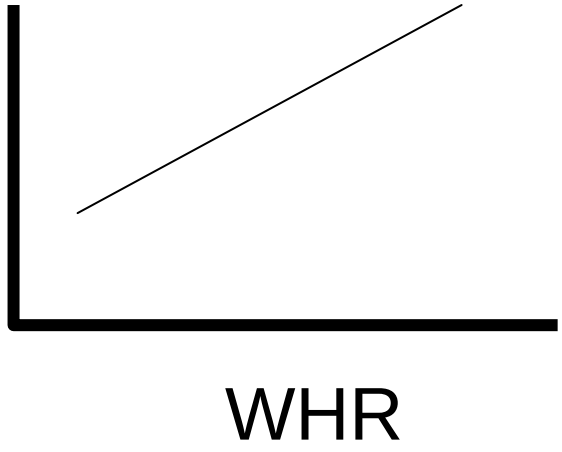
WHR = Waist-Hip Ratio

WHR: Male>Female

Androgen

CVD (Zhang et al, 2004)
Diabetes (Hartz et al., 1984)
Breast cancer (Sonnenschein et al. 1999)

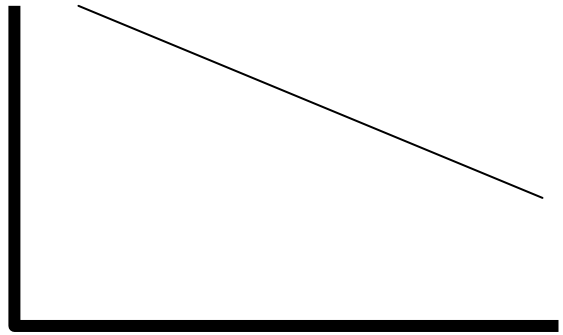
Estrogen



1. Average WHR is larger than the putative optimum

1-1. What is the optimum WHR?

Fecundity (e.g., Kirchengst and Huber 2004)



WHR

The most attractive WHR for men = 0.7

Singh and Lois 1995
Henss 2000
Furnham et al 2003
Streeter and Mcburney 2003

Donor insemination study (Zaadstra et al. 1993):
0.1 of WHR=probability of conception=-30%

Low WHR with large breasts:
=probability of conception= × 3 than the other groups
(Jasienska et al. 2004)

This study attempted a cross-cultural test of Singh's (1993a,b; 1994) theory of the relationship of waist-to-hip ratio (WHR) on judgements of female attractiveness using the stimulus figures designed by Tassinary and Hansen (1998). One hundred British (half male, half female) and 100 Kenyan (half male, half female) young people rated 18 two-dimensional line drawings of a female figure varying in weight (light vs. heavy) waist size (small, medium, large) and hip size (small, medium, large) on five 7-point scales: attractiveness, sexy, easy to bear children, health, easy to become pregnant. Results showed the ratings factored into two dimensions relating to fecundity and sexual attractiveness. As before participants rated the WHR of 0.7 as most attractive. Light figures were judged more attractive than heavy, particularly by the British. An interaction showed that Kenyans thought light figures more fecund than heavy figures whereas it was the opposite pattern for the British. Implications of the cross-cultural differences are noted.

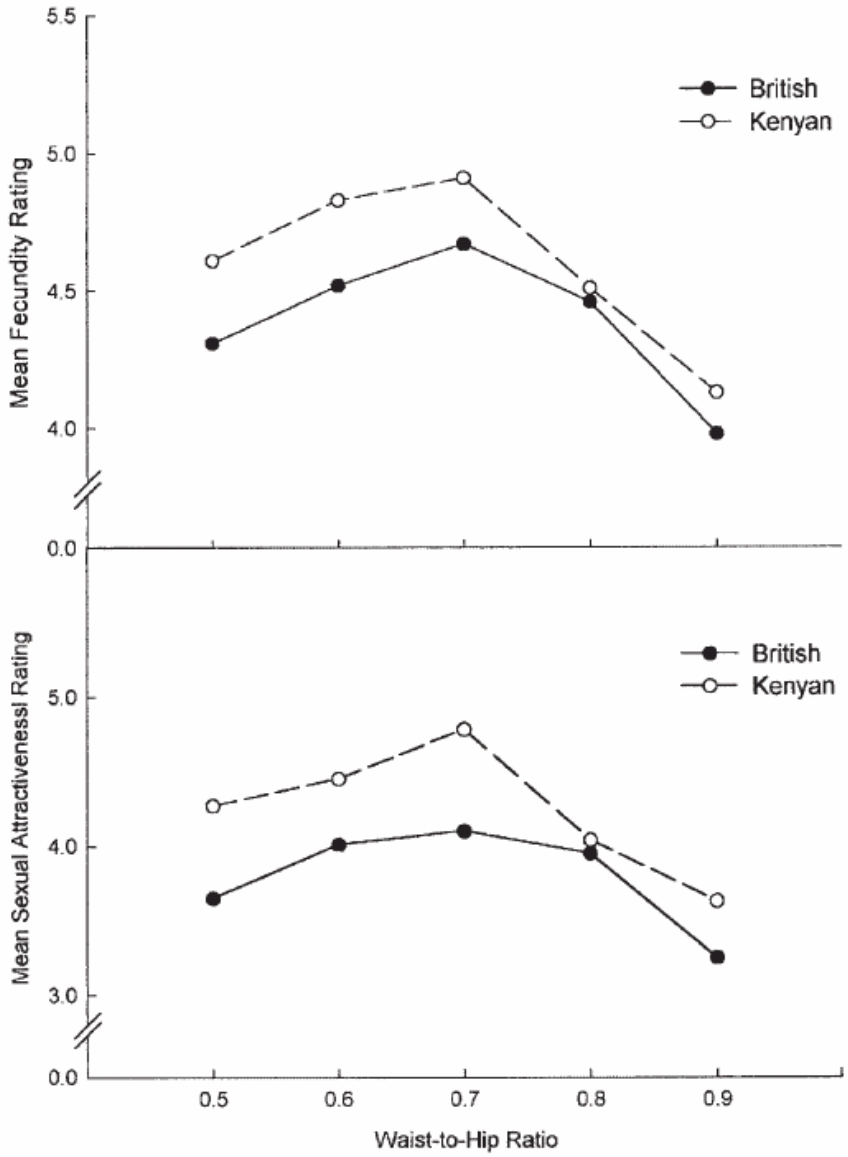
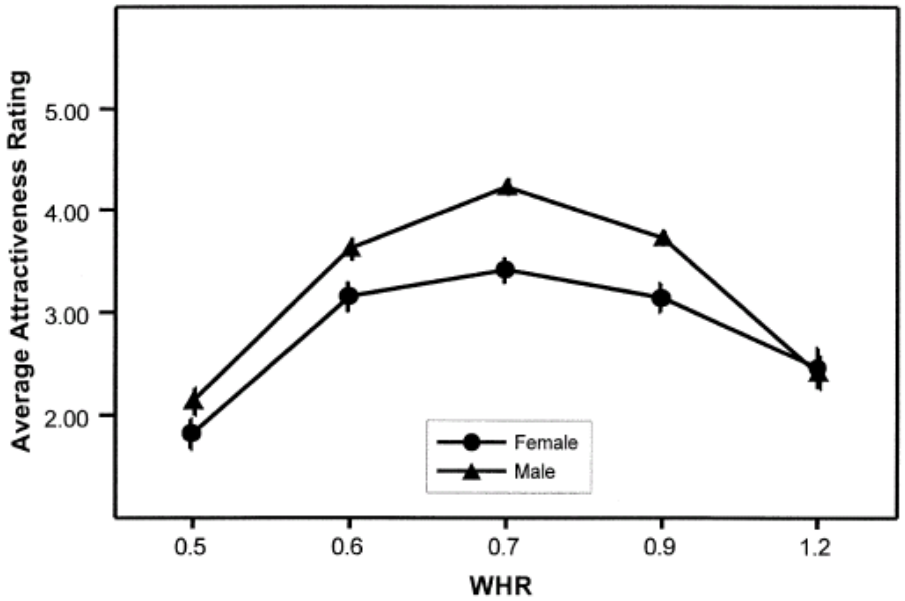


FIG. 1. *Mean fecundity rating (top panel) and mean sexual attractiveness rating (bottom panel) as a function of waist-to-hip ratio and cultural background.*

FURNHAM et al. (2003) Psychology, Health &Medicine, 8: 219-230.

An evolutionary model of mate choice predicts that humans should prefer honest signals of health, youth, and fertility in potential mates. Singh and others have amassed substantial evidence that the waist–hip ratio (WHR) in women is an accurate indicator of these attributes, and proposed that men respond to WHR as an attractiveness cue. In response to a recent study by Tassinary and Hansen [Psychol. Sci. 9 (1998) 150.] that purports to disconfirm Singh's hypothesis, we present evidence showing a clear relationship between WHR and evaluations of attractiveness. We evaluated responses to a range of waist, hip, and chest sizes, spanning the 1st through 99th percentiles of anthropometric data. Waist, hip, and chest sizes were altered independently to give WHRs of 0.5, 0.6, 0.7, 0.9, and 1.2. We replaced line drawings with more realistic computermanipulated photographs. The preferred WHR was 0.7, concordant with the majority of previous results. By asking participants to estimate weight in each stimulus figure, we were able to statistically control for the effects of weight on attractivene

Streeter et al. (2003) Evolution and Human Behavior, 24: 88-98.



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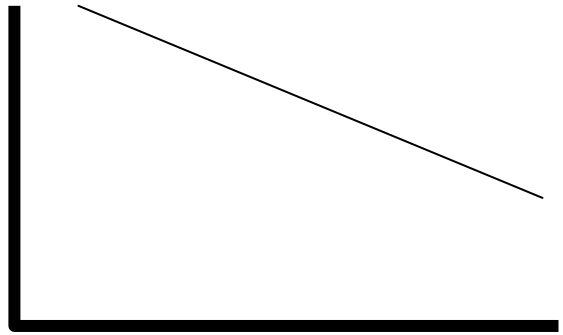

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1-2. Average values of WHR

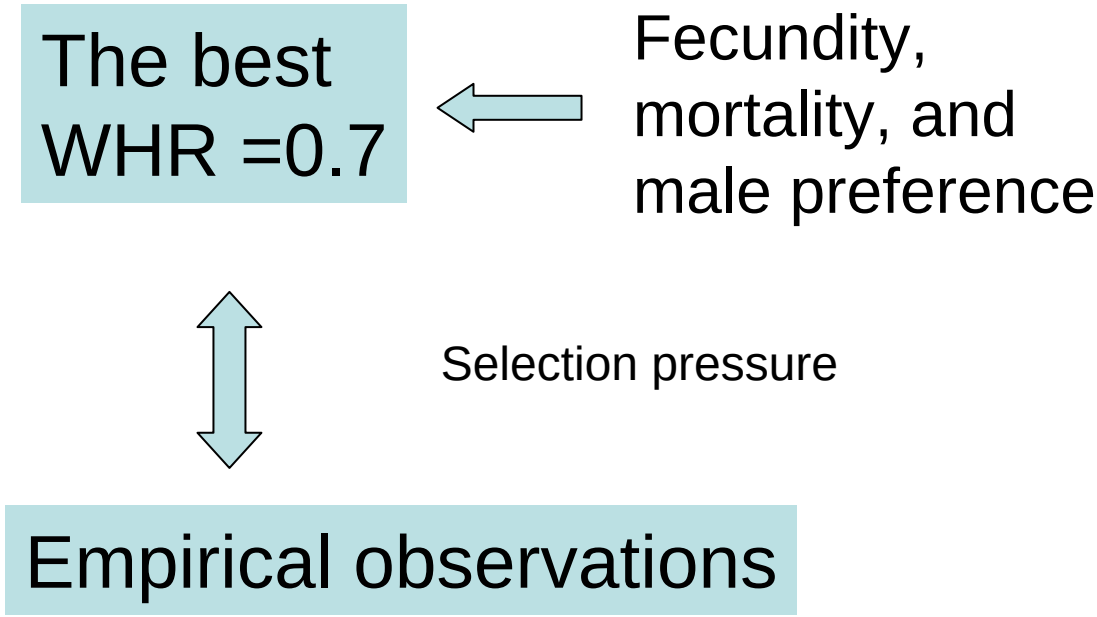


Table 1: normal weight
Table 2: overweight/obesity
Table 3: young adults only

Sources for Tabular Data: New Caledonia: Tassie et al. 1997; Eskimo: Risica et al. 2000; Algonquin: Delisle et al. 1995; Thailand: Aekplakorn et al. 2006; UK Chinese, UK European, UK South Asian: Patel et al. 1999; Hawaii: Curb et al. 1991; Korea: Kim et al. 2004; Jamaica: Wilks et al. 1999; South China: Folsom et al. 1994; Mauritius: Dowse et al. 1991; Shuar: S. L. Sugiyama, personal communication; Arnhem Land, Australia: Shemesh et al. 2007; Saudi Arabia: Al-Rehaimi and Björntorp 1992; Havasupai: Vaughan et al. 1997; Australia: Guest et al. 1993; Shiawar: Sugiyama 2004 and S. L. Sugiyama, personal communication; Hadza: Marlowe et al. 2005 and Sherry and Marlowe 2007; Mongolian nomads: Beall and Goldstein 1992; Australian Vietnamese: Bermingham et al. 1996; Singapore Chinese: Duerenberg-Yap 1999; Guatemala: Schroeder and Martorell 1999; central Australia: O'Dea et al. 1993; Jarawa: Sahani 2003; Iran: Janghorbani and Parvin 1998; Orang Asli: Yusof et al. 2007; New Zealand: Rush et al. 1999; Playboy centerfolds: Katzmarzyk and Davis 2001.

Table 1. Female BMI and WHR across Populations: Normal Weight

Society	*n*	Age (years)	BMI	WHR
Older normal-weight samples (40s):				
UK Chinese	197	25–64	23.5	.84
Korea	3,416	46.5	23.4	.84
South China:				
Urban	1,400	45.3	21.9	.81
Rural	1,755	46.0	20.2	.80
Mauritius:				
Muslim	371	41.7	24.7	.82
Creole	744	45.3	24.9	.82
Hindu	1,353	42.5	23.8	.81
Chinese	201	46.9	23.3	.78

Society	*n*	Age (years)	BMI	WHR
Younger normal-weight samples (30s):				
Aboriginal Australia (Arnhem Land)	204	36	23.2	.93
Shiawar (Amazonian forager/farmers)	24	34.3	24.7	.87
Hadza (East African foragers)	75	37.5	20.3	.83
Mongolia (nomads)		25–39	23.7	.82
			21.3	.80
Singapore Chinese	1,211	37.8	22.1	.73
Youngest normal-weight samples (20s):				
Guatemala	547	18–25	22.0	.91
Shiawar (Amazonian forager/farmers)	12	23.5	24.0	.86
Jarawa (Andaman foragers)	16	28.2	19.8	.82
Iran	1,000	16.2	19.8	.80
Hadza (East African foragers)	10	22.0	20.6	.79
Orang Asli (Malay forager/farmers)	≈69	≈29	21.0	.79
Mongolia (nomads)	. . .	18–24	21.5	.73
Playboy centerfolds	240	19–35	18.1	.68

Even the youngest foragers had WHRs～0.8

Table 2. Female BMI and WHR across Populations: Overweight

Society	*n*	Age (years)	BMI	WHR
Older overweight samples (40s):				
New Caledonia:				
Urban Melanesian	428	30–59	29.7	.97
Urban European	299	30–59	26.1	.90
Rural Melanesian	3,493	30–59	28.5	.90
Rural European	317	30–59	27.3	.83
Alaskan Eskimo	237	≥25	27.5	.93
Algonquin:				
Rural	70	38.3	29.1	.92
Urban	98	43.9	27.0	.85
Thailand	>900	42	25.4	.84

Society	*n*	Age (years)	BMI	WHR
United Kingdom:				
South Asian	322	25–64	27.4	.86
European	309	25–64	26.1	.78
Hawaii (native)	134	20–59	31	.84
Jamaica	783	46.2	28.0	.80
Younger overweight samples (30s):				
Shuar (Amazonian farmers)	7	35.6	26.0	.98
Saudi Arabia	100	36	32.0	.90
Havasupai	50	34	34.0	.89
Aboriginal Australia (southeast)	108	34.1	28.8	.87
Youngest overweight samples (20s):				
Aboriginal Australia (central)	131	22.2	26.5	.83
Hawaii (native)	27	20–29	29	.81
New Zealand:				
Polynesian	40	21.7	31.2	.77
European	40	22.3	28.9	.75

Table 3. Female BMI and WHR in Young Adult Samples

Society	*n*	Age (years)		BMI	WHR
		Mean	Range		
Age 18–29 years:					
Shiawar	12	23.5	18–29	24.0	.86
Hawaiian	27	. . .	20–29	29	.81
Hadza	13	24.2	18–29	20.6	.81
New Zealand:					
Polynesian	40	21.7	18–27	31.2	.77
European	40	22.3	18–27	28.9	.75
Age 18–24 years:					
Guatemalan	547	. . .	18–25	22.0	.91
Shiawar	6	21.2	18–24	24.0	.87
Aboriginal Australian	131	22.2	16–27	26.5	.83
Iranian	1,000	16.2	14–21	19.8	.80
Hadza	10	. . .	18–24	. . .	.79
Mongolian nomads	. . .	. . .	18–24	21.5	.73

1-2. Average values of WHR

The best WHR =0.7

Fecundity, mortality, and male preference

Selection pressure

Empirical observations

?

Table 1: normal weight
Table 2: overweight/obesity
Table 3: young adults only

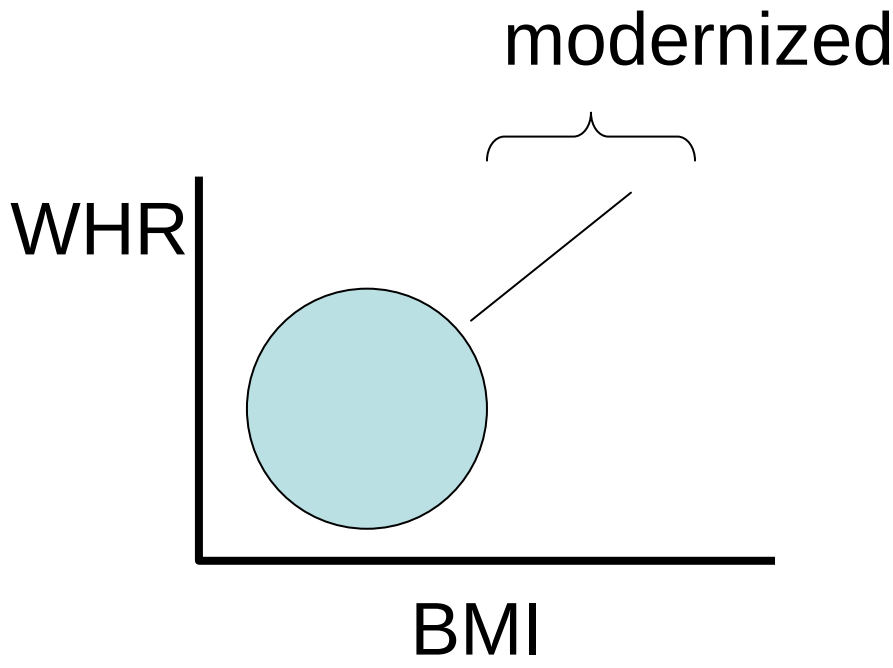
1-3. Is it a consequence of variation in weight?

Selection by male by fatness not by WHR?

Male preferred fatter females when the resources were limited, then the females with higher WHR were selected?

WHR ---- Fatness (adipose tissue)

(Molarius et al. 1999)
N=32000:
BMI explained
only 18% of WHR



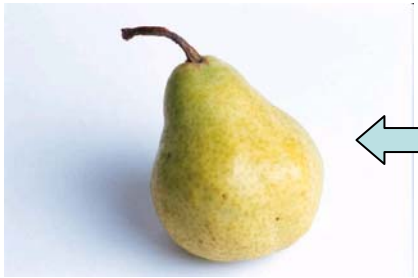
1-4. Compensating advantages to a high WHR

High WHR

◎Androgen
◎Cortisol
×Estrogen

Muscle mass
Competitive aggression
Physical strength

Effective response of mind and body to stress



◎Estrogen
×Androgen
×Cortisol

Low WHR

Scarce environment vs affluent environment

1-5. Women need more than fecundity

Low WHR = ◎ reproduction (mating, conception),
◎health

High WHR = ◎ resource competition

Murdock and White (1969) Database for 186 societies

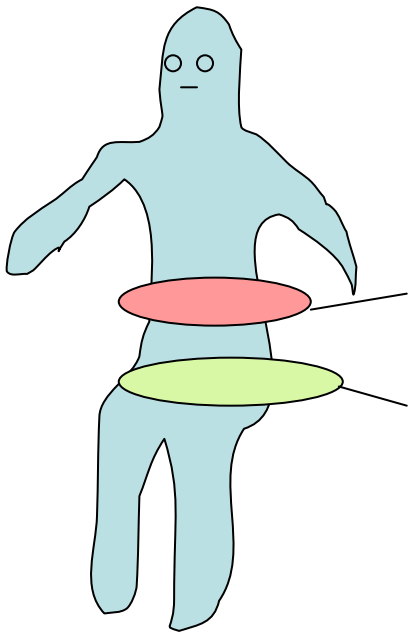
Avg. 34%: women's contribution to subsistence
83% of societies: predominant in determining the use of resources
45% of societies: women are political actors (arrangement of marriage)
57% of societies: influence in political affairs

⟹ Strong and aggressive women will be adaptive

2. Hormonal effects on WHR and behavior

2-1. Cortisol effects

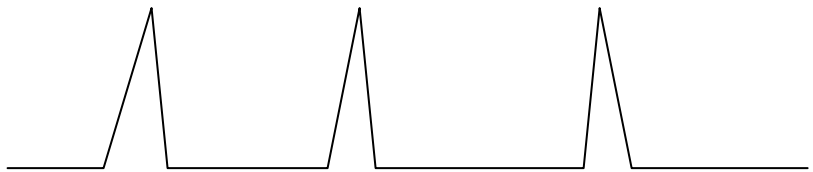
Cortisol → Blood pressure, Cardiac output ↑ → Activate Energy ↑



Active energy

Storage energy

High WHR women:
-react to a stressful situation with greater cortisol reactivity (Marin et al. 1992)



2-2. Androgen effects

Androgens

-Career oriented (Purifoy and Koopmans, 1979)
-Aggressive by self-report (Harris et al. 1996)
-Aggressive in behavioral measures (Dabbs and Hargrove 1997)
-Competitive, through verbal aggression (Cashdan 2003)
-Having more stamina, initiative.. (Johnannsson et al 2002)

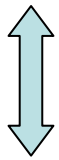
Useful when a woman must depend on her own resources to support herself and her children

3. Is it facultative?

Steroid hormones: sensitive to environmental conditions
Estimated heritability for body shape=40-70%

WHR=0.7

Optimum fecundity
Attractiveness



Toughness
Being aggressive

WHR>0.8

Benign

Environmental conditions

Role of woman in a society

Difficult

4. Explaining Variation in WHR

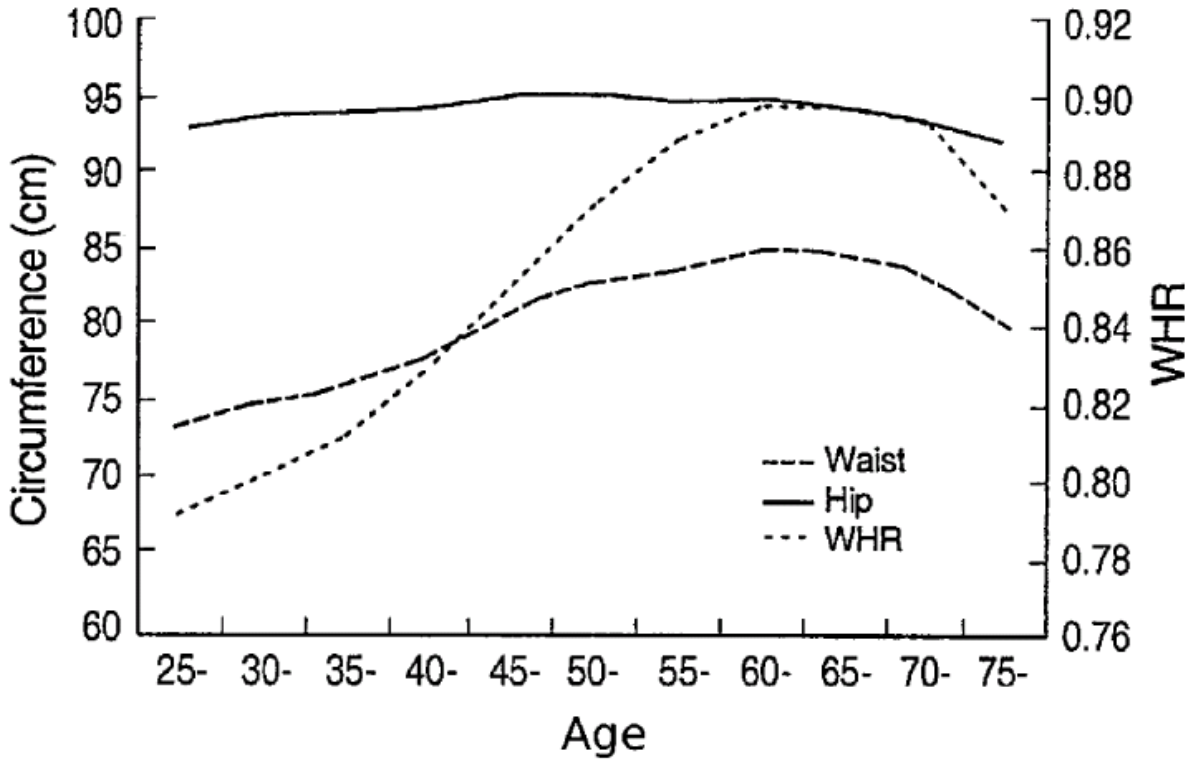
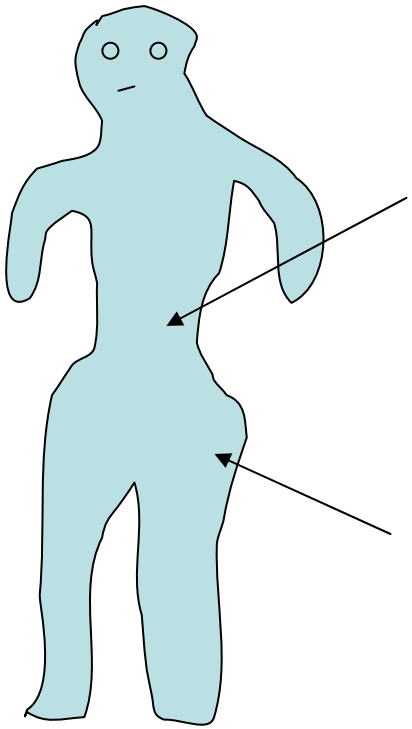


Figure 1. Age change in waist and hip circumference among Korean women. Reproduced from Kim et al. (2004).

4-1. Age and parity are the independent predictor of WHR: Plausible explanation

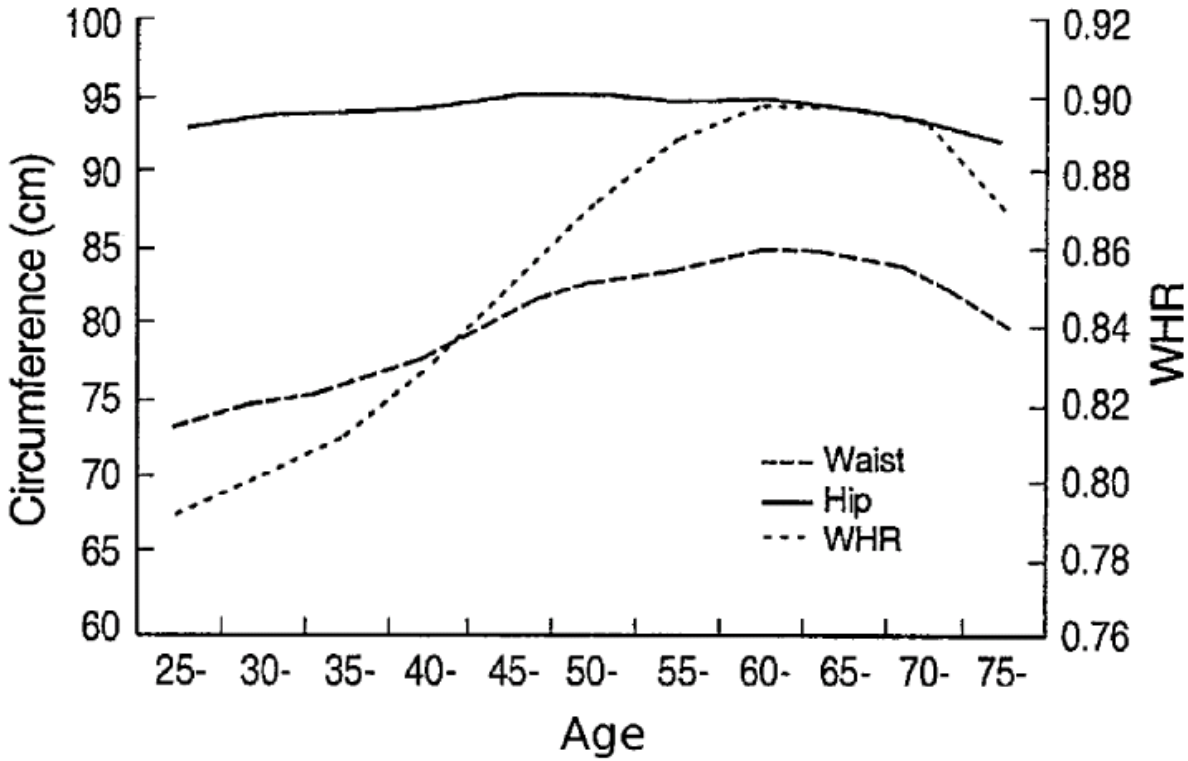


-Readily metabolizable
-Increase after delivery
-Important in maintaining a women's own energy balance

-Less metabolically active, resistant to weight loss except during late-pregnancy and lactation (Rebuffe-Scrive et al. 1985), rich in long-chain polyunsaturated fatty acids important in infant brain growth (Lassek and Gaulin 2006) .
-With each live birth, hip circumference decrease by 0.5 cm, while waist increase by 0.5 cm.

Fat on hips/thighs → Fat on waist

Reproduction Nurture



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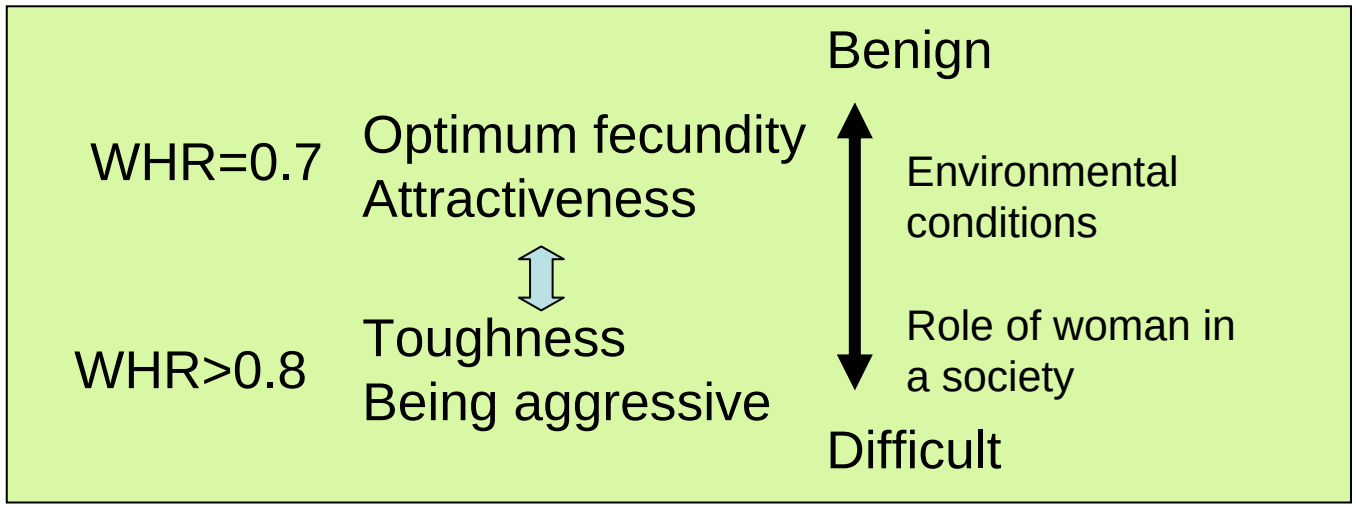
4-2. Population differences



No strong preference of lower WHR:

Shiawar (Sugiyama 2004), Hadza (Wetsman and Marlove 1986), Matsigenka (Yu and Shepard 1998), Zulu (Tovee et al. 2006), Men in Western societies during periods of economic and social hard times (Pettijohn and Jungeborg 2004).

Strong preference of lower WHR:

Greece (Swami et al 2006), Japan (Swami 2006), Portugal (Furham and Nordling 1998): less sexually egalitarian societies >Britain or Demark

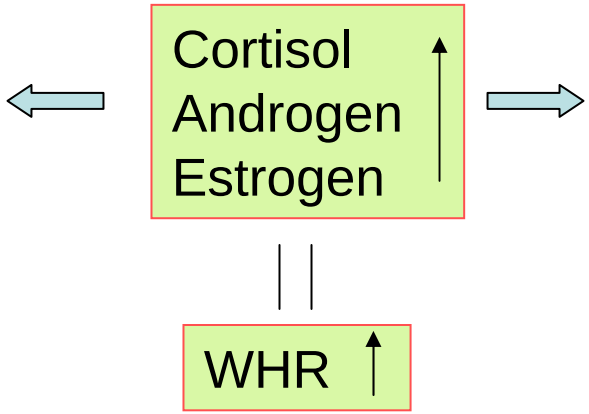
Women's mate preference: High-WHR women: less concerned that their mates have resources and more concerned (Pawlowski and Jesienska 2008)

5. Conclusion

(a) most women have a larger WHR than would seem to be optimal,
(b) there is a lot of variation in the trait, which may reflect environmental conditions, and
(c) WHR in women rises with age and parity.

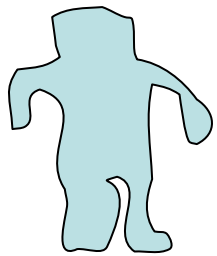
Why?

Low fecundity
Less Healthy



Adaptive to environmental and situational challenges

Fecund, healthy, and graceful women?



Strong, tough and politically competitive women?

"And from a woman's perspective, men's preferences are not the only thing that matters."