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Original Article

# Lumbar curvature: a previously undiscovered standard of attractiveness

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ABSTRACT

This paper reports independent studies supporting the proposal that human standards of attractiveness reflect the output of psychological adaptations to detect fitness-relevant traits. We tested novel *a priori* hypotheses based on an adaptive problem uniquely faced by ancestral hominin females: a forward-shifted center of mass during pregnancy. The hominin female spine possesses evolved morphology to deal with this adaptive challenge: wedging in the third-to-last lumbar vertebra. Among ancestral women, vertebral wedging would have minimized the net fitness threats posed by hypolordosis and hyperlordosis, thereby creating selective pressures on men to prefer such women as mates. On this basis, we hypothesized that men possess evolved mate preferences for women with this theoretically optimal angle of lumbar curvature. In Study 1, as hypothesized, men's attraction toward women increased as women's lumbar curvature approached this angle. However, vertebral wedging and buttock mass can both influence lumbar curvature. Study 2 thus employed a forced-choice paradigm in which men selected the most attractive woman among models exhibiting the same lumbar curvature, but for different morphological reasons. Men again tended to prefer women exhibiting cues to a degree of vertebral wedging closer to optimum. This included preferring women whose lumbar curvature specifically reflected vertebral wedging rather than buttock mass. These findings reveal novel, theoretically anchored, and previously undiscovered standards of attractiveness.



## 1. Introduction

A prevalent historical view in the behavioral sciences has been that human standards of beauty are arbitrary and dependent on sociocultural processes alone (e.g., Berscheid & Walster, 1974; Langlois et al., 1987). This view contrasts with evidence from non-human species that an organism's attractiveness as a mate is linked to traits that help solve adaptive challenges related to survival and reproduction (Norris, 1993; Petrie, 1994; Birkhead & Fletcher, 1995; Stacey, Eileen, Rebecca, & Kevin, 2011). We report independent studies testing the overarching proposal that human standards of attractiveness reflect the output of evolved psychological mechanisms designed to detect fitness-relevant traits (Symons, 1995; Thornhill & Gangestad, 1999; Gangestad & Scheyd, 2005; Sugiyama, 2005; Singh & Singh, 2011). Specifically, we tested novel hypotheses based on an adaptive challenge uniquely faced by ancestral hominin females: a bipedal fetal load.

### 1.1. Pregnancy and lumbar curvature

The combination of bipedalism and increased abdominal mass during pregnancy uniquely posed ancestral hominin females with the adaptive challenge of a forward-shifted center of mass (COM) during pregnancy. If this COM were not moved back over the hips, ancestral women would have been subjected to a nearly 800% increase in hip torque during pregnancy (Whitcome, Shapiro, & Lieberman, 2007). The muscular fatigue and lower back pain resulting from this hip torque would have impaired foraging efficiency (Whitcome et al., 2007). This would have left women and their families—including fetus, offspring, and mate—at risk of nutritional stress (Marlowe, 2003; Whitcome et al., 2007). Selection would therefore have favored morphological adaptation in women that enabled them to shift the gravid COM back over the hips.

The female hominin spine[1]—but not the male hominin spine—possesses evolved morphology to deal with this adaptive challenge: women possess wedging in the third-to-last lumbar vertebra (Whitcome et al., 2007). This wedging helps pregnant women shift their COM back over their hips, thereby reducing hip torque by over 90% (Whitcome et al., 2007). The inability to shift the COM back over

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[1] The contributions of the second and third authors were equal to one another.

[1] This includes the spine of females from the *Homo* genus as well as that of females from extinct bipedal hominin lineages (Whitcome et al., 2007).

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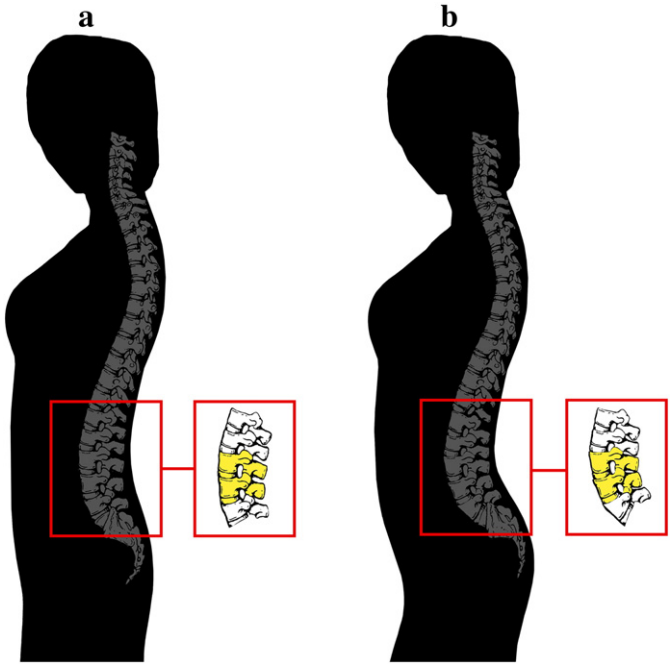


**Fig. 1.** A woman with (a) less vertebral wedging at the third-to-last lumbar vertebra (modal L3 depicted), and (b) greater wedging, resulting in a more acute angle of lumbar curvature.

the hip joints, on the other hand, results in sustained contraction of the lower back muscles, which increases risk of fatigue and injury (White & Punjabi, 1990).

Indeed, insufficient lumbar curvature (hypolordosis) is associated with lower back pain (Rath & Rath, 1997), but so is excessive lumbar curvature (hyperlordosis; Christie, Kumar, & Warren, 1995; Magnora, 1975). These countervailing forces would have resulted in stabilizing selection on ancestral women's spines. Selection would have favored vertebrae in women that were (1) sufficiently wedged to center the gravid COM back over the hips, but nonetheless (2) provided sufficient skeletal reinforcement to prevent hyperlordosis, fatigue, and spinal injury (White & Punjabi, 1990; Whitcome et al., 2007).

### 1.2. Women's lumbar curvature and male mating psychology

The fitness benefits experienced by ancestral women with a beneficial intermediate degree of lumbar wedging between hypolordosis and hyperlordosis would have created the background selective conditions for the evolution of a male mate preference for such women. Men who preferred and selected these women as mates would have gained several key fitness benefits, including having a mate who was less vulnerable to spinal injuries, better at foraging during pregnancy, and better able to sustain multiple pregnancies without debilitating injury. On this basis, we advance the hypothesis that selection fashioned psychological adaptations in men to detect cues to lumbar vertebral wedging in women and regulate mating attraction accordingly.

Ancestral men could not have directly observed potential mates' vertebrae, so their detection of vertebral wedging had to be based on observable cues. One cue to lumbar vertebral wedging is the curvature of the lower back (George, Hicks, Nevitt, Cauley, & Vogt, 2003). Wedging in the lumbar vertebrae extends the tailbone relative to the rest of the spine, resulting in a more acute angle between the thoracic back and buttocks (see Fig. 1).[2]

[2] Consistent with this, the sex difference in vertebral wedging is associated with a sex difference in external lumbar curvature (Fernand & Fox, 1985; women: mean = 47.19°, men: mean = 43.25°, Cohen's $d$ = .35).

We therefore advanced the hypothesis that men possess evolved mate preferences for lumbar curvature in women. Because the theoretically optimal degree of vertebral wedging for women is one that minimizes the net fitness threats posed by hypolordosis and hyperlordosis, we hypothesized that men should possess an evolved preference for women with an angle of lumbar curvature maximally distant from these countervailing threats, which orthopedic medical literature indicates is approximately 45.5° (see Fernand & Fox, 1985).

## 2. Study 1: lumbar curvature and attractiveness

Men rated the attractiveness of female models varying in lumbar curvature. Unlike previous research, we used profile rather than frontal images; the latter cannot capture important cues available only from alternative perspectives (Marlowe, Apicella, & Reed, 2005), such as lumbar curvature from the side. Consequently, the current studies are (1) among the few to employ non-frontal views, and (2) the first to assess the influence of lumbar curvature on physical attractiveness.

### 2.1. Method

#### 2.1.1. Participants

One hundred two men ($M_{age}$ = 19.00 years, $SD_{age}$ = 2.41, age range: 17–34 years) were recruited from the psychology subject pool at The University of Texas at Austin. Participants received course credit for participation.

#### 2.1.2. Photographic stimuli and attractive ratings

Fifteen images were generated in Adobe Photoshop by manipulating the angle of lumbar curvature of female targets. For each target, we generated five morphs of varying angles of lumbar curvature (see Fig. 2). These stimuli captured the naturally occurring range of lumbar curvature in the population (stimuli range: 14–69°; see Fernand & Fox, 1985). The targets' lumbar curvature was the sole variable that we manipulated.

All morphs were presented in random order to participants, who rated the attractiveness of each morph on a 10-point scale (1 = extremely unattractive, 10 = extremely attractive).

### 2.2. Results

#### 2.2.1. Statistical analysis

Because each participant rated the attractiveness of multiple morphs of each target, we tested the relationship between lumbar curvature and attractiveness via hierarchical linear modeling (HLM). Attractiveness ratings were clustered by participant-target combination to control for baseline differences in participants' perceptions of the targets' attractiveness. Controlling for between-target differences in attractiveness eliminated between-target influences on attractiveness (facial appearance, clothing, etc.), thereby isolating the relationship between lumbar curvature and attractiveness.

#### 2.2.2. Lumbar curvature and attractiveness

To test the relationship between women's lumbar curvature and attractiveness, we fitted three different models: (1) a simple linear relationship, (2) a curvilinear relationship with an unspecified inflection point, and (3) an inverse linear relationship between women's attractiveness and their lumbar *deviation* from the hypothesized optimum of 45.5°. Model 1 differs from model 3 in that model 1 posits that increases in lumbar curvature above the hypothesized optimum are associated with further increases in attractiveness, whereas model 3 proposes that further increases above this angle are associated with *decreased* attractiveness as women's spines approach hyperlordosis. Although both model 2 and model 3 are consistent with an evolutionary history of stabilizing selection, model 3 more directly reflects the idea that men possess an evolved mate preference specifically for the angle