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## RESEARCH IN ACTION

# Coital positions and clitoral blood flow: A biomechanical and sonographic analysis

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### KEYWORDS

Clitoris;  
Biomechanics;  
Sexual positions;  
Sonography

### Summary

**Objective.** – To create biomechanical models of five common coital positions, and evaluate the degree of contact and forces against the clitoris. To evaluate clitoral blood flow before and after engaging in these positions.

**Methods.** – Biomechanical models were rendered of a male and female pelvis in the following coital positions: face-to-face/female above, sitting/face-to-face, face-to-face/male above (with and without pillow), and kneeling/rear entry. The thrusting force and gravitational force were estimated for the pelvis(es) providing the main forces. The areas of contact between the pelvises were identified and highlighted. Sonography of the clitoris was performed before and after a healthy volunteer couple engaged in each position, using a Philips Lumify™ ultrasound (Koninklijke Philips N.V., Amsterdam, Netherlands) with a L12-4 linear array transducer (4–12 MHz).

**Results.** – The biomechanical models for each position, with the exception of kneeling/rear entry, reveal a large amount of contact with the clitoris. Clitoral blood flow increased after engaging in each position except for kneeling/rear entry. Positions in which the gravitational force of the thrusting partner was in the same direction of (and thereby augmenting) the thrusting force resulted in intense clitoral blood flow (face-to-face/female above, and face-to-face/male above). Augmenting the face-to-face/male above position with a pillow generated a component of the male pelvic gravitational force in the direction of the clitoris; this resulted in more blood flow to all components of the cavernous body.

**Conclusion.** – From a biomechanical perspective, different coital positions vary in their potential to stimulate the clitoris. These positions lead to variable increases in clitoral blood flow, concordant with our biomechanical models.

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## Introduction

The purported benefits of various coital positions are described in numerous magazines, books, and public forums. However, there is little scientific research that evaluates the association between different coital positions and their ability to produce female orgasm. A survey of Swedish women evaluated the tendency of various sexual techniques (but not positions) to cause climax. In this study, 51–57% of women achieved orgasm through penile penetration alone, and 50% through clitoral stimulation alone (Fugl-Meyer et al., 2006). Swieczkowski and Walker evaluated the ability of different coital positions to produce orgasm by administering a questionnaire with a 40-point Likert scale (ranging from 0/“not at all” to 40/“exclusively”). The average ratings, in order of decreasing orgasm potential, were: face-to-face/male above (28), face-to-face/female above (26.36), manipulation of female genitals by partner (23.47), cunnilingus (17.94), face-to-face/side position (16.73), stimulation of breasts and other non-genital areas (11.69), sitting/face-to-face (10.78), prone/rear entry (8.23), kneeling/rear entry (5.85), sitting/rear entry (3.81), stimulation by vibrator (2.26), and anal intercourse (0.89) (Swieczkowski and Walker, 1978).

In 2018, Krejcová et al. investigated coital positions in a group of Czech volunteers. Participants were shown a series of black and white drawings of 13 sexual positions and were asked to estimate what percentage of the time they led to orgasm; 9 positions were coital: face to face/male above, prone/rear entry, standing/face-to-face, standing, face-to-face/female above, supine/female above, kneeling/rear entry, sitting/face-to-face, and standing/rear entry. The most common positions (over participants' lifetimes, and within the past 5 years) were: face to face/male above (median 80% for females), face-to-face/female above (median 40% for females), and kneeling/rear entry (median 42% for women). The face to face/female above and sitting/face-to-face positions were most likely to result in orgasm, while the kneeling/rear entry position was least likely (Krejcová et al., 2020).

Krejcová et al. attribute the success of face-to-face positions to their ability to facilitate communication, both verbal and physical (Krejcová et al., 2020). Although these psychological factors are involved in orgasm (Meston et al., 2004; Brody, 2010; Brody and Costa, 2017; Adam et al., 2020), physical stimulation of the clitoris, which has been recognized as “possibly the most critical organ for female sexual health,” likely plays a dominant role (Mazloomdoost and Pauls, 2015). Female orgasm is hypothesized to be regulated by both autonomic and somatic nerves, and involves a complex reflex arc. According to O’Connell et al. (O’Connell et al., 2005) this process probably involves:

- Receptors within the clitoris and vulva detecting stimulus (i.e. touch);
- somatic afferents of the pudendal nerve (dorsal clitoral and perineal branches);
- S2-4 spinal cord levels transmitting information to the brain;
- visceral efferents of the pelvic splanchnic nerves;

- parasympathetic stimulation of the clitoris resulting in dilation of the of the clitoral arteries;
- erectile tissue of the clitoris becoming engorged with blood (increased inflow and decreased outflow of blood);
- secretions from the Bartholin and/or Skene glands and urethra;
- sympathetic stimulation of the urovaginal plexus (through the hypogastric nerves and inferior hypogastric plexus);
- skeletal muscle contraction of the vagina, anus, and urethra (through the pudendal nerve).

From a biomechanical perspective, pelvic floor muscles are also crucial to orgasm, with stronger pelvic floor muscles associated with improved sexual function (Kanter et al., 2015; Kegel, 1952; Graber and Kline-Graber, 1979; Lowenstein et al., 2010; Martinez et al., 2014). Although other biomechanical factors (i.e. forces against the clitoris) likely play a major role in this process, female orgasm has yet to be formally studied from this perspective. Researchers generally agree that there is a distinction between orgasms resulting from clitoral stimulation, or “clitoral orgasm” (CO), and those resulting from vaginal penetration without clitoral stimulation, or “vaginally activated orgasm” (VAO) (Jannini et al., 2012; Buisson and Jannini, 2013). A VAO is hypothesized to involve stimulation of the clitorourethrovaginal (CUV) complex (Jannini et al., 2012; Buisson and Jannini, 2013). Buisson and Jannini performed a sonographic study to evaluate clitoral blood flow after external and internal stimulation (Buisson and Jannini, 2013). Additional sonographic studies have evaluated the CUV complex (Buisson et al., 2008; Gravina et al., 2008; Foldes and Buisson, 2009; Battaglia et al., 2009; Battaglia et al., 2010a; Battaglia et al., 2010b). However, no sonographic studies have been performed to evaluate the efficacy of different coital positions.

## Materials/Patients

We evaluated different common coital positions and their ability to stimulate areas in the female pelvis that are involved in orgasm, with attention to the clitoris. The following five positions were assessed: face-to-face/female above, sitting/face-to-face, face-to-face/male above (with and without pillow), and kneeling/rear entry. These five positions were chosen because they were among the most or least likely to cause orgasm, or were the most common based on the results of Krejcová et al. (Krejcová et al., 2020). In their study, the face-to-face/female above and sitting/face-to-face positions were most likely to cause orgasm. The kneeling/rear entry position was least likely to cause orgasm. The face-to-face/male above position was evaluated because it was the most common (Krejcová et al., 2020). We also evaluated the face-to-face/male above position with a pillow because it is a common coital practice.

The five positions were performed by a healthy medical doctor couple, both 32-years-old, at home. Given the sensitive nature of the research, the participants were chosen because they were well-known to the researchers, and willingly volunteered for the study. The participants were in a monogamous relationship with each other. Both participants were healthy and had no sexually transmitted illnesses

or significant past medical history. They completed the Arizona Sexual Experiences Scale (ASEX) and the short form of the Female Sexual Function Index (FSFI-6), two validated tools for evaluating for sexual dysfunction; neither volunteer had sexual dysfunction. Informed consent was obtained for both participants. This study was carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki).

## Methods

Biomechanical anatomical drawings of a generic male and female pelvis were rendered in the five positions using Adobe Photoshop™ software. The male pelvis and penis were depicted with decreased opacification to better visualize the clitoris and vagina. Areas of contact between the female vulva, vagina, and her partner's skin and penis were rendered in pink. The dominant forces involved in each coital position were depicted with vector arrows. Of note, the magnitudes of the vectors were chosen arbitrarily, as they depend on participant mass and thrusting forces (which are partner-dependent). The gravitational force at the pelvic center of mass was depicted for the pelvis that provided the thrusting force; this allowed us to evaluate whether gravity (or its resolved components) added to the overall force directed against the clitoris. The location of the center of gravity was estimated based on data from the Human Performance Lab (Cincinnati Children's Hospital) (Body Center of Mass, 2022).

The five positions were evaluated in the volunteer couple. The duration of each position was 10 minutes. The objective was to compare clitoral blood flow before and after coitus in each of the five positions, after a standardized period of time. Although it was not necessary to achieve orgasm, it was recorded if it occurred. Clitoral ultrasound was performed, with grayscale and color Doppler ultrasound images obtained before and after coitus, in the coronal and sagittal planes. Ultrasound was chosen as the imaging modality, as it is an efficient, low-cost method to evaluate the clitoris, and can be performed in any setting (i.e. at home). Grayscale ultrasound images (not evaluating blood flow) were acquired to assess clitoral anatomy. Color Doppler ultrasound images were obtained to evaluate blood flow before and after clitoral stimulation. The ultrasound images were obtained with a Philips Lumify™ ultrasound machine and L12-4 linear array (4–12 MHz) transducer. Clitoral blood flow was assessed qualitatively with a uniform gain setting for all Doppler acquisitions. A uniform light pressure was applied with the transducer, acknowledging that heavier pressure could skew blood flow. Each coital position was evaluated on a different day to allow the clitoral blood flow to return to baseline. This ensured that the order in which the coital positions was evaluated did not influence the results.

## Results

The ultrasound acquisitions in the transverse plane reveal paired, hypoechoic cavernous bodies on either side of the urethra. In the sagittal image, the glans, raphe, and body of the cavernous body are visualized. The ischiopubic ramus is

adjacent to the cavernous body. The vestibular bulbs are on a more medial plane than the cavernous bodies, and are not seen in the sagittal image (Fig. 1).

The biomechanical models for each position, with the exception of the kneeling/rear entry position, reveal a large amount of contact between the female's clitoris and her partner's skin.

In the biomechanical model for the face-to-face/female above position, the gravitational force at the female pelvis center of mass is in the same direction as the female thrusting force (Fig. 2a). This resulted in intense, symmetric blood flow to all three parts of the cavernous bodies: the medial aspect of the body and raphe, and the proximal aspect of the glans (Fig. 2).

For the sitting/face-to-face position, both partners provide a thrusting force in opposite directions. The location of the center of gravity for the male and female pelvis are approximately in the same location between the partners. This gravitational force is perpendicular to both thrusting force vectors (Fig. 3a). This position led to a relatively small, symmetric increase in blood flow, localized to the medial aspect of the cavernous bodies (Fig. 3).

In the face-to-face/male above position, the gravitational force of the male pelvis is almost perpendicular to his thrusting force (Fig. 4a). This led to an intense, diffuse increase in blood flow to all aspects of the cavernous bodies, and to the surrounding pelvic tissues (Fig. 4). Modifying the face-to-face/male above position with a pillow can be modeled with the male and female pelvises on an inclined plane. The force of gravity from the male pelvis ( $F_g$ ) is resolved into two components: the gravitational force perpendicular to the inclined plane ( $F_{\perp}$ ), and the gravitational force parallel to the plane ( $F_{\parallel}$ ) (Fig. 5a). This led to an intense, symmetric blood flow to the body and raphe of the cavernous body (Fig. 5).

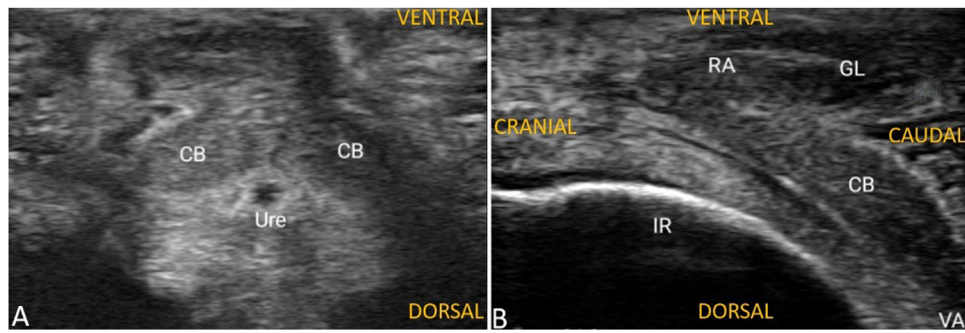
The biomechanical model for the kneeling/rear entry position reveals minimal contact between the female's clitoris and her partner's skin. The male thrusting force is perpendicular to the gravitational force at the female pelvis' center of gravity (Fig. 6a). This resulted in a negligible increase in blood flow (Fig. 6).

The male and female volunteers achieved orgasm during all five sessions.

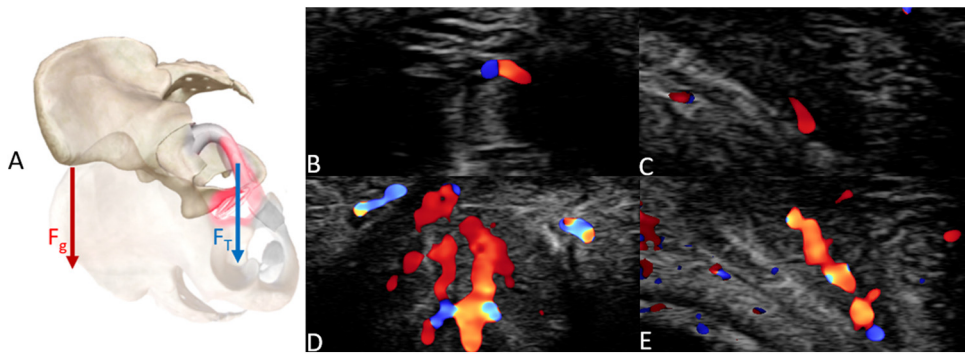
## Discussion

The biomechanical models of the face-to-face positions (including face-to-face/female above, face-to-face/male above with and without pillow, and sitting/face-to-face) demonstrate a considerable amount of contact between the female pelvis and her partner's skin. Although Krejcová et al. attribute the success of the face-to-face positions to their ability to facilitate verbal and physical communication (Krejcová et al., 2020), our models support our hypothesis that face-to-face positions also maximize clitoral stimulation and increase blood flow. The kneeling/rear entry position produces the least amount of direct clitoral contact, and resulted in a negligible increase in blood flow compared to the face-to-face positions.

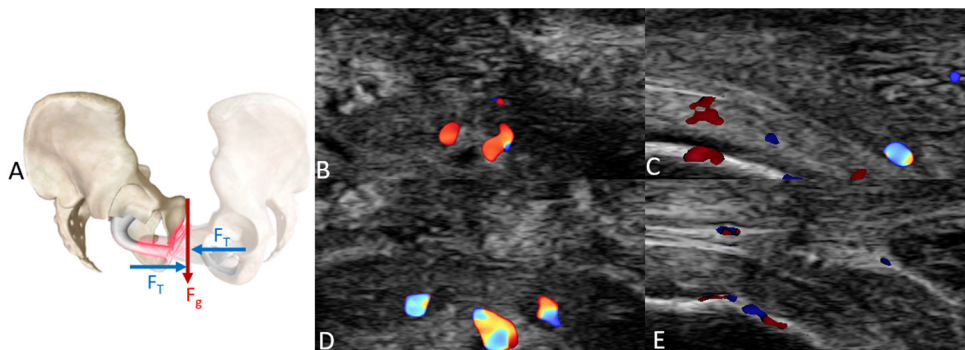
According to Krejcová et al., the face-to-face/female above position was among the most likely to lead to



**Figure 1** Transverse (a) and sagittal (b) views of the clitoris depicting the paired cavernous bodies (CB) urethra (Ure), glans (GL), raphe (RA), ischiopubic ramus (IR), and vagina (VA).



**Figure 2** Biomechanical model of the face-to-face/female above position. The thrusting force ( $F_T$ ) is provided by the female pelvis, and is in the same direction as the gravitational force ( $F_g$ ) at the female pelvis center of mass (a). Transverse and sagittal views of the clitoris before (b and c) and after (d and e) engaging in the face-to-face/female above position, with color Doppler flow.

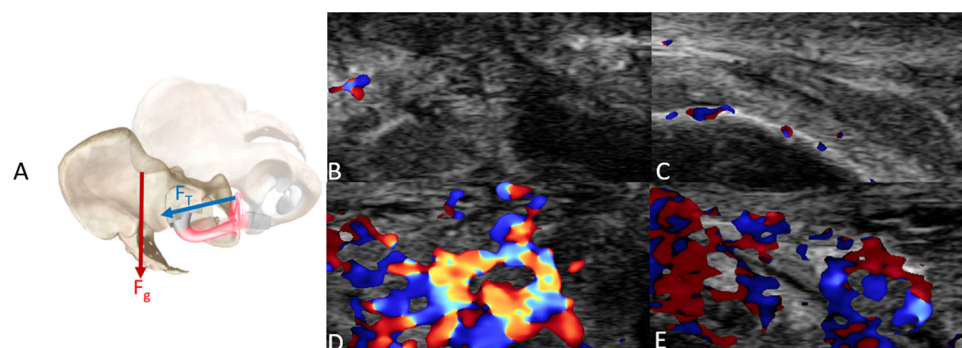


**Figure 3** Biomechanical model of the sitting/face-to-face position (a). Both partners apply a thrusting force ( $F_T$ ) in opposite directions, which are both perpendicular to the female and male pelvis gravitational force ( $F_g$ ). Transverse and sagittal views of the clitoris before (b and c) and after (d and e) engaging in the sitting/face-to-face position, with color Doppler flow.

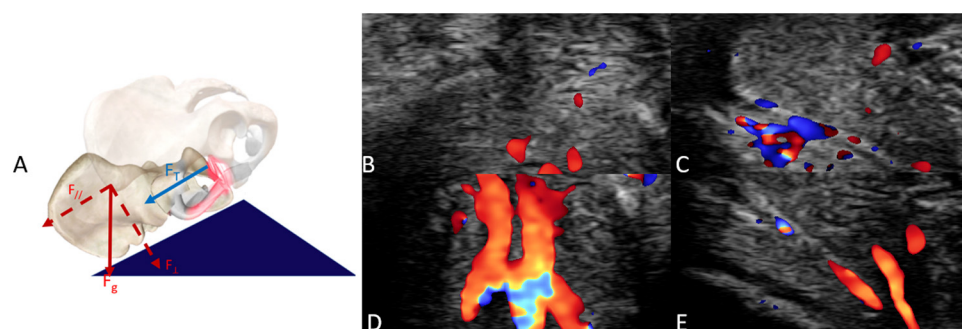
orgasm (Krejcová et al., 2020). Based on the biomechanical model, with the female positioned above, the downward force of gravity maximizes the pressure on the clitoris. This gravitational force is also in the same direction as the female thrusting force, which can help facilitate this motion. Additionally, compared to when she is below her partner, she has more control over the pressure exerted against the clitoris. Although this position did not lead to the largest increase in blood flow, it was the only position in which all aspects of the cavernous body were involved.

Krejcová et al. found that the sitting/face-to-face position had a high likelihood of causing orgasm (Krejcová et al., 2020), which is supported by our model. This position allows each partner equal opportunity to exert a thrusting force against the other, which can increase the pressure against the clitoris. Of note, the gravitational force is perpendicular to both partners' thrusting forces, and does not contribute to the total force (and therefore pressure) exerted against the clitoris. These biomechanical factors might explain why the sitting/face-to-face position has a high likelihood of causing climax, but is not the most likely. These findings are

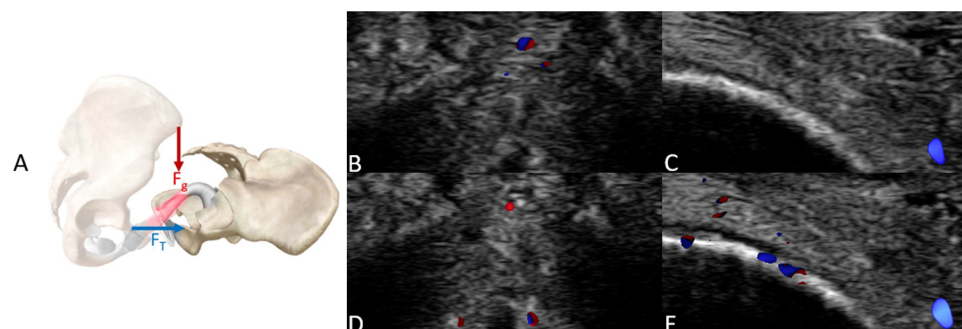




**Figure 4** Biomechanical model of the face-to-face/male above position (a). The thrusting force ( $F_T$ ) is provided by the male pelvis, and is approximately perpendicular to the gravitational force of the male pelvis ( $F_g$ ). Transverse and sagittal views of the clitoris before (b and c) and after (d and e) engaging in the face-to-face/male above position, with color Doppler flow.



**Figure 5** Biomechanical model of the face-to-face/male above with a pillow (a). The thrusting force ( $F_T$ ) is provided by the male pelvis. The force of gravity from the male pelvis ( $F_g$ ) is resolved into two components: the gravitational force perpendicular to the inclined plane ( $F_{\perp}$ ), and the gravitational force parallel to the plane ( $F_{\parallel}$ ). Transverse and sagittal views of the clitoris before (b and c) and after (d and e) engaging in the face-to-face/male above position with pillow, with color Doppler flow.



**Figure 6** Biomechanical model of the kneeling/rear entry position (a). The thrusting force ( $F_T$ ) is provided by the male pelvis, and is approximately perpendicular to the gravitational force of the male pelvis ( $F_g$ ). Transverse and sagittal views of the clitoris before (b and c) and after (d and e) engaging in the kneeling/rear entry position.

corroborated by ultrasound: the sitting/face-to-face position resulted in increased blood flow compared to baseline, but less than the positions in which pelvic gravitational force is exerted against the clitoris.

The face-to-face/male above position (without a pillow) was the most common position reported by Krejcová et al. (median 80% for females). However, it was not among the positions most likely to lead to orgasm (Krejcová et al., 2020). This finding might be explained by the woman having less control over the pressure exerted against the vulva. Interestingly, this position led to the largest increase in

blood flow to the clitoris and surrounding tissues, which was diffuse. A variation of this position involves the woman tilting her pelvis upwards, sometimes with the aid of a pillow. Pillows marketed for this intention, often referred to as “sex pillows,” or “positioning pillows” are usually firm and wedged shaped, providing more precise and consistent pelvic angulation than conventional bed pillows. Although Krejcová et al. did not evaluate the frequency of orgasm when a pillow was used in this position, the biomechanical models suggest that a pillow would increase the likelihood of orgasm: a female can adjust herself on the pillow to increase

the amount of contact between the clitoris and her partner's skin. The  $F_{//}$  component of gravity created by the "inclined plane" of the pillow allows more force (and therefore pressure) to be directed from the male pelvis to the clitoris. In addition to increasing the amount of contact and pressure on the clitoris, pillows can increase the depth of penetration. Of note, the participants studied by Krejcová et al. rated positions with deep vaginal penetration as more pleasurable (Krejcová et al., 2020). In our volunteer couple, this position resulted in an intense, symmetric increase in blood flow to the clitoris, less diffuse than when a pillow was not used.

Krejcová et al. found that the median frequency of the kneeling/rear entry position was among the least likely to result in orgasm (Krejcová et al., 2020). Because the penis spans the posterior aspect of the perineum to enter the vagina, this position might result in decreased contact with the clitoral bulbs, therefore making orgasm less likely. This was supported by our biomechanical model, which demonstrates the least clitoral contact compared to the other positions studied. This led to a minimal increase in clitoral blood flow.

Our study was limited to creating biomechanical models for five coital positions, and evaluating changes in clitoral blood flow in one female volunteer after engaging in these positions. Individual women might have different responsiveness to stimulation from these positions. Additionally, different partners might exert varying degrees of thrusting forces, which would impact the predictions of the biomechanical models. Psychological factors also play a role in clitoral blood flow and orgasm, and are not accounted for in this investigation (Meston et al., 2004; Brody, 2010; Brody and Costa, 2017). Since this is a pilot study, it is important that it be replicated with a larger number of subjects.

## Conclusions

Our findings suggest that, from a biomechanical perspective, different coital positions vary in their potential to stimulate the clitoris. These positions lead to variable increases in clitoral blood flow, concordant with our biomechanical models. According to our results, face-to-face positions are more likely to lead to orgasm because they maximize clitoral stimulation and blood flow. In addition, positions in which the female partner has more control over the pressure exerted on the clitoris (i.e. female above) produce more uniform increases in clitoral blood flow. These results can help clinicians inform patients with sexual dysfunction. Difficulty achieving orgasm, the causes of which are multifactorial, is one component of sexual dysfunction. Clinicians can use these findings to counsel patients about which coital positions might help them achieve climax.

## Disclosure of interest

The authors declare that they have no competing interest.

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