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Testosterone-dependent facial and body traits predict men's sociosexual attitudes and behaviors

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Abstract
Objectives: Strategic Pluralism Theory contends that human mating strategies are calibrated toward short-term (ST) or long-term (LT) mating according to the expression of condition-dependent traits and characteristics of the social and physical environment. Traits reflecting the effects of testosterone have been considered condition-dependent traits that provide information about the calibration of male mating strategy. We investigated the relationship of muscle mass and facial masculinity with attitudes and behaviors reflecting ST and LT mating tactics.
Methods: We measured skeletal muscle mass (SMM) through bioelectrical impedance and facial width-to-height ratio (fWHR) in a sample of Chilean men ($n = 206$; mean age $= 22.52 \pm 4.65$ SD), and collected information about sociosexual attitudes and past sexual behavior.
Results: Our results showed an interaction effect of SMM and fWHR on unrestricted (but not restricted) sociosexual attitudes and past sexual behavior. Individuals with a consistent expression of both traits (ie, high SMM and fWHR or low SMM and fWHR) reported higher levels of unrestricted sociosexual attitudes and a greater number of lifetime and previous-year sexual partners.
Conclusions: These findings suggest that the intensity and consistency of expression of body and facial masculinity is important in signaling male mating tactics and sociosexual attitudes.

1 | INTRODUCTION

Natural selection favors traits that facilitate survival and reproduction (Andersson, 1994). Given limited resources, including time and energy, investment in the development, maintenance, and display of such traits is costly and must be considered together with other investments (Stearns, 1992). A foundational trade-off is that between mating effort and parental care (Magrath & Komdeur, 2003). In this regard, humans display physical and psychological traits as part of a mating repertoire that is related to both mating and parental effort (Buss & Schmitt, 2019; Wilson, Miller, & Crouse, 2017). Humans are highly altricial (Lovejoy, 1981) and possess neurophysiological systems that facilitate long-term (LT) pair-bonding (Young, 2003). However, infidelity, poaching, and cuckoldry have been documented across cultures (Macintyre & Sooman, 1991; MØller & Birkhead, 1989; Puts, 2010; Wrangham, 1993), indicating that some individuals are prone to pursuit of short-term (ST) mating. These phenomena have motivated the study of traits that underlie variation in human mating strategies (Buss & Schmitt, 2019).

Strategic Pluralism Theory proposes that mating strategies of both men and women are calibrated toward ST or LT mating according to the expression of condition-dependent traits and characteristics of the social and physical environment (Gangestad & Simpson, 2000). Short-term mating tactics can be characterized by low commitment and low investment in the current partner and by a high number of past sexual partners, whereas LT mating tactics include high commitment and high investment in the current partner and fewer past

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sexual partners (Buss & Schmitt, 1993). Consequently, the pluralistic mating strategy of humans represents a flexible solution to the trade-off between investing in mating or in parenting. This trade-off is especially salient for men, who have higher potential reproductive rates than women due to a difference in minimum obligatory parental investment (Trivers, 1972). As a general pattern, the sex that invests less in parental care is expected to pursue low-investment mating with multiple partners (Symons, 1979). However, pursuing this mating strategy is time-consuming and risky due to the potential consequences of intrasexual competition (Höglund & Sheldon, 1998). It is costly in terms of foregone paternal investment that in ancestral environments contributed to offspring survival (Geary, 2000). Moreover, such men must be selected as mates by women who accept their lower parental investment. As a result, pursuit of multiple mates may benefit only those men displaying traits that increase their success as a ST mate and in male–male competition for mates (Gangestad & Simpson, 2000). Empirical evidence indicates that there is variation in the expression of ST and LT mating strategies in men and that some of this variation may be attributed to differences in testosterone (T) levels affecting morphology and behavior (Buss & Schmitt, 2019).

Traits reflecting effects of T, such as body muscularity and facial masculinity (Evans, 2004), have been considered condition-dependent traits that provide information about male mating strategy because they are involved in both mate choice and male-male competition. Regarding mate choice, T levels during development correlate with traits that may be honest indicators of immunocompetence in males (Bribiescas, 2001; Foo, Nakagawa, Rhodes, & Simmons, 2017). There is some disagreement about the role of T as an immunosuppressant (Nowak, Pawłowski, Borkowska, Augustyniak, & Drulis-Kawa, 2018; Scott, Clark, Boothroyd, & Penton-Voak, 2012). Such traits are rated as attractive by females pursuing a ST mate. Women prefer facial and bodily masculinity in the context of ST mating (Crossley, Cornelissen, & Tovée, 2012; Dixson, Halliwell, East, Wignarajah, & Anderson, 2003; Dixson, Sulikowski, Gouda-Vossos, Rantala, & Brooks, 2016; Frederick & Haselton, 2007; Hönekopp, Rudolph, Beier, Liebert, & Müller, 2007; Johnston, Hagel, Franklin, Fink, & Grammer, 2001; Jones et al., 2018; Little, Cohen, Jones, & Belsky, 2007; Marcinkowska, Jasienska, & Prokop, 2017; Puts, Jones, & DeBruine, 2012; Sell, Lukazsweski, & Townsley, 2017; Thornhill & Gangestad, 1999; Valentine, Li, Penke, & Perrett, 2014). Regarding male–male competition, there is evidence from the study of men's psychology, behavior, and anatomy that intrasexual competition was a source of ancestral selection pressure for men (Puts, 2010). T-dependent traits are related to fighting ability and success in contest competition with other men (Puts, Bailey, & Reno, 2015). Accordingly, the role of T-dependent traits seems to be related to competition between men by self-promotion as well as by direct contest competition (Puts et al., 2015; Roney, 2009), thereby functioning as dual signals (Berglund, Bisazza, & Pilastro, 1996).

Previous studies have documented links between male body and facial masculinity and sociosexuality. Sociosexuality refers to individual differences in willingness to engage in uncommitted sexual relationships and is often considered an aggregation of sexual attitudes and behaviors (Jackson & Kirkpatrick, 2007; Penke & Asendorpf, 2008; Simpson & Gangestad, 1991). Sociosexual attitudes reflect interest in committed or uncommitted sex. Those with a *restricted* sociosexual attitude require commitment and closeness to engage in sexual relationships, whereas those with an *unrestricted* sociosexual attitude feel comfortable engaging in sexual relationships without commitment or closeness (Gangestad & Simpson, 2000). Sociosexual behavior, measured as the number of previous sexual partners, is the behavioral manifestation of sociosexual attitudes and reflects the allocation of effort to ST versus LT mating tactics. Self-reported measures of body muscularity are positively associated with the number of lifetime sexual partners, the number of ST sexual partners, and the number of affairs with already-partnered women (Frederick & Haselton, 2007). Moreover, women's ratings of men's muscularity are positively correlated with men's display of a ST mating tactic (Gangestad, Garver-Apgar, Simpson, & Cousins, 2007). Indirect measures of muscularity also are positively related to men's ST mating tactic. Concretely, hand grip strength (HGS) and shoulder-to-hip ratio (SHR) are positively correlated with unrestricted sociosexual attitudes and several measures of mating success, including number of sexual partners, age of first intercourse, number of extra-pair copulations, and number of sex partners concomitantly engaged in other relationships (Gallup & Fink, 2018; Gallup, White, & Gallup Jr, 2007; Hughes & Gallup, 2003; Lukaszewski, Larson, Gildersleeve, Roney, & Haselton, 2014).

Direct measures of male muscularity and their relationships with measures of sociosexuality are less frequently reported in the literature. Limb muscle volume is positively related to the number of lifetime and previous-year sexual partners and negatively related to age at first intercourse, whereas fat-free body mass is positively related to the number of lifetime sexual partners (Lassek & Gaulin, 2009). However, the association of muscular mass (assessed objectively) with sociosexual attitudes has not been investigated. Measures of facial masculinization have been associated with unrestricted sociosexual attitudes and greater number of sexual partners (Boothroyd, Cross, Gray, Coombes, & Gregson-Curtis, 2011; Boothroyd, Jones, Burt, DeBruine, & Perret, 2008; Kruger, 2006). Anthropometric measures of masculinity, including facial width-to-height ratio (fWHR), have been related in both sexes to sex drive and unrestricted sociosexual attitudes (Arnocky et al., 2018). Facial width-to-height ratio is a widely-used measure of masculinity associated with aggression and dominance (Alrajih & Ward, 2014; Carré & McCormick, 2008; Geniole, Denson, Dixson, Carré, &

McCormick, 2015; Haselhuhn, Ormiston, & Wong, 2015). Further evidence indicates a relationship between fWHR and (a) levels of pubertal T controlling for age (Hodges-Simeon, Hanson Sobraske, Samore, Gurven, & Gaulin, 2016), and (b) levels of adult baseline and reactive T (Lefevre, Lewis, Perrett, & Penke, 2013). However, these findings have been disputed, as other studies did not find the links between fWHR and basal and reactive levels of T (Bird et al., 2016). In addition, there is controversy about whether fWHR is a sex-dimorphic facial metric because some studies reported sex differences (Geniole et al., 2015) whereas other studies did not (Kramer, 2017; Lefevre, Etchells, Howell, Clark, & Penton-Voak, 2014).

Most of the previous studies reporting anthropometric correlations with sociosexuality were based on indirect measures of muscularity, such as HGS and SHR. In addition, these studies considered sociosexual attitudes as a unidimensional construct, precluding the investigation of whether T-related traits are independently associated with mating and parenting effort. Lukaszewski et al. (2014) found that physical strength and attractiveness were related to unrestricted sociosexual attitude, but unrelated to restricted sociosexual attitude, suggesting two independent dimensions of sociosexual attitudes. In this study, we measured skeletal muscular mass (SMM) and fWHR to investigate the relationships between T-related morphological traits and sociosexual attitudes and behaviors. Although both traits are related to pubertal levels of T, SMM (vs fWHR) is more dependent on current condition and can be modified after the pubertal developmental period. In this regard, inconsistencies in the expression of both traits may indicate an inability to maintain a current investment in muscular tissue according to their levels of facial markers of pubertal T (ie, individuals high in fWHR but low in SMM) or the ability to overexpress the investment in muscular tissue according to their levels of facial markers of pubertal T (ie, individuals low in fWHR but high in SMM). Accordingly, the traits and their consistent or inconsistent expression may convey somewhat different information that may affect female decisions and male sociosexual behaviors (Little, Connely, Feinberg, Jones, & Roberts, 2011; Wagstaff, Sulikowski, & Burke, 2015). Furthermore, the use of multiple cues in sexual selection processes (eg, mate choice, sexual coercion) is common in many organisms, emphasizing the need to consider multiple traits to increase our understanding about sexual selective processes (Candolin, 2003). Thus, in this study, we investigated the joint effect of both variables to evaluate the possibility that different traits correlated with T levels interact to predict sexual strategy. We considered both the total SMM and upper-body fat-free mass because research indicates that upper-body strength is one of the most important traits in intrasexual competition in humans (Puts, 2010; Sell, Hone, & Pound, 2012). Accordingly, the relationship between T-related traits with sociosexual attitudes and behaviors may be greater when considering only traits involved in the upper body.

We hypothesized that body muscularity and facial masculinity would be related to ST but not to LT mating tactics in men. Thus, men with greater SMM (or upper body fat-free mass) and fWHR should report a higher unrestricted sociosexual attitude. This relationship should be greater when both traits are highly expressed (Hypothesis 1). Moreover, men with greater SMM (upper body fat-free mass) and fWHR should report more past sexual partners, both over the lifetime and in the previous year, and more one-time sexual partners. This relationship should be greater when both traits are highly expressed (Hypothesis 2). Finally, we expected that both traits SMM (upper body fat-free mass) and fWHR would be unrelated to the expression of a restricted sociosexual attitude (Hypothesis 3).

2 | MATERIAL AND METHODS

2.1 | Participants

Our sample was 206 heterosexual men aged 18 to 38 years ($M = 22.52$, SD = 4.65). Participants were recruited from the student and general populations in the region of Valparaíso (Chile) through billboard advertisements. Anthropometric measurements were collected in the *Laboratorio de Comportamiento Animal y Humano, Centro de Estudios Avanzados* of *Universidad de Playa Ancha*. Participants provided written informed consent, and the study protocol was approved by the Ethics Committee of the Universidad de Playa Ancha. At the end of the data collection session, participants were dismissed and were paid 5.000 Chilean pesos as a compensation for their time and a variable amount from 0 to 2.000 Chilean pesos according to their choices in several economic games they played as a part of a wider study.

2.2 | Anthropometric Measures

2.2.1 | Body Measurements

Body height (cm) was measured barefoot and with a stadiometer (SECA 213). Skeletal muscle mass (kg), upper-body fat-free mass (kg), and body mass index (BMI) were assessed with a body composition analyzer (Inbody 370). This device employs a tetrapolar 8-point tactile electrode for measurements through a direct segmental multifrequency bioelectrical impedance analysis method (DSM-BIA). The technology assumes the body as five cylinders (four limbs and one trunk) and measures the bioelectrical impedance of these parts separately. The DSM-BIA is a valid tool for the assessment of total and segmental body composition (Ling et al., 2011). The device automatically records skeletal body mass of the full body and fat-free mass, but not skeletal body mass, for each of the five segments.

2.2.2 | Facial Measurement

Facial photographs were taken in frontal view with a digital SLR camera (Nikon D7000) under constant conditions of light, head orientation, focal length (3 m), shutter speed (1/60 s) and aperture (f/5.6). Any facial adornment was removed, and participants were instructed to look straight into the camera with a neutral expression.

Facial width-to-height ratio was measured from photographs following the protocol provided by Carré and McCormick (2008) and used in previous studies (Muñoz-Reyes et al., 2014; Sanchez-Pages, Rodriguez-Ruiz, & Turiegano, 2014). Four landmarks were placed on digital images of participants' faces using TPSdig software (see http://life.bio.sunysb.edu/morph). These landmarks delineate the distance (in pixels) between the upper part of the lip and the forehead (facial height) and the distance between the left and right zygion (facial width). Finally, the width measurement was divided by the height measurement.

2.3 | Psychometric and sociodemographic measures

2.3.1 | Sociosexual Orientation Inventory

Participants completed a Chilean adaptation (Fernández et al., unpublished) of the Multifactorial Sociosexual Orientation Index developed by Jackson and Kirkpatrick (2007). This index assesses unrestricted sociosexual attitudes (10 items), restricted sociosexual attitudes (seven items), and sociosexual behavior (five items). Three of the sociosexual behavior items are related to previous sexual behavior (lifetime, previous-year, and one-time sexual partners), one item to sexual fantasies, and one item to expectations about the number of future sexual partners. In this study, we considered only the attitudinal items and behavioral items related to previous sexual behavior. The attitudinal items are answered on a 7-point Likert scale (1 = strongly disagree to 7 = strongly agree) and the behavioral items use an open format that requires numerical responses. Internal consistency, measured with Cronbach's alpha, was high for both unrestricted ($\alpha = 0.90$) and restricted ($\alpha = 0.85$) sociosexual attitudes. Three and five individuals did not provide information about lifetime and one-time sexual partners, respectively, thus reducing the sample size to n = 203 and n = 201 accordingly.

2.3.2 | Sociodemographic questionnaire

Participants answered a brief questionnaire about their relationship status (ie, whether they were single or in a romantic relationship), the duration of their current relationship (months), age (years), sexual orientation (open question), and place where they grew up (open question).

2.4 | Data Analysis

We fitted five general linear models (GLM) to test our three hypotheses. The main difference between them was the dependent variable: unrestricted sociosexual attitude for Hypothesis 1, lifetime, previous-year, and one-time sexual partners for Hypothesis 2, and restricted sociosexual attitude for Hypothesis 3. As commonalities for all GLMs, individuals were classified into high- or low-muscular men if their values for SMM were above or below the mean value of SMM in the sample, respectively. The same procedure was performed to classify individuals as high or low in fWHR. Preliminary analysis with the original variables (ie, continuous SMM and fWHR) showed that the interaction between both variables was significant when analyzing unrestricted sociosexual attitudes, lifetime, and previous-year sexual partners. After classification of these variables, these interactions remained significant. BMI and height were treated as covariates because they may influence muscularity and fWHR (Lassek & Gaulin, 2009). Finally, age and current relationship status may affect sociosexual attitudes and behavior; thus, both variables were included in the analyses as covariates. We used a step-up strategy to identify the simplest model that provides the best fit to the observed data (Burnham & Anderson, 2002). Thus, we compared nested models with the likelihood ratio test and selected only models that significantly improved the fit of the previous model.

The assessment of the distribution of residuals revealed no violation of the assumption of normality for unrestricted and restricted sociosexual attitudes. However, this assumption was violated for lifetime, previous-year, and one-time sexual partners. Log-transformation of data solved the normality violation, but only in the case of lifetime and previous-year sexual partners. In these instances, the results did not differ when considering original or log-transformed data and they are reported for original data. Due to the violation of the normality assumption in the case of one-time sexual partners even after the transformation, we fitted a logistic binary regression considering the following two categories for one-time sexual partners: those men who reported less than two one-time sexual partners and those that reported more than one.

Finally, consideration of only the upper body fat-free mass instead of the SMM did not change the results. In fact, the variables were highly correlated ($r = 0.96$, n = 206, $P < 0.001$). Consequently, we report only results from total SMM. We used IBM SPSS 21 for statistical analysis and set the level of significance to 0.05.

3 | RESULTS

Table 1 reports descriptive statistics for physical and behavioral measures. With regard to the relationships of SMM and fWHR with unrestricted sociosexual attitude (Hypothesis 1), the fitted model ($F(4,201) = 5.76$, $P < 0.001$, $\eta_p^2 = 0.103$) is shown in Table 2. There was a main effect of relationship status ($F(1,201) = 11.54$, $P = 0.001$, $\eta_p^2 = 0.054$) and an interaction effect of SMM and fWHR ($F(1,201) = 12.59$, $P < 0.001$, $\eta_p^2 = 0.059$). According to estimated marginal means, single men reported higher scores on unrestricted

TABLE 1 Mean and SD, and median, minimum, and maximum values for each variable according to their distribution

	M ± SD	*N*		*Mdn* (min, max)	*N*
UnSA	44.46 ± 14.10	206	**Lifetime partners**	4 (0, 50)	203
ReSA	39.04 ± 10.09	206	**Last year partners**	1 (0, 12)	206
SMM	32.27 ± 4.11	206	**One-time partners**	1 (0, 10)	201
fWHR	2.11 ± 0.17	206	**BMI**	23.40 (16.70, 36.20)	206
Age	22.36 ± 4.46	206			
Height	173.41 ± 6.29	206			

Note: UnSA, Unrestricted sociosexual attitude; ReSA, Restricted sociosexual attitude; fWHR, Facial width-to-height ratio; BMI, Body mass index.

sociosexual attitude ($M = 46.46$, SE = 1.26) than men who reported to be in a relationship ($M = 39.96$, SE = 1.47; $M \pm$ SE difference = 6.51 ± 1.92; $P = 0.001$). Figure 1 illustrates the interaction of SMM and fWHR in relation to unrestricted sociosexual attitude. According to estimated marginal means, high-muscular men reported higher scores of unrestricted sociosexual attitude ($M = 45.59$, SE = 1.77) than low-muscular men ($M = 39.35$, SE = 2.15), but only if they were classified as high in fWHR ($M \pm$ SE difference = 6.24 ± 2.76; $P = 0.025$). The pattern was reversed for individuals classified as low in fWHR, such that high-muscular men reported lower scores of unrestricted sociosexual attitude ($M = 40.21$, SE = 2.14) than low-muscular men ($M = 47.70$, SE = 1.65; $M \pm$ SE difference = −7.49 ± 2.70; $P = 0.006$). Similarly, men high in fWHR reported higher scores on unrestricted sociosexual attitude ($M = 45.59$, SE = 1.77) than men low on fWHR ($M = 40.21$, SE = 2.14), but only if they were classified as high in muscularity ($M \pm$ SE difference = 5.38 ± 2.76; $P = 0.053$). Men high on fWHR reported lower scores on unrestricted sociosexual attitude ($M = 39.35$, SE = 2.15) than men low on fWHR ($M = 47.70$, SE = 1.65), but only if they were classified as low in muscularity ($M \pm$ SE difference = −8.35 ± 2.72; $P = 0.002$).

To test our second hypothesis, two GLM and a logistic binary regression were fitted. Table 3 reports the fitted model for the relationships between SMM and fWHR with the number of lifetime sexual partners ($F(4,198) = 15.58$, $P < 0.001$, $\eta_p^2 = 0.239$). There was a main effect of age ($F(1,198) = 48.56$, $P < 0.001$, $\eta_p^2 = 0.197$) and an interaction effect of SMM and fWHR ($F(1,198) = 8.62$, $P = 0.004$, $\eta_p^2 = 0.042$). Age was positively related to number of lifetime sexual partners ($b = 0.76$, SE = 0.11, $P < 0.001$, $\eta_p^2 = 0.197$). Figure 2 depicts the interaction of SMM and fWHR in relation to the number of lifetime sexual partners. According to estimated marginal means, high-muscular men reported more lifetime sexual partners ($M = 7.90$, SE = 0.90) than low-muscular men ($M = 4.52$, SE = 1.09), but only if they were classified as high in fWHR ($M \pm$ SE difference = 3.38 ± 1.41; $P = 0.018$). The pattern was reversed for individuals classified as low in fWHR, such that high-muscular men reported fewer lifetime sexual partners ($M = 4.51$, SE = 1.10) than low-muscular men ($M = 6.94$, SE = 0.85; $M \pm$ SE difference = −2.44 ± 1.39; $P = 0.081$). Similarly, men high on fWHR reported more lifetime sexual partners ($M = 7.90$, SE = 0.90) than men low on fWHR ($M = 4.51$, SE = 1.10), but only if they were classified as high in muscularity ($M \pm$ SE difference = 3.39 ± 1.42; $P = 0.018$). Men high on fWHR reported fewer lifetime sexual partners ($M = 4.52$, SE = 1.09) than men low on fWHR ($M = 6.94$, SE = 0.85), but only if they were classified as low in muscularity ($M \pm$ SE difference = −2.42 ± 1.38; $P = 0.080$).

Table 4 reports the fitted model for the relationships between SMM and fWHR with the number of previous-year sexual partners ($F(3,199) = 3.43$, $P = 0.018$, $\eta_p^2 = 0.049$). The model only includes the interaction between SMM and fWHR ($F(1,199) = 9.72$, $P = 0.002$, $\eta_p^2 = 0.047$). Figure 3 illustrates the interaction between SMM and fWHR with previous-year sexual partners. According to estimated marginal means, high-muscular men reported more previous-

TABLE 2 Unrestricted sociosexual attitude fitted model

	b	*t*-value	*P*	η_p^2
Intercept	42.34	20.07	< 0.001***	0.667
RS = Single	6.51	3.40	0.001**	0.054
fWHR = Low	−5.38	−1.95	0.053	0.018
SMM = Low	−6.24	−2.26	0.025*	0.025
fWHR = Low * SMM = Low	13.73	3.55	< 0.001***	0.059

Note: Predictor variables: RS (relationship status): single/paired, fWHR (facial width-to-height ratio): low/high, SMM (skeletal muscle mass): low/high. Outcome variable: Unrestricted sociosexual attitude.
*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.

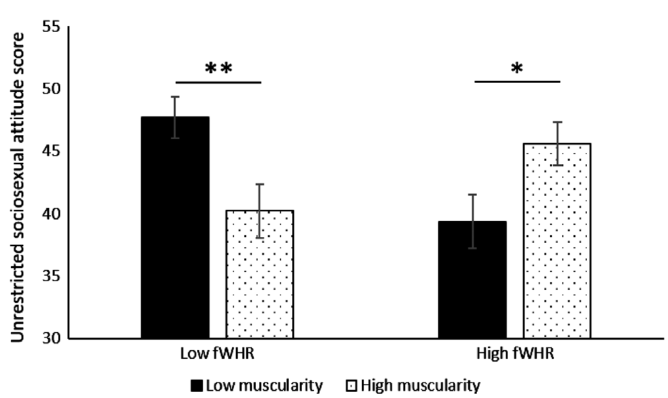

FIGURE 1 Estimated marginal means of unrestricted sociosexual attitude scores for low (black bars) and high (dotted bars) muscular men when fWHR was low and high

TABLE 3 Lifetime sexual partners fitted model

	b	t-value	P	η_p^2
Intercept	−9.04	2.69	0.001**	0.054
Age	0.76	6.97	< 0.001***	0.197
fWHR = Low	−3.39	−2.39	0.018*	0.028
SMM = Low	−3.38	−2.39	0.018*	0.028
fWHR = Low * SMM = Low	5.81	2.94	0.004**	0.042

Note: Predictor variables: Age, fWHR (facial width-to-height ratio): low/high, SMM (skeletal muscle mass): low/high. Outcome variable: Number of lifetime sexual partners.
*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.

TABLE 4 Previous-year sexual partners fitted model

	b	t-value	P	η_p^2
Intercept	1.97	8.98	< 0.001***	0.288
fWHR	−0.84	−2.41	0.017*	0.028
SMM	−0.92	−2.66	0.008**	0.034
fWHR*SMM	1.51	3.12	0.002**	0.047

Note: Predictor variables: fWHR (facial width-to-height ratio): low/high, SMM (skeletal muscle mass): low/high. Outcome variable: Number of previous-year sexual partners.
*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.

year sexual partners ($M = 1.97$, SE = 0.22) than low-muscular men ($M = 1.05$, SE = 0.27), but only if they were classified as high in fWHR ($M \pm$ SE difference = 0.92 ± 0.35; $P = 0.008$). The pattern was reversed for individuals classified as low in fWHR, such that high-muscular men reported fewer previous-year sexual partners ($M = 1.13$, SE = 0.27) than low-muscular men ($M = 1.72$, SE = 0.21; $M \pm$ SE difference = −0.60 ± 0.34; $P = 0.082$). Similarly, men high on fWHR reported more previous-year sexual partners ($M = 1.97$, SE = 0.22) than men low on fWHR ($M = 1.13$, SE = 0.27), but only if they were classified as high in muscularity ($M \pm$ SE difference = 0.84 ± 0.35; $P = 0.017$). Men high on fWHR reported fewer previous-year sexual partners ($M = 1.05$, SE = 0.27) than men low on fWHR ($M = 1.72$, SE = 0.21), but only if they were classified as low in muscularity ($M \pm$ SE difference = −67 ± 0.34; $P = 0.048$).

Table 5 reports the fitted model for the relationships between SMM and fWHR with the number of one-time sexual partners ($\chi^2 = 7.46$, $df = 1$ $P = 0.006$, $R^2_{\text{Nagelkerke}} = 0.05$). Only age was a significant predictor of the number of one-time sexual partners ($B = 0.09$, Wald tests = 7.08, $P = 0.008$). The odds ratio and confident interval for age was 1.10 (95% CI = 1.03-1.18).

Finally, when assessing the relationships of morphological traits with restricted sociosexual attitude (Hypothesis 3), we found that the inclusion of neither a single variable nor their interactions improved the null model significantly (see Table 6).

4 | DISCUSSION

In humans, T-related traits may provide information about male reproductive investments (Archer, 2006; Muehlenbein & Bribiescas, 2005). Masculine men are expected to invest more in mating, whereas investment in parenting is more strongly related to measures of socioeconomic status (Gangestad & Simpson, 2000). Body muscularity and fWHR have been linked to pubertal, reactive, and basal T levels in men (Hodges-Simeon et al., 2016; Lefevre et al., 2013), and these traits are considered condition-dependent traits associated with male mating strategy. In this study, both traits were related to unrestricted sociosexual attitude and sociosexual behavior, but not to restricted sociosexual attitude in a sample of Chilean men. However, we did not find a main effect of body muscularity and fWHR on unrestricted sociosexual attitude and sociosexual behavior; rather, both traits interact with these variables. In other words, the expected effect of muscularity on unrestricted sociosexual attitude and sociosexual behavior is moderated by fWHR. Accordingly, our main finding supports the relationship between T-related traits with unrestricted sociosexual attitude and sociosexual behavior, but this relationship is the result of the interaction between both morphological traits, suggesting a more complex effect of these traits on male sexual strategy.

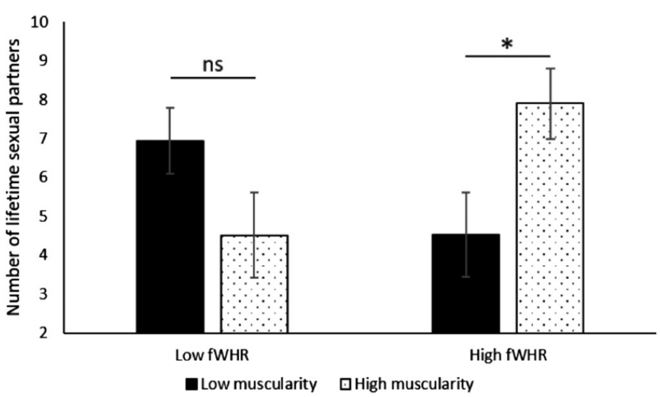

FIGURE 2 Estimated marginal means of the number of lifetime sexual partners for low (black bars) and high (dotted bars) muscular men when fWHR was low and high. Estimated marginal means were calculated considering the mean value of age

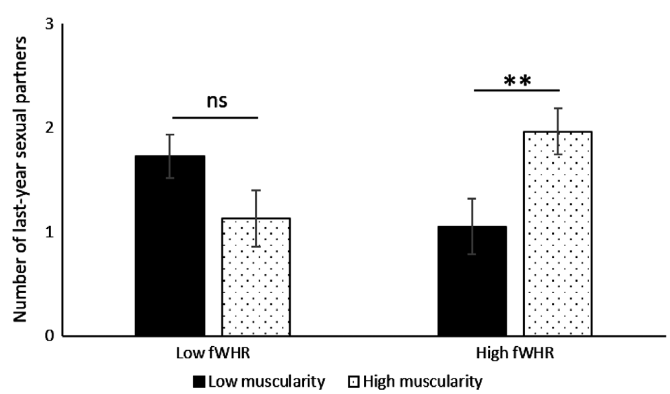

FIGURE 3 Estimated marginal means of the number of lifetime sexual partners for low (black bars) and high (dotted bars) muscular men when fWHR was low and high

TABLE 5 One-time sexual partners fitted model

	b	Wald	*P*	Exp(*b*)
Intercept	−2.76	11.61	0.001**	0.063
Age	0.09	7.08	0.008**	1.099

Note: Predictor variables: Age in years. Outcome variable: One-time sexual partners.
*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.

We hypothesized that male muscularity and fWHR would be positively related to unrestricted sociosexual attitude (Hypothesis 1) and to the number of lifetime, previous-year, and one-time sexual partners (Hypothesis 2). Unrestricted sociosexual attitude is associated with mating effort such that it is expected to lead to a greater number of sexual partners. Individuals with this orientation tend to pursue uncommitted relationships of short duration (Simpson & Gangestad, 1991). Previous studies found that correlates of muscularity (eg, SHR or HGS) are related to number of sexual partners and to unrestricted sociosexual attitudes (Gallup et al., 2007; Hughes & Gallup, 2003; Lukaszewski et al., 2014). In addition, direct measures of muscularity are also related to number of sexual partners (Lassek & Gaulin, 2009). For instance, number of lifetime sexual partners is predicted by fat-free mass and limb muscle volume. However, number of previous-year sexual partners and age of first sexual intercourse is predicted by limb muscle volume, but not by fat-free mass (Lassek & Gaulin, 2009). Relatedly, more masculine faces are more attractive to women, especially in the context of a ST relationship (Dixson et al., 2016; Johnston et al., 2001; Little et al., 2007; Marcinkowska et al., 2017; Puts et al., 2012; Thornhill & Gangestad, 1999; Valentine et al., 2014) and more masculine faces are related to unrestricted sociosexual attitudes and number of sexual partners (Arnocky et al., 2018; Boothroyd et al., 2008; Boothroyd et al., 2011).

Our results partially support the first and second hypotheses but also reveal several unexpected patterns. High-muscular men reported higher unrestricted sociosexual attitude and more lifetime and previous-year sexual partners than low-muscular men, but only when their fWHR was above the mean value. The same is true for men high in fWHR compared to men low on fWHR, but only when their muscularity is above the mean. However, high-muscular men reported lower unrestricted sociosexual attitude and fewer lifetime and previous-year sexual partners than low-muscular men, when their fWHR were below the mean value. Similarly, men high in fWHR reported lower unrestricted sociosexual attitude and fewer lifetime and previous-year sexual partners than men low in fWHR, when their muscularity was below the mean. These results are in contrast to our expectations, given that men who had low expression of both traits indicated unrestricted sociosexual attitude and more lifetime and previous-year sexual partners. Thus, men with a low T profile were behaving similarly to individuals with a high T profile.

TABLE 6 Restricted sociosexual attitude full model

	b	*t*-value	*P*	η_p^2
Intercept	38.36	1.36	0.175	0.009
RS = Single	−0.23	−0.16	0.877	<0.001
fWHR = Low	3.14	1.48	0.140	0.011
SMM = Low	1.10	0.45	0.655	0.001
fWHR = Low * SMM = Low	−1.15	−0.39	0.695	0.001
Height	−0.02	−0.13	0.896	<0.001
BMI	0.00	0.01	0.993	<0.001
Age	0.11	0.59	0.556	0.002

Note: Predictor variables: RS (relationship status): single/paired, fWHR (facial width-to-height ratio): low/high, SMM (skeletal muscle mass): low/high, height, BMI (body mass index), age. Outcome variable: Restricted sociosexual attitude.

Men with average or even feminine faces are preferred by women for LT relationships (Little, Jones, Penton-Voak, Burt, & Perrett, 2002). In addition, men with less muscular bodies are perceived as having higher commitment and being less volatile than men with more muscular bodies and, therefore, may also be preferred by women seeking a LT relationship (Frederick & Haselton, 2007). A possible explanation for the association of low muscularity and low fWHR to number of sexual partners and unrestricted sociosexual attitude is that men with lower T are exploiting their attractiveness as LT partners to increase their number of ST sexual partners. Another possible explanation is that men with less muscular bodies and low fWHR are less preferred by women, and pursue any sexual opportunity. These individuals might be expected to report high unrestricted sociosexual attitude as a consequence of their opportunistic behavior when choosing a mate, and a higher number of sexual partners if they are unable to maintain a sexual partner. Regardless of the possible explanation, our results parallel the findings reported by Gettler et al. (2017). They found that both high and low levels of androgenicity in men are related to lower relationship stability and decreased paternal care. Whereas the authors argued that high androgenicity may be related to a ST mating strategy, the effects reported for low androgenicity may be caused by balancing selection favoring parental care in individuals with intermediate levels of androgenicity (Gettler et al., 2017). As a corollary, men in the current study that displayed inconsistent traits (ie, low muscularity and high fWHR or high muscularity and low fWHR) report lower unrestricted sociosexual attitude and fewer lifetime and previous-year sexual partners, suggesting that the consistent expression of T-related traits in the face and body is important in determining male mating strategy.

These results raise several questions. For example, why are there "inconsistent" phenotypes regarding the expression of muscularity and fWHR? Although identifying the physiological mechanisms that lead to a different expression of these traits is not the purview of this study, the development of a muscular body depends on several variables in addition to pubertal levels of T. In this regard, drive for muscularity, defined as the dissatisfaction with current level of muscularity and preoccupation with performing behaviors geared toward increasing muscularity, is negatively related to self-esteem both in adolescent and adult males (Bergeron & Tylka, 2007; Smolak & Stein, 2006). In turn, self-esteem is positively associated with physical attractiveness and appearance (Judge & Cable, 2004). Therefore, men with high muscularity and low fWHR may have low self-esteem and little previous mating success. The high levels of muscularity of these men may be an attempt to compensate for their lesser facial masculinization or lesser facial attractiveness. Individuals displaying high pubertal T in their face morphology but with low muscle mass may be signaling incompetence to develop muscular tissue in accordance with their phenotypic markers of T. These two explanations link inconsistency in the expression of muscularity and fWHR with lower mating success; however, this inconsistent expression may be signaling intermediate levels of androgenicity rather than self-esteem issues or incompetence to develop muscular tissue. In accord with the results of Gettler et al. (2017) in which men with intermediate androgenicity invested more in paternal care and reported higher stability in their relationships, the lower number of sexual partners reported by men with inconsistent expression of these traits may be indicative of a LT mating strategy. It is interesting to note that whereas men with inconsistent expression of these traits are less oriented toward unrestricted sociosexual attitude, they do not differ in their orientation toward restricted sociosexual attitude.

In contrast to the number of lifetime and previous-year sexual partners, the number of one-time sexual partners is not explained by SMM nor fWHR as initially hypothesized. Considering the low effect sizes reported in this study, the need to categorize the variable number of one-time sexual partners in order to perform a logistic binary regression may explain the null results. Alternatively, we assumed that the number of partners with whom one has had one-time sex was indicative of ST mating strategy. However, one-time sexual partners may be indicative of being unable to maintain a relationship.

Muscularity and fWHR did not predict restricted sociosexual attitudes, consistent with our third hypothesis. This null result documents that traits predicting unrestricted sociosexual attitudes do not predict restricted sociosexual attitudes in the opposite direction. Accordingly, both facets of sociosexual orientation can be understood as two dimensions rather than as opposite poles of the same dimension. Our results are in accord with those of previous studies (Jackson & Kirkpatrick, 2007; Thomas & Stewart-Williams, 2018) and emphasize the importance of considering these two attitudes as different dimensions. Furthermore, this conceptualization of unrestricted versus restricted sociosexuality, or ST versus LT mating orientation, is more in accordance with the theoretical proposal of strategic pluralism which argues that humans have evolved to pursue multiple mating tactics that in some cases may be pursued simultaneously (Gangestad & Simpson, 2000; Jackson & Kirkpatrick, 2007).

Our study has several limitations. The sample size is near the threshold of the necessary size to detect effect sizes that are typical of these studies (Lukaszewski et al., 2014). Moreover, we used a psychometric test to estimate sociosexual orientation which seems to be less referenced in previous studies than other questionnaires (eg, Penke & Asendorpf, 2008). This circumstance may limit the comparison of our results with previous studies. Finally, despite the consideration of two different traits denoting pubertal T levels in the current study, future studies will benefit from the inclusion of other measures of facial and body masculinity.

In conclusion, our study links sociosexual attitudes and behaviors with direct morphological measures of muscularity assessed by bioelectrical impedance, and shows that body muscularity and fWHR are related to ST (but not LT) mating tactics. The use of two morphological traits allowed us to investigate the relationship between pubertal T-related traits and men's ST mating tactics. Both the intensity and consistency in the expression of these traits seem to be important in predicting male mating strategies. In addition, we showed that the fWHR influenced the relationship between body muscularity and sociosexual attitudes and behaviors, suggesting that despite being a controversial measure, this metric is related to male ST mating strategy. Finally, our results evidenced the importance of considering two dimensions of sociosexual attitudes (ie, ST and LT mating orientation) since these dimensions are not completely dependent.

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AUTHOR CONTRIBUTIONS

PP and JAMR designed the study and collected the data. PP analyzed the data and drafted the manuscript. PP, JAMR, MP, TDS and BF edited the manuscript for intellectual content and provided critical comments on the manuscript.

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