Brain, Behavior, and Immunity 123 (2025) 151–161

Contents lists available at ScienceDirect

Brain Behavior and Immunity

journal homepage: www.elsevier.com/locate/ybrbi

Full-length Article

Do inflammation and relational motivation coordinate having better sex? The interplay between C-reactive protein and relational approach motivation on sexual well-being

Tatum A. Jolink [a,b,*,1], Baldwin M. Way [c,d], Ayana Younge [e], Sara B. Algoe [b]

[a] Department of Psychology, University of Michigan, Ann Arbor, MI, USA
[b] Department of Psychology & Neuroscience, University of North Carolina at Chapel Hill, Chapel Hill, NC, USA
[c] Department of Psychology, The Ohio State University, Columbus, OH, USA
[d] Institute for Behavioral Medicine, The Ohio State University, Columbus, OH, USA
[e] Darden School of Business, University of Virginia, Charlottesville, VA, USA

ARTICLE INFO

Keywords:
Interpersonal relationships
Motivation
Inflammation
C-reactive protein
Sexual satisfaction
Orgasms
Social behavior

ABSTRACT

Much evidence on heightened inflammation and social behavior focuses on social withdrawal. Building on recent theory (Muscatell and Inagaki, 2021), we focused instead on the socially affiliative experience of sex. We investigated the interplay between immunology and motivation on sexual well-being among 158 individuals in romantic relationships. Inflammation, indexed by C-reactive protein (CRP), and sexual well-being were measured multiple times over a month. Relational approach motivation (i.e., motivation toward rewards in relationships) was measured at study entry. Results revealed significant associations between CRP and sexual satisfaction and partnered orgasms frequency for those most motivated to approach rewards with their partner. Interaction effects were replicated with relationship-focused psychological correlates of sexual well-being (e.g., touch, shared laughter, social support), but not with individual-focused outcomes (e.g., adapting to change, goal progress). This is one of the first human studies to demonstrate the body and mind coordinate to promote satisfying sexual experiences within romantic relationships.

Humans have sex for many reasons, including to experience pleasure, reduce stress, promote a relationship, and reproduce (Meston and Buss, 2007). In fact, people who are predisposed to seek out positive aspects of and experiences in their relationships (i.e., approach motivated, Gable, 2006; Gable and Impett, 2012) may be more psychologically motivated to engage in relationship-promoting behaviors, like sex. The body may also influence sexual activity via arousal, hormone levels, and even inflammation. However, how biological and motivational systems work together to coordinate sexual activity and sexual well-being within romantic relationships is not well understood.

Most work on inflammation and "sickness behavior" has focused on social withdrawal (Dantzer and Kelley, 2007; Eisenberger et al., 2010; Hennessy et al., 2014; Kelley et al., 2003), but recent theory and evidence suggest this may not always be so. Specifically, when the social response is directed toward a close other, heightened inflammation may be associated with approaching or affiliating with them (Eisenberger et al., 2017; Hennessy et al., 2014; Muscatell and Inagaki, 2021). In the only known studies testing this idea, higher inflammation predicted greater self-reported desire to be near a support figure (Inagaki et al., 2015) and was associated with faster reaction time to approach a photo of a close other (Jolink et al., 2022), greater reports of momentary social connection (e.g., felt support) with a close other (Jolink et al., 2024), and more frequent use of social media to interact with others (versus for entertainment; Lee et al., 2023). A recent social network study found that higher inflammation was associated with developing new positive (not conflicted) friendships, over time (Kornienko et al., 2022). In sum, people experiencing heightened inflammation may be specifically motivated to affiliate with someone they love and trust, such as a close other (Muscatell and Inagaki, 2021). We hypothesize this could extend to sexual intimacy between romantic partners.

* Corresponding author at: Department of Psychology, University of Michigan, 3432 East Hall, 530 Church Street, Ann Arbor, MI 48109, USA.
E-mail address: tjolink@umich.edu (T.A. Jolink).

[1] The study was conducted while Dr. Tatum A. Jolink was a graduate student at the University of North Carolina at Chapel Hill. Dr. Tatum A. Jolink is now at the Department of Psychology, University of Michigan.

https://doi.org/10.1016/j.bbi.2024.08.054
Received 22 February 2024; Received in revised form 23 August 2024; Accepted 26 August 2024
Available online 3 September 2024

For those in high-quality romantic relationships, having sex represents an opportunity to connect and affiliate (Meston and Buss, 2007; Schwartz and Young, 2009). However, indices of sexual well-being—frequency of sex, frequency of partnered orgasms, sexual satisfaction—are unique psychological experiences within romantic relationships that predict different outcomes (Frederick et al., 2017; Haning et al., 2007). Having more frequent sex and consistent orgasms is generally associated with greater sexual and relationship satisfaction (Frederick et al., 2018; Haning et al., 2007). Furthermore, each sexual well-being dimension uniquely predicts benefits (e.g., sexual frequency, Yabiku and Gager, 2009; sexual satisfaction, Lawrance and Byers, 1995; partnered orgasms, Frederick et al., 2017). Thus, the current study examines how inflammation may be related to the multifaceted, affiliative experience of sex between romantic partners.

Prior work has examined associations between inflammation and sexual activity and dysfunction. The association may be reciprocal. First, having sex may "activate" the immune system (Charnetski and Brennan, 2004). Alternatively, inflammation can influence sexual health, by serving as a risk factor of sexual dysfunction in males (e.g., penile vascular disease, Bank et al., 2003; erectile dysfunction, Yao et al., 2012), contributing to dysregulated sexual desire and arousal in females (Clephane et al., 2021; for review, see Lorenz, 2019), and fluctuating naturally across the female menstrual cycle (Lorenz et al., 2015, 2017, 2018). Altogether, inflammation in the peripheral body seems to play a role in healthy sexual functioning (Calmasini et al., 2019), but little work has studied the link between inflammation and *multiple* indices of sexual well-being among healthy, sexually active individuals in romantic relationships or what relational factors that be particularly important to this association.

Individual differences in motivation could be a potential moderator of the association between inflammation and sexual well-being. In fact, humans have social motivational systems that work to direct social behavior, including toward close others (Gable, 2006; Gable et al., 2000). One of those systems motivates approach social goals, which are those oriented toward rewards or positive outcomes within social relationships; relational approach motivation is orthogonal to avoidance motivation, which orients individuals away from negative outcomes in relationships (Gable, 2006; Gable and Impett, 2012). Greater approach motivation toward one's romantic partner has been associated with positive relationship outcomes, including better conflict resolution (Kuster et al., 2017) and experiencing greater positive emotions after positive interactions with a partner (Don et al., 2022). Additionally, having sex to satisfy approach-oriented goals, such as wanting to feel connected to or demonstrate love/affection toward a partner, is generally better for the immediate sexual experience and long-term relationship quality (Cooper et al., 2011; Impett et al., 2005; 2008; Muise et al., 2017). Thus, relational approach motivation may be an important facilitator of any association between inflammation and sexual well-being.

1. The current study

We first aimed to extend new theorizing on inflammation and affiliation with close others (Muscatell and Inagaki, 2021) by testing the hypothesis that levels of systemic inflammation would be positively associated with sexual well-being with a romantic partner. Next, we examined relational approach motivation as a moderator of this association; these tests were exploratory as we did not have specific predictions about how approach motivation and inflammation would interact. Using a sample of individuals in established romantic relationships, this study employed a repeated measures within-subjects design in which inflammation and psychological experiences were measured multiple times over one month. C-reactive protein (CRP), a fluctuating, acute phase protein, was the marker of inflammation measured from dried capillary blood (Pepys and Hirschfield, 2003). Sexual well-being was measured on multiple self-reported dimensions: sexual frequency, sexual satisfaction, and partnered orgasm frequency, all from the prior month. Unpartnered orgasm frequency was measured to test discriminant validity (i.e., relationship-specific orgasms versus orgasms motivated by solo sexual/physical pleasure; Das, 2007; Herbenick et al., 2023).

Having sex also shares features with many relationship-promoting activities (Algoe, 2019). To better understand the psychological underpinnings of the effects, we explored if CRP and relational approach motivation interacted to predict other experiences psychologically similar to sex: relationship-promoting behaviors (i.e., affectionate touch, shared laughter, expressed gratitude; Jolink and Algoe, 2024), perceived social support from the partner (Sarason et al., 1987), and individual positive behaviors (e.g., adapting to change, volunteering).

2. Open practices statement

The data and code for this study can be found on OSF [https://osf.io/upqg8/?view_only=c6d282a06c6e4a3eb04811e26fe87d97]. There is not a preregistration for this study.

3. Methods

3.1. Participants

One hundred fifty-eight individuals (84 % female sex assigned at birth; 16 % male sex assigned at birth; age *range* = 18–55) who were above the age of 18 and below the age of 60 and had been in a committed, exclusive romantic relationship for at least six months participated in a one-month study in the fall/winter of 2017 (Algoe, 2022a). See Table 1 for full characteristics of this convenience sample. Participants were recruited from the community around Chapel Hill, North Carolina, U.S.A., using flyers, listserv emails, and other recruitment sites in the local community (e.g., Researchmatch, jointheconquest). Exclusion criteria focused on pre-existing conditions or health behavior known to alter inflammation and included being pregnant or nursing (within the past six months), having arthritis, rheumatoid arthritis/joint problems, diabetes, an immune or autoimmune disorder (e.g., HIV), a disease of the endocrine system (e.g., Cushing's Disease), a sleep disorder, or a psychiatric disorder other than depression or anxiety. Participants were also ineligible if they currently/regularly took anti-inflammatory medication (e.g., low-dose aspirin, Ibuprofen, Tylenol), smoked tobacco, or consumed six or more alcoholic drinks in one sitting at least twice a week. Additional details on the original study procedure can be found in Jolink et al. (2023).

An *a priori* power analysis conducted using G*Power revealed a target sample size of 153 participants was estimated to provide 80 % power to detect a medium effect ($f = 0.25$); power analysis accounted for all (up to eight) predictors in the model when testing for two main effects, an interaction, and controlling for five covariates.

3.2. Procedure

All procedures were performed in compliance with relevant laws and the study was approved by the institutional review board prior to commencing (UNCCH IRB#17-2353, approved on 10/13/2017). Following an initial screening questionnaire in which eligibility was assessed, initial consent was obtained from participants. Participants completed a study in which they attended three in-lab appointments every two weeks over the course of one month (i.e., first lab visit; second lab visit two weeks after first visit; third lab visit four weeks after first visit). All in-lab appointments followed the same procedure; blood was collected at each visit. Specifically, after participants' height and weight were measured, the experimenter pricked their finger with a small lancet, and a few drops of blood were collected for later assay (see Measures below). Then, participants completed a questionnaire on a private laboratory computer. Twenty-four hours prior to the first and

Table 1
Characteristics of Sample ($N = 158$).

	M (*SD*)	% (*n*)
Age	*24.70* (7.56)	
Female Sex Assigned at Birth		84 % (135)
Regular menstrual cycle		65 % (104)
Birth control use		51 % (80)
BMI	*23.27* (3.9)	
Race/Ethnicity[1]		
Black/African American		9.3 % (15)
East Asian		8.7 % (14)
Hispanic		3.7 % (6)
Latino		3.1 % (5)
Middle Eastern		0.6 % (1)
South Asian		6.2 % (10)
Southeast Asian		0.6 % (1)
Pacific Islander/Native Hawaiian		0.6 % (1)
White/Caucasian		75.2 % (121)
Education Level[2]		
High school graduation or equivalent		5.6 % (9)
Some college		49.4 % (79)
College graduation		30.0 % (48)
Professional/post-graduate degree		15.0 % (24)
Relationship status		
Dating casually		1.3 % (2)
Dating exclusively		74.7 % (118)
Engaged		5.7 % (9)
Married		17.7 % (28)
Other[3]		0.6 % (1)
Relationship length (in months)	*44.6* (53.44)	
	Median = 28	
CRP visit 1 (μg/ml)	*0.92* (1.35)	
CRP visit 2 (μg/ml)	*1.09* (1.55)	
CRP visit 3 (μg/ml)	*0.93* (1.4)	

Note. Sample was limited in the number of males, racial and ethnic minorities, and older adults represented.

[1] Groups are not mutually exclusive as participants could endorse more than one race/ethnicity.

[2] We note education level may be confounded with age in this sample ($r = 0.71$, $p < 0.001$).

[3] Participants who answered 'other' then had the opportunity to specify what type of romantic relationship they were in; no one provided additional information.

third in-lab visit, participants received a pre-lab survey they completed from home. The in-lab survey included questions about recent health behaviors that might influence measurement and levels of inflammation and a weekly personal and romantic relationship check-in that was administered each week of the study. The pre-lab survey assessed more stable, trait-level well-being and social/relational variables (e.g., approach and avoidance motivation), and individual demographics.

After the first lab visit ($N = 158$), nine participants did not attend their second lab visit two weeks later ($N = 149$). Two additional participants did not attend the third lab visit or complete the accompanying pre-lab survey ($N = 147$).

Self-report measures relevant to the current study were assessed at various timepoints. See Table 2 for administration overview of each measure and how many participants completed each time point.

3.3. Measures

3.3.1. C-reactive protein (CRP)

Inflammation was measured using assays of CRP taken from dried blood spots. CRP is not static, and it fluctuates in response to inflammatory stimuli and psychosocial factors in everyday life (Pepys and Hirschfield, 2003). CRP measurement collected from dried blood spots

Table 2
Assessment timepoint for each main and exploratory study variable.

Measure name	Assessment timepoint				
	Pre-lab survey 1 $N = 158$	Visit 1 $N = 158$	Visit 2 $N = 149$	Pre-lab survey 3 $N = 147$	Visit 3 $N = 147$
Approach/avoidance motivation	X				
C-reactive protein		X	X		X
Primary outcomes: Sexual well-being					
Sexual satisfaction	X			X	
Frequency of sex					X
Frequency of partnered orgasm					X
Discriminant validity outcome					
Frequency of unpartnered orgasm					X
Exploratory outcomes[1]					
Affectionate touch [5] 5-item weekly touch [1] 1-item weekly touch	X_5	X_1	X_1	X_5	X_1
Shared laughter [g] general laughter [w] weekly laughter	X_g	X_w	X_w	X_g	X_w
Expressed gratitude (weekly)		X	X		X
Perceived social support	X			X	
Individual positive behavior		X	X		X

[1] See Supplemental Material for full item information.

shows excellent correspondence with CRP collected from venipuncture (McDade et al., 2004). To collect the drops of blood, a participant's finger was swabbed with an alcohol wipe and punctured with an 18-gauge needle. Blood drops were collected on a Whatman 903 Protein Saver Card and cards were dried for 24 h. Once the samples had dried, blood spots were punched using a 3 mm Biopsy Punch (Henry Schein) and stored in microcentrifuge tubes at −80 °C until data collection was complete and the full sample was ready for assay. Samples were then shipped on dry ice to the Analytical and Development Laboratory at the Ohio State University (https://ccts.osu.edu/content/ccrm-crc-analytical-specimen-labs) for analysis. For assay, a single 3 mm punch was thawed and 200 μL of buffer (phosphate-buffered saline with 0.1 percent Tween 20) was added followed by overnight (~16 h) incubation at 4 °C while shaking at 60 rpm. The following morning, eluate was diluted 1:10 and CRP was assayed according to the manufacturer's instructions using Meso Scale Delivery Vplex Plus Kits (K151STG), which is a high sensitivity assay. Across all 12 plates, the intraassay coefficient of variation (CV) was 1.95 %; the interassay coefficient of variation was 3.24 %.[2] One blood sample was not collected from one participant who did not provide the final blood sample. Finally, two CRP values that were greater than 10 μg/ml were removed from analyses, as values above 10 are often indicative of an acute infection (Pearson et al., 2003). All CRP variables were log-transformed before analyses (log-transformed: $M_{visit1} = -0.39$, $SD_{visit1} = 0.57$; $M_{visit2} = -0.33$, $SD_{visit2} = 0.59$; $M_{visit3} = -0.39$, $SD_{visit3} = 0.59$; raw/unadjusted: $M_{visit1} = 0.92$, $SD_{visit1} = 1.35$, $\text{range}_{visit1} = 0.01–6.61$; $M_{visit2} = 1.09$, $SD_{visit2} = 1.55$, $\text{range}_{visit2} = 0.01–9.12$; $M_{visit3} = 0.93$, $SD_{visit3} = 1.4$, $\text{range}_{visit3} = 0.01–9.57$).

[2] Intraassay CV refers to the variation between sample replicants within one assay plate (i.e., datapoint consistency). Interassay CV refers to the variation between sample replicants on different plates (i.e., plate-to-plate consistency).

3.3.2. Relational approach/avoidance motivation toward the romantic relationship

Approach motivation toward the partner/relationship was measured using the six-item relational *approach* subscale from the twelve-item approach-avoidance motives scale (Elliot et al., 2006). Following the prompt, "how much of your commitment to your current relationship is based on each of the following reasons?", participants answered items such as, "I want to continue having fun with my partner" and "I want to continue giving support to my partner" on a scale from 1 (*not at all*) to 7 (*very much*). Relational approach motivation items were averaged to form a composite ($M = 6.27$, $SD = 0.88$, $\alpha = 0.89$); higher scores indicated those with higher motivation to approach the rewards of one's romantic relationship.

Participant's relational avoidance motivation toward their partner/relationship was measured on the same 7-point scale with the remaining six items (e.g., "I don't want to be alone"). Relational avoidance items were averaged to form a composite ($M = 3.79$, $SD = 1.95$, $\alpha = 0.94$); higher scores indicated higher motivation to avoid the consequences of one's relationship.

3.3.3. Frequency of sex

Frequency of sex was measured with the following item, "how many times did you have sex with another person in the past month?" ($M = 7.91$, $SD = 8.43$, min = 0, max = 45, *mode* = 0).[3] Two values were more than 3 SDs above the mean; the two values were winsorized to the value of 3 SDs above the mean for analyses and retained in the dataset.[4]

3.3.4. Sexual satisfaction

Current sexual satisfaction was assessed using an adapted global measure of sexual satisfaction (GMSEX, Lawrance and Byers, 1995). Following the prompt, "please rate your sex life on the following dimensions," participants rated five 7-point bipolar scales on the dimensions *bad* (1) – *good* (7), *unpleasant* (1) – *pleasant* (7), *negative* (1) – *positive* (7), *unsatisfying* (1) – *satisfying* (7), *worthless* (1) – *valuable* (7). The five items were averaged to form a composite of sexual satisfaction, where smaller numbers reflected less sexual satisfaction and bigger numbers reflected greater sexual satisfaction. Scale items were reliable in our sample at each time point (α visit 1 = 0.95, α visit 3 = 0.93). At the first lab visit, five participants were missing data on this variable ($M = 5.81$, $SD = 1.22$). At the third lab visit, no participants were missing data on sexual satisfaction ($M = 5.93$, $SD = 1.14$). There were five values greater than 3 SDs below the mean (3 from the first lab visit and 2 from the third lab visit); the values were winsorized and retained in the dataset for analyses.

3.3.5. Frequency of partnered orgasms

Participants reported the number of *partnered* orgasms they had in the prior month: "how many orgasms- with a sexual partner- did you have in the past month?" ($M = 5.57$, $SD = 6.85$, min = 0, max = 30, mode = 0, missing data = 2). Three values were more than 3SDs above the mean (i.e., greater than 26 partnered orgasms in the prior month). Those values were winsorized for analyses and retained in the dataset.

3.3.6. Discriminant validity: frequency of unpartnered orgasms

Participants reported the number of unpartnered orgasms: "How many orgasms- without a sexual partner- did you have in the past month?" ($M = 4.99$, $SD = 6.35$, min = 0, max = 30, missing data = 2). Three values were more than 3 SDs above the mean (i.e., greater than 24 unpartnered orgasms); those values were winsorized for analyses and retained in the dataset.

3.3.7. Exploratory outcomes

See Table 2 for procedural information about exploratory measures.

3.3.7.1. Affectionate touch. Participants reported on the overall affectionate touch with their partner from the prior week with one item: "My partner and I have had positive/warm physical contact this week (e.g., touching, holding hands, hugging, cuddling)." Average levels of weekly affectionate touch were above the midpoint across the three time points ($M = 4.28$, $SD = 2.20$). See SM for details about an additional self-reported touch measure.

3.3.7.2. Shared laughter. Participants also reported on the extent to which they engaged in shared laughter over the prior week with the following item, "My partner and I frequently shared moments of laughter this past week" (Algoe and Fredrickson, 2019). On average, weekly shared laughter scores were above the midpoint ($M = 4.74$, $SD = 1.42$). See SM for information about a general shared laughter measure.

3.3.7.3. Expressed gratitude. Expressed gratitude toward the partner in the prior week was measured with: "I expressed gratitude to my partner this week." Average levels of weekly expressed gratitude across the three measurements were above the midpoint ($M = 4.81$, $SD = 1.29$).

Due to an administrative error, weekly touch, laughter, and gratitude were measured from 0 (*not at all*) to 6 (*very much*) at visit 1 and 3 but measured from 1 (*not at all*) to 7 (*very much*) at visit 2. The visit 2 measure was recoded to be consistent with visits 1 and 3.

3.3.7.4. Perceived social support from the partner. Perceived social support from the partner was measured using a brief 7-item measure of social support (Sarason et al., 1987). Scale items included, "to what extent can you count on this person to listen to you when you are very angry at someone else?" and "to what extent could you count on this person for help with a problem". The first six items were assessed on a scale from 1 (*not at all*) to 7 (*very much*). The final item, "overall, my partner takes good care of me", was measured from 1 (*disagree strongly*) to 5 (*agree strongly*). Items were standardized before an average of perceived social support from the partner was computed for each time point (visit 1: $M = 0.0$, $SD = 0.79$, missing = 0; visit 3: $M = 0.0$, $SD = 0.84$, missing = 1). Reliability was high across scale items at each time point (α visit 1 = 0.90; α visit 3 = 0.93).

3.3.7.5. Individual positive behaviors. Each week, participants also reported on the extent to which they engaged in a suite of positive *individual* behaviors. Items included, "I adapted to change well this week", "I made progress on the goals I set out to accomplish this week", and "how often did you voluntarily help or assist people other than your partner this week?" An administrative error also occurred with these measures, such that at each assessment they were measured on a different timescale (always from *not at all* to *very much*). This measure was standardized, and the three items were averaged at each timepoint.

3.3.8. Covariates

All analyses controlled for sociodemographic and health factors known to affect inflammation (O'Connor et al., 2009). Specifically, all analyses accounted for participant's biological sex, age, BMI, based on participant's height and weight measured at the first lab visit, whether they were on birth control (yes: $n = 80$, 51 %), or had taken over-the-counter medication for cold, flu, or any infection within 24 h of their in-lab appointment (yes: n visit 1 = 8; n visit 2 = 14, n visit 3 = 10). We

[3] Because of how this item was worded, participants were not specifically asked about frequency of sex with their *current romantic partner*. However, due to the fact that being in an exclusive (i.e., monogamous), committed romantic relationship was an inclusion criterion for the study, we feel safe in assuming the majority of participants were responding about their sexual activity with their romantic partner. This is an important methodological limitation of the study.

[4] Henceforth, any winsorizing replaced the outlying value with the value of 3 SDs above the sample mean of the relevant scale.

also conducted additional models controlling for antihistamine use (n = 20, measured at study baseline) and day-of NSAID use (NSAID use visit 1 n = 1, visit 2 n = 3, visit 3 n = 6); see SM for measurement information and results with these covariates.

Consistent with our standard practice (Jolink et al., 2023), we explored an additional set of covariates to more comprehensively account for sociodemographic variables related to inflammation. Prior work has found that race/ethnicity may moderate health and psychological effects of the immune system (Albert, 2007; Carroll et al., 2009; Feairheller et al., 2011; Gruenewald et al., 2009; Lockwood et al., 2017; Stepanikova et al., 2017) and thus, we wanted analyses to account for potential race-related differences in inflammation (see Table 1). Next, recent work suggests antidepressants may lower inflammation in the peripheral body (Hamer et al., 2011; Więdłocha et al., 2018) or that higher basal inflammation may inhibit efficacy of antidepressant use (Gasparini et al., 2022). Although findings in this literature are mixed—that is, not every inflammatory marker may increase as a function of antidepressant use—we felt controlling for anti-depressant use (yes: n = 23, 15 %) was a conservative test to include in our analyses. Finally, prior work has found that inflammation may be sensitive to proximal changes in sleep and exercise (sleep: Jackowska et al., 2013; Prather et al., 2013; exercise: Lavie et al., 2011). Thus, we controlled for sleep quality the night prior to (all *M*s >7 out of 10/*slept extremely well*), and exercise the day of (yes: n visit 1 = 15; n visit 2 = 15; n visit 3 = 15), the inflammation measurement.

3.4. Data analysis plan

All analyses were run in R and tested concurrent associations. We modeled the interaction between log-transformed CRP and participant's individual relational approach motivation on each outcome of sexual well-being separately, in which associations were concurrent between CRP and the outcome; no analyses were prospective. When the outcome was measured only once during the study (i.e., sexual frequency, partnered and unpartnered orgasm frequency), regression analyses was used (lm function). When the outcome was measured multiple times (e.g., sexual satisfaction), multilevel analyses (lmer function from the lme4 package) was used to account for the nested nature of the repeated measures CRP and outcome data (Bates et al., 2014; Kenny et al., 1998). In each model, CRP was used to predict concurrent outcomes.

Following standards of moderation analyses, for these regressions, both the main predictor (CRP) and the relational approach motivation moderator were mean-centered to aid in interpretation. Specifically, relational approach motivation was grand-mean centered (i.e., based on sample mean). CRP values were mean-centered based on the sample mean at that specific time point (e.g., at baseline, the overall CRP baseline/visit 1 mean was subtracted from individual baseline CRP values; at visit 2, the overall CRP visit 2 mean was subtracted from individual visit 2 CRP values, etc.).

All models controlled for relational avoidance motivation and sociodemographic and health covariates relevant to inflammation (see Measures). We also conducted additional sensitivity analyses with the full range of CRP values (including those above 10 μg/ml), which can be found in the SM.

3.4.1. Ancillary models addressing relational avoidance motivation

Because relational avoidance motivation is a separate motivational system (Gable and Impett, 2012), to provide a comprehensive picture of the evidence for future reference, we explored whether relational *avoidance* motivation moderated the association between CRP and sexual well-being, controlling for relational approach motivation.

3.4.2. Exploratory models for convergent and discriminant validity of sexual well-being

An additional set of exploratory outcomes was tested to understand the limits of the association between CRP and sexual well-being. Using the same predictors (inflammation × relational approach motivation), we probed three behaviors known to promote relationships (i.e., affectionate touch, shared laughter, expressed gratitude), perceived social support from the partner, and three individual positive behaviors. All models were conducted using multilevel analyses (lmer function) to account for the nested structure of these measures, but always testing concurrent associations between CRP and the outcome.

4. Results

Bivariate correlations for main study variables can be found in Table 3.

4.1. Sexual well-being

CRP did not directly predict any of the sexual well-being outcomes. Relational approach motivation was not associated with either the frequency in which participants had sex in the prior month or their frequency of partnered orgasms. However, relational approach motivation was positively associated with sexual satisfaction, such that those with greater relational approach motivation reported being more satisfied with sex in the prior month.

Next, a significant positive interaction emerged between CRP and relational approach motivation for sexual satisfaction and separately, frequency of partnered orgasms, with the same pattern emerging for both sexual well-being outcomes. Specifically, after probing simple slopes, we found participants who were the most approach motivated demonstrated a significant and positive association between CRP and sexual satisfaction (and partnered orgasms). The simple slopes at the mean and lowest levels of relational approach motivation were not significantly different than zero for either outcome. For frequency of sex, the interaction between CRP and relational approach motivation was approaching statistical significance, but as p was not <0.05, we did not probe simple slopes. See Fig. 1 for plot of the significant interactions and Table 4 for full results for sexual satisfaction, frequency of partnered orgasms, and frequency of sex.

4.2. Discriminant validity: unpartnered orgasms

To test for discriminant validity, we examined CRP × relational approach motivation on unpartnered orgasm frequency. As expected, no main effects or interaction emerged for CRP and relational approach motivation predicting the number of unpartnered orgasms (see Supplementary Table 3 for full results).

4.3. Ancillary models: Moderation by relational avoidance motivation

As documented in Supplementary Tables 9–17, there was no evidence that relational avoidance motivation moderated the association between CRP and any of the outcomes *except* frequency of unpartnered orgasms (see Fig. 2). According to simple effects tests on this outcome, those with the lowest relational avoidance motivation demonstrated a significant and negative association between CRP and frequency of unpartnered orgasms. The simple slopes at mean or high levels of relational avoidance motivation were not significantly different from zero.

4.4. Exploratory outcomes

4.4.1. Relationship-promoting behaviors

CRP was not associated with any of the three relationship-promoting behaviors: affectionate touch, shared laughter, or expressed gratitude. However, relational approach motivation was positively associated with shared laughter and separately, expressed gratitude; the effect of relational approach motivation on affectionate touch was approaching statistical significance.

Finally, a significant positive interaction emerged between CRP and

Table 3
Zero-order correlations of main study variables.

	1	2	3	4	5	6	7	8	9
1. Relational approach motivation 1	–								
2. Relational avoidance motivation 1	0.05	–							
3. CRP 1 (log)	0.05	−0.02	–						
4. CRP 3 (log)	0.06	−0.07	0.82***	–					
5. Sex satis. 1	0.43***	−0.10	0.07	0.14	–				
6. Sex satis. 3	0.48***	−0.06	0.11	0.15	0.79***	–			
7. Sex freq. 3	0.01	−0.06	0.02	0.05	0.30***	0.29***	–		
8. Partnered orgasm freq. 3	−0.03	0.03	−0.06	0.04	0.32***	0.31***	0.81***	–	
9. Unpartnered orgasm freq. 3	−0.12	−0.01	−0.14	−0.14	0.02	0.01	0.24**	0.32***	–

Numbers 1, 2, and 3 denote which lab visit measure was collected (1 = first lab visit, 2 = second lab visit two weeks atter first, 3 = third lab visit four weeks after first). Satis = satisfaction. Freq = frequency. CRP was log-transformed. Used log-transformed versions (but not mean-centered) of CRP and relational approach/avoidance variables.
Note. No sexual well-being measures assessed at second lab visit (2), so CRP 2 is not represented here; see SM for correlations between all three CRP timepoints and exploratory outcome measures.
* $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$.

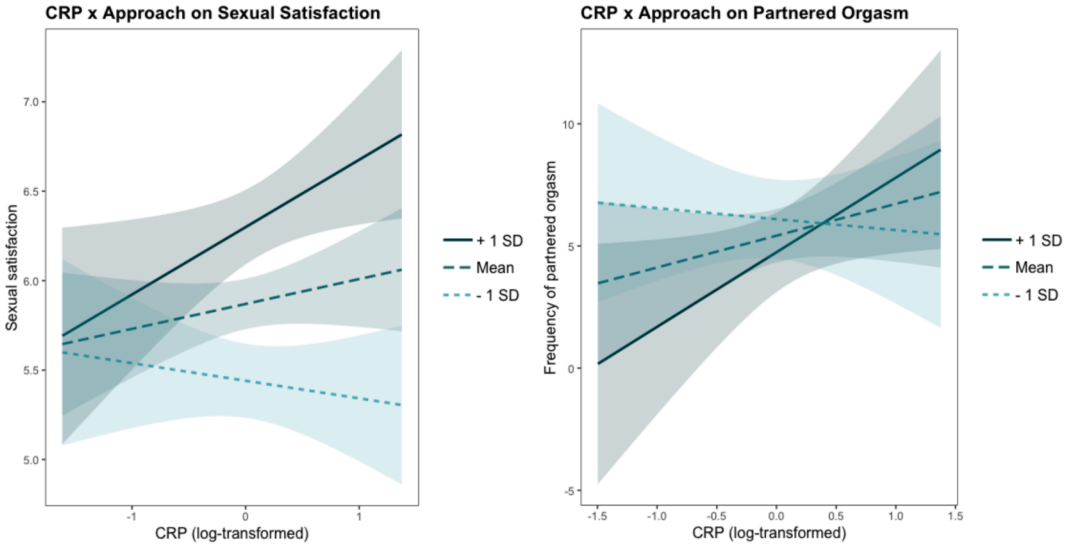

Fig. 1. Note. Panel A) Significant interaction between CRP × relational approach motivation on sexual satisfaction. +1SD simple effect significantly different from zero. Panel B) Significant interaction between CRP × relational approach motivation on partnered orgasms. + 1SD simple effect significantly different from zero.

relational approach motivation for affectionate touch and shared laughter (see Fig. 3), but not for expressed gratitude; a slightly different pattern emerged for the simple effects for touch versus laughter. For affectionate touch, when we probed simple slopes, participants who were the *least* approach motivated demonstrated a significant and negative association between CRP and affectionate touch. The simple slope at the mean level of relational approach motivation was not significantly different than zero; the simple slope at the highest levels of relational approach motivation showed a positive association approaching statistical significance between CRP and affectionate touch. For shared laughter, participants who were the *most* relationally approach motivated had a significant and positive association between CRP and shared laughter. The simple slopes at the mean and lowest levels of relational approach motivation were not significantly different than zero. See Supplementary Tables 4-6 for full results.

4.4.2. *Perceived social support from the partner*

CRP was not associated with perceived social support, but relational approach motivation was positively associated with perceived social support. Next, a significant positive interaction emerged between CRP and relational approach motivation (see Fig. 4, Supplementary Table 7). When we probed simple slopes, participants with the highest relational approach motivation demonstrated a significant and positive association between CRP and perceived social support. The simple slopes at the mean and lowest levels of relational approach motivation were not significantly different than zero.

4.4.3. *Individual positive behavior*

Across the three individual positive behaviors – adapting to change, progressing on a goal, volunteering to assist others – CRP was only positively associated with adapting to change. Relational approach motivation was positively associated with both the extent to which participants felt they adapted to change and the extent to which they voluntarily assisted others. Overall, there were no significant interactions between CRP and relational approach motivation on any of the three individual positive behaviors (see Supplementary Table 8).

5. Discussion

The present study investigates how sex, an affiliative behavior within relationships, is influenced by the interplay of systemic inflammation with approach motivation toward rewarding outcomes with a romantic partner. First, we did not find significant main effects of CRP on sexual well-being. However, building on new theorizing that higher inflammation may be particularly relevant to approaching *close others* (Muscatell and Inagaki, 2021), combined with the fact that some individuals may be motivated to approach "rewards" particularly in close relationships (Gable and Impett, 2012), we gained a more nuanced

Table 4
CRP × relational approach motivation predicting sexual satisfaction (top panel), frequency of partnered orgasms in the prior month (middle panel), frequency of sex in the prior month (bottom panel).

Predictor	*b*	*B*	*t*	*p*	CI 95 %	
					Lower	Upper
	Outcome: Sexual satisfaction					
CRP	0.14	0.07	1.16	0.25	−0.09	0.38
Approach	0.49	0.38	5.49***	0<.001	0.32	0.66
Avoidance	−0.06	−0.10	−1.59	0.11	−0.14	0.01
Bio sex	−0.29	−0.09	−1.28	0.20	−0.72	0.14
Age	−0.03	−0.22	−3.02**	0.003	−0.05	−0.01
BMI	0.02	−0.06	0.88	0.38	−0.02	0.06
OTC meds use	−0.67	−0.13	−3.56***	0<.001	−1.03	−0.29
BC use	0.08	0.04	0.46	0.64	−0.26	0.42
CRP × approach	0.27	0.12	2.15*	0.03	0.03	0.51
−1SD	−0.10	–	−0.68	0.49	−0.40	0.19
Mean	0.13	–	1.10	0.27	−0.10	0.37
+1SD	0.37	–	2.13*	0.03	0.03	0.70
	Outcome: Frequency of partnered orgasms					
CRP	1.36	0.12	1.27	0.21	−0.76	3.48
Approach	−0.77	−0.10	−1.12	0.27	−2.12	0.59
Avoidance	0.04	0.01	0.15	0.89	−0.55	0.64
Bio sex	−4.19	−0.24	−2.55*	0.01	−7.45	−0.93
Age	−0.04	−0.05	−0.48	0.63	−0.20	0.12
BMI	−0.14	−0.08	−0.88	0.38	−0.45	0.17
OTC meds use	0.40	0.01	0.17	0.86	−4.13	4.93
BC use	0.81	0.06	0.60	0.55	−1.89	3.52
CRP × approach	1.98	0.16	2.02*	0.045	0.04	3.92
−1SD	−0.45	–	−0.35	0.72	−2.95	2.05
Mean	1.30	–	1.22	0.22	1.07	−0.81
+1SD	3.05	–	2.07*	0.04	0.13	5.97
	Outcome: Frequency of sex					
CRP	1.30	0.09	0.99	0.32	−1.30	3.90
Approach	−0.83	−0.09	−1.00	0.32	−2.47	0.82
Avoidance	−0.20	−0.05	−0.54	0.59	−0.92	0.53
Bio sex	−2.38	−0.11	−1.18	0.24	−6.37	1.61
Age	−0.09	−0.09	−0.97	0.33	−0.28	0.10
BMI	−0.22	−0.11	−1.15	0.25	−0.60	0.16
OTC meds use	1.14	0.03	0.41	0.69	−4.42	6.70
BC use	1.84	0.12	1.11	0.27	−1.44	5.13
CRP × approach	1.95	0.13	1.62	0.11	−0.43	4.32

Note. CRP = C-reactive protein. Bio sex = biological sex. BMI=body mass index. OTC meds = over-the-counter medicine. BC=birth control. Primary rows are the main effects and interaction term, and the sub-rows are simple effects of any statistically significant interaction.
* $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$.

understanding of the association between CRP and satisfying sexual experiences. Specifically, relational approach motivation moderated the association between CRP and sexual satisfaction *and* the number of partnered orgasms in the prior month; higher CRP was associated with being more sexually satisfied and having more partnered orgasms for those highest in relational approach motivation. The interaction between CRP and relational approach motivation on frequency of having sex was approaching statistical significance in the same direction (see Supplemental Fig. 1). As confirmation this association is relevant for *relationship-specific* sexual well-being, there was no such interaction between CRP and approach motivation for unpartnered orgasms. Our results suggest that for those highly motivated to approach the rewards of their romantic relationship, higher levels of CRP may be beneficial in the bedroom for one's sexual well-being.

We also explored outcomes that might share *psychological* overlap with aspects of sexual well-being and found similar interaction effects for affectionate touch, shared laughter, and perceived social support. First, these findings extend beyond animal models of sexual behavior (Bilbo et al., 1999), suggesting researchers interested in human inflammation should attend to the multidimensional experience of having sex that reflects meaningful underlying psychological processes.

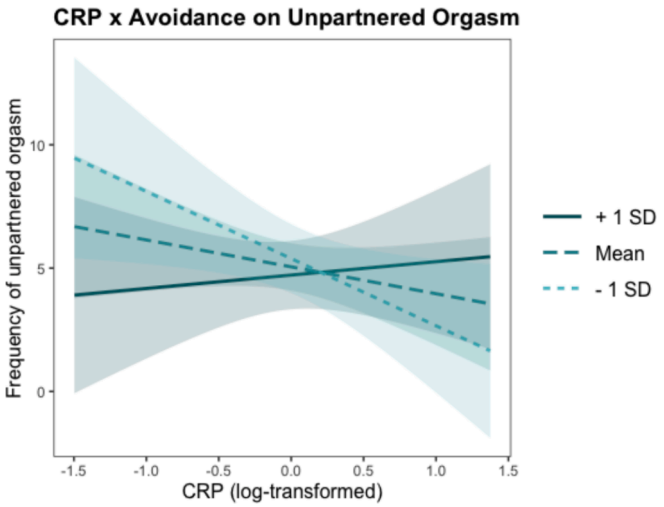

Fig. 2. Note. Significant interaction between CRP × relational avoidance motivation on unpartnered orgasms. −1SD simple effect significantly different from zero.

Second, these findings suggest the body and mind (i.e., CRP and relational motivation) work together to promote affiliative behaviors, even beyond sex. Affectionate touch and sexual intimacy can simultaneously co-occur, and each provides an intimate moment of connection with another person (Jakubiak and Feeney, 2017; Jolink et al., 2022). Shared laughter, like sex, is also a moment of connection, specifically a shared mental connection between two people (Kurtz and Algoe, 2015). Perceived social support and satisfying sex may similarly signify that one's partner is safe and caring (Birnbaum et al., 2006). Notably, a recent meta-analysis found a negative association between CRP and a broad index of social support/social integration (Uchino et al., 2018). That is not inconsistent with the theoretical argument made in the present work, which focuses on perceptions of support *from the romantic partner*, showing interactions between CRP and approach motivation that were consistent with other measures of affiliation with the same partner.

CRP and relational approach motivation did not interact to predict participant's frequency of unpartnered orgasms, expressed gratitude toward the partner, or individual positive behavior. Overall, experiences that were about the *individual*—not the partner—were non-significant. This suggests the interaction between inflammation and relational approach motivation may be (romantic) relationship-specific; however, the null effect with expressed gratitude does not fit this trend. It is possible this is due to participants being instructed to monitor their gratitude as part of the larger study (Algoe, 2022a). Regardless, to better understand this null result, future work should examine the interplay between inflammation, approach motivation, and gratitude.

Why is relational approach motivation particularly important as inflammation increases? New theorizing suggests heightened inflammation may drive us toward social interactions with those it might be beneficial to approach when we are vulnerable (i.e., close others, Muscatell and Inagaki, 2021).[5] Approaching a close other when inflamed hinges upon that close other supporting and caring for us when we need them; our evidence points to a circumstance under which this theory is supported. That is, the individuals most likely to notice (Gable and Poore, 2008) and gain further benefits from (Don et al., 2022) those affiliative relationship behaviors are those already oriented toward those benefits of their relationship partner. In contrast, those who are

[5] The current results reflect heightened inflammation levels in the absence of a sickness or acute inflammatory challenge model, but more data are needed to understand magnitude differences in inflammation on social behavior.

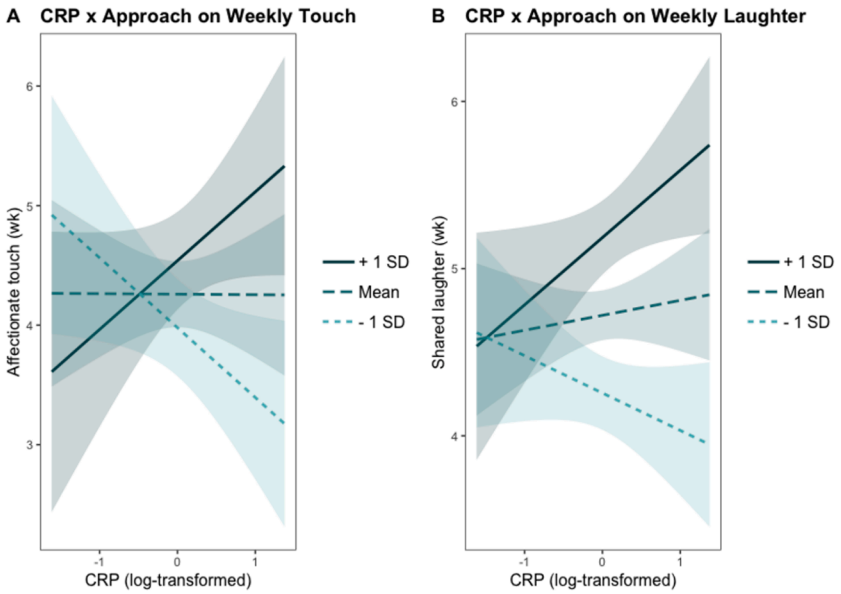

Fig. 3. Note. Significant interaction between CRP × relational approach motivation on relationship-promoting behavioral outcomes. Left panel depicts weekly affectionate touch; −1SD simple effect significantly different than zero; +1SD simple effect trending significant. Right panel depicts weekly shared laughter; +1SD simple effect significantly different than zero.

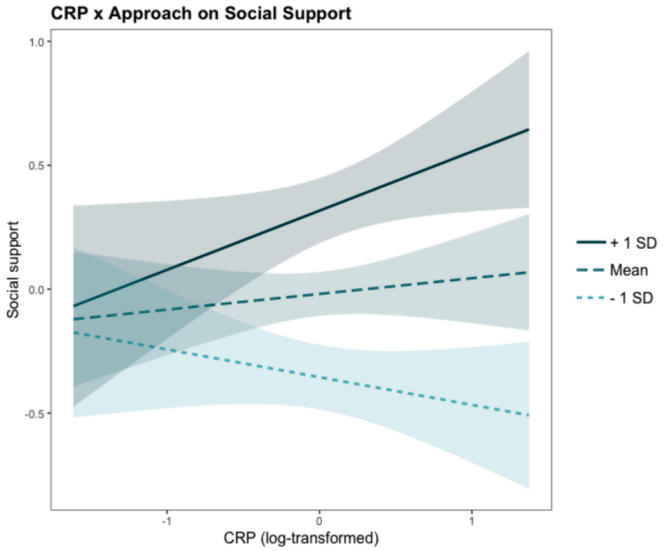

Fig. 4. Note. Significant interaction between CRP × relational approach motivation on perceived social support. + 1SD simple effect significantly different from zero.

not oriented toward the positive aspects of their relationship (i.e., are *less* relationally approach motivated) may *not* turn to that partner when experiencing heightened inflammation.[6] Additionally, relational *avoidance* motivation neither moderated the effects of CRP nor uniquely predicted affiliation. This provides corroborating evidence that approach motivation is driving high-inflammation individuals toward relational rewards, which includes a variety of ways to affiliate (e.g., partnered orgasms, shared laughter).

[6] Notably, we did not find any *negative* associations between CRP and sexual well-being, which might imply inhibited sexual behavior as a result of heightened inflammation. Even for those lower in approach motivation (for whom most simple effects were non-significant), these findings do not provide evidence of sexual inhibition/social withdrawal.

These data generate additional questions. First, what is the role of stress? Chronic stress is associated with elevated CRP (Baumeister et al., 2016; Hughes et al., 2017; Johnson et al., 2013), and stress is also one reason people report wanting (i.e., seeking relief) or not wanting to have sex (Hill and Preston, 1996; Meston and Buss, 2007). Based on its relevance to inflammation and motivation for sex, stress may moderate or mediate some of the associations presented here and therefore dissecting its role will be an important goal for future research. Second, what is the role of reward? Prior evidence has demonstrated an inflammatory challenge (e.g., endotoxin) predicts brain activation in regions associated with reward (i.e., ventral striatum and ventromedial prefrontal cortex), including in response to receiving positive feedback from someone (Muscatell et al., 2015) and in response to viewing a photograph of a close other (Inagaki et al., 2015). Another study found Lipopolysaccharide (LPS) administration increased motivation to work for high-value monetary rewards (Lasselin et al., 2017). To the extent that affiliating with a close other is rewarding, heightened inflammation may motivate similarly "rewarding" experiences with a close other, such as having satisfying sex with a romantic partner. In fact, the psychological experience of affiliation *may be* rewarding, through a few different theoretical pathways (Baumeister and Leary, 1995; Hill, 1987; Murray, 1938). Relatedly, these processes may function differently with individuals experiencing altered motivational and inflammatory states, such as individuals with major depressive disorder or anhedonia (Grahek et al., 2019; Majd et al., 2020; Miller and Raison, 2016).

Third, what is the underlying neurobiology of this interaction between motivation and inflammation? It is well known that dopamine is an important contributor to approach motivation (e.g. incentive salience; Depue and Collins, 1999). There is growing evidence that inflammation alters dopamine signaling. For example, chronic administration of an inflammatory cytokine (IFN-a) reduces dopamine release and dopamine receptor (D2) density in the striatum of nonhuman primates (Felger et al., 2013). Furthermore, these dopaminergic changes were associated with reduced experienced reward to sucrose solution. Similar effects of this inflammatory cytokine on dopamine signaling and anhedonia have been found in humans (Capuron et al., 2012). Importantly for the present work, CRP levels moderated the effects of administration of a dopamine boosting agent (L-DOPA) in humans, such that only amongst those with CRP >2 mg/L was the dopaminergic-related reduction in anhedonia related to connectivity in reward

circuitry in the brain (Bekhbat et al., 2022). These pharmacological neuroimaging findings suggest that inflammation can interact with motivation related circuitry to impact the degree of interest and pleasure one derives from life experiences such as intimate interactions with a romantic partner, and future work should test this possibility. Although the current study does not explicitly test these pathways—stress, reward, dopamine—this work highlights many opportunities for future exploration. We also hope we have started to make the case that researchers in other literatures trying to understand human health, functioning, and relationships should more seriously consider the multifaceted experience of having sex as an important behavioral indicator of well-being.

This work may at first seem at odds with prior findings that have demonstrated a negative association between heightened inflammation and sexual activity in both males and females (Bank et al., 2003; Clephane et al., 2021; Lorenz et al., 2017,2018; Lorenz and van Anders, 2014; Yao et al., 2012). In response, we first would like to point out that findings with sexual frequency do not necessarily contradict the existing literature showing heightened inflammation, especially in females, can dampen sexual arousal and inhibit sexual activity (Avitsur and Yirmiya et al., 1999a,b; Lorenz et al., 2017, 2018; Yirmiya et al., 1995); in the present study, no association between CRP and frequency of sex emerged. Next, we would like to suggest an alternative view, which is that these findings only represent CRP levels within a healthy range and that associations may differ—and perhaps become non-linear—with a less restricted range of CRP. As indirect evidence to this point, prior work on corticosteroid hormones and glucose levels have found curvilinear effects on behavior, specifically an inverted U-shape (Gold et al., 1986; Joëls, 2006), such that moderate levels of the biological measure were associated with the highest levels of behavior and low/high levels were associated with the lowest levels of behavior. In the present study, we collected a restricted range in terms of CRP, in that our samples were comprised of healthy, predominantly young adults, who were not acutely sick or experiencing inflammation-related chronic health conditions. The conclusions with the current data should thus be limited to those who are healthy and not those who are experiencing acutely or chronically high levels of inflammation. With more variance in the measure of inflammation, we may have been able to test for non-linear effects, especially if higher concentrations of inflammation were present in the data. For example, an inverted-U relationship between inflammation and affiliation toward close others would indicate that affiliation is highest at moderate levels of inflammation (perhaps the high end of the range in the current data among healthy individuals), but affiliation is lowest at low and high levels of inflammation (e.g., low levels and at acute sickness levels). This pattern of results would suggest a threshold for the positive associations found in the current studies, with the trend taking a downturn at levels indicating the individual is acutely ill or experiencing chronic inflammation. Future work should target participants with higher inflammation levels, or use an acute inflammatory challenge (e.g., endotoxin). Then, we could potentially test for non-linear effects with social and relational outcomes to understand the degree to which the present findings extend to acute sickness levels of inflammation. However, in these data with a restricted range of CRP, a non-linear pattern of effects cannot be ruled out.

5.1. Limitations and future directions

These findings are all correlational, and no causal conclusions should be made. Conclusions are also limited to individuals in satisfying romantic relationships; these relationships are characterized by interactions that are positively-valenced and rewarding (Algoe, 2019). It is thus an open question whether less satisfying relationships would show similar effects and future work should attempt to replicate in a less satisfied sample or extend to outcomes more relevant to avoiding threat/consequences (Gable and Impett, 2012). Additionally, while we presume participants reported on their sexual well-being with their current romantic partner (i.e., being partnered was an eligibility requirement for the study), they were not explicitly instructed to do this (e.g., measures instead anchored on "sexual partner"). People can have sex/orgasms outside a committed romantic relationship (e.g., casual sexual relationship; Grello et al., 2006). This introduces potential measurement error among the sexual well-being items, in contrast with the exploratory outcomes that *did* anchor on the romantic partner, and future work should use more precise language. Additionally, this sample was restricted in many ways that may have influenced results. Namely, the sample was young, predominantly White, and the majority identified as female, and we should be cautious about generalizing results beyond individuals with these characteristics. Further, we did not measure certain health information that may have influenced our effects (e.g., females' menstrual cycle phase, the presence of sexually transmitted infections, psychotropic medication use). Finally, CRP is just one marker of inflammation, and findings should be replicated with others. However, this work is some of the first to extend findings that heightened inflammation may promote affiliation toward close others beyond the inflammatory cytokine interleukin-6 (IL-6) to a marker of peripheral, systemic inflammation in CRP.

6. Conclusion

Inflammation alone may not drive people toward – or away from – having satisfying, orgasm-filled sex. Instead, individuals highly motivated to reap the rewards of having a romantic partner may have more rewarding sexual experiences with that partner as they experience higher levels of inflammation. But also, they are motivated to connect with their partner by affectionately touching them, sharing laughter with them, and perceiving their partner as supportive. These findings expand the empirical case for the theoretical assumptions of the role of inflammation in driving affiliation with close others (Muscatell and Inagaki, 2021). The findings also expand our understanding of the conditions under which heightened inflammation facilitates, instead of inhibits, as has been previously found, sexual experiences with a partner. Specifically, relational approach motivation may be an important point at which to intervene (i.e., upregulate) for individuals experiencing reductions in sexual arousal, desire, and activity, and/or for those whose body states (e.g., chronic pain, chronic inflammation, sickness symptoms) interfere with their sexual lives. Overall, this study illuminates the importance of one's relational approach motivation as a pre-condition of when inflammation may coordinate affiliative experiences with a romantic partner, resulting in *more satisfying, orgasm-filled* sex.

Funding

This work was supported by the John Templeton Foundation (grant #56458 and grant #61280) awarded to Dr. Sara Algoe.

CRediT authorship contribution statement

Tatum A. Jolink: Writing – original draft, Visualization, Investigation, Formal analysis, Conceptualization. **Baldwin M. Way:** Writing – review & editing, Methodology, Investigation, Funding acquisition. **Ayana Younge:** Writing – review & editing, Investigation. **Sara B. Algoe:** Supervision, Funding acquisition, Methodology, Investigation, Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

I have shared the link to my data/code in the manuscript.

Acknowledgements

The authors would like to thank the participants for their contributions and the team of study staff and research assistants who helped make the study possible. We specifically would like to thank Christopher Oveis, Paschal Sheeran, Elizabeth Crenshaw, Lexi Keaveney, Isabel Leavitt, and Michael Robinson for the contributions to this study. See Algoe, 2022b for a full list of the research assistants and staff who worked on this project.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.bbi.2024.08.054.

References

Albert, M.A., 2007. Inflammatory biomarkers, race/ethnicity and cardiovascular disease. Nutr. Rev. 65 (suppl_3), S234–S238.
Algoe, S.B., 2019. Positive interpersonal processes. Curr. Dir. Psychol. Sci. 28 (2), 183–188.
Algoe, S.B., 2022a. Everyday social behavior and health, 2017. UNC Dataverse V1. https://doi.org/10.15139/S3/1NRDMW.
Algoe, Sara; Fredrickson, Barbara, 2019, "Carolina Couples Study, 2008 ("CC08")", https://doi.org/10.15139/S3/MFYEHZ, UNC Dataverse, V1.
Algoe, Sara, 2022b, "Greater Good Science Center Study 2, 2013-2014", https://doi.org/10.15139/S3/SUBN6X, UNC Dataverse, V1.
Avitsur, R., Yirmiya, R., 1999a. Cytokines inhibit sexual behavior in female rats: I. Synergistic effects of tumor necrosis factor α and interleukin-1. Brain Behav. Immun. 13 (1), 14–32.
Avitsur, R., Yirmiya, R., 1999b. The immunobiology of sexual behavior: gender differences in the suppression of sexual activity during illness. Pharmacol. Biochem. Behav 64 (4), 787–796.
Bank, A.J., Billups, K.L., Kaiser, D.R., Kelly, A.S., Wetterling, R.A., Tsai, M.Y., Hanson, N., 2003. Relation of C-reactive protein and other cardiovascular risk factors to penile vascular disease in men with erectile dysfunction. Int. J. Impot. Res. 15 (4), 231–236.
Bates, D., Mächler, M., Bolker, B., Walker, S., 2014. Fitting linear mixed-effects models using lme4. arXiv preprint arXiv:1406.5823.
Baumeister, D., Akhtar, R., Ciufolini, S., Pariante, C.M., Mondelli, V., 2016. Childhood trauma and adulthood inflammation: a meta-analysis of peripheral C-reactive protein, interleukin-6 and tumour necrosis factor-α. Mol. Psychiatry 21 (5), 642–649.
Baumeister, R.F., Leary, M.R., 1995. The need to belong: desire for interpersonal attachments as a fundamental human motivation. Psychol. Bull. 117 (3), 497.
Bekhbat, M., Li, Z., Mehta, N.D., Treadway, M.T., Lucido, M.J., Woolwine, B.J., Felger, J. C., 2022. Functional connectivity in reward circuitry and symptoms of anhedonia as therapeutic targets in depression with high inflammation: evidence from a dopamine challenge study. Mol. Psychiatry 27 (10), 4113–4121.
Bilbo, S.D., Klein, S.L., DeVries, A.C., Nelson, R.J., 1999. Lipopolysaccharide facilitates partner preference behaviors in female prairie voles. Physiol. Behav. 68 (1–2), 151–156.
Birnbaum, G.E., Reis, H.T., Mikulincer, M., Gillath, O., Orpaz, A., 2006. When sex is more than just sex: attachment orientations, sexual experience, and relationship quality. J. Pers. Soc. Psychol. 91 (5), 929.
Calmasini, F.B., Klee, N., Webb, R.C., Priviero, F., 2019. Impact of immune system activation and vascular impairment on male and female sexual dysfunction. Sex. Med. Rev. 7 (4), 604–613.
Capuron, L., Pagnoni, G., Drake, D.F., Woolwine, B.J., Spivey, J.R., Crowe, R.J., Miller, A.H., 2012. Dopaminergic mechanisms of reduced basal ganglia responses to hedonic reward during interferon alfa administration. Arch. Gen. Psychiatry 69 (10), 1044–1053.
Carroll, J.F., Fulda, K.G., Chiapa, A.L., Rodriquez, M., Phelps, D.R., Cardarelli, K.M., Cardarelli, R., 2009. Impact of race/ethnicity on the relationship between visceral fat and inflammatory biomarkers. Obesity 17 (7), 1420–1427.
Charnetski, C.J., Brennan, F.X., 2004. Sexual frequency and salivary immunoglobulin A (IgA). Psychol. Rep. 94 (3), 839–844.
Clephane, K., Wilson, M.C., Craig, A.N., Heiman, J.R., Lorenz, T.K., 2021. Inflammation predicts sexual arousability in healthy women. Compreh. Psychoneuroendocrinol. 8, 100086.
Cooper, M.L., Barber, L.L., Zhaoyang, R., Talley, A.E., 2011. Motivational pursuits in the context of human sexual relationships. J. Pers. 79, 1031–1066. https://doi.org/10.1111/j.1467-6494.2010.00713.x.
Dantzer, R., Kelley, K.W., 2007. Twenty years of research on cytokine-induced sickness behavior. Brain Behav. Immun. 21 (2), 153–160.
Das, A., 2007. Masturbation in the United States. J. Sex Marital Ther. 33 (4), 301–317.
Depue, R.A., Collins, P.F., 1999. Neurobiology of the structure of personality: Dopamine, facilitation of incentive motivation, and extraversion. Behav. Brain Sci. 22 (3), 491–517.
Don, B.P., Fredrickson, B.L., Algoe, S.B., 2022. Enjoying the sweet moments: Does approach motivation upwardly enhance reactivity to positive interpersonal processes? J. Pers. Soc. Psychol. 122 (6), 1022.
Eisenberger, N.I., Inagaki, T.K., Mashal, N.M., Irwin, M.R., 2010. Inflammation and social experience: an inflammatory challenge induces feelings of social disconnection in addition to depressed mood. Brain, behavior, and immunity 24 (4), 558–563.
Eisenberger, N.I., Moieni, M., Inagaki, T.K., Muscatell, K.A., Irwin, M.R., 2017. In sickness and in health: the co-regulation of inflammation and social behavior. Neuropsychopharmacology 42 (1), 242–253.
Elliot, A.J., Gable, S.L., Mapes, R.R., 2006. Approach and avoidance motivation in the social domain. Pers. Soc. Psychol. Bull. 32 (3), 378–391.
Feairheller, D.L., Park, J.Y., Sturgeon, K.M., Williamson, S.T., Diaz, K.M., Veerabhadrappa, P., Brown, M.D., 2011. Racial differences in oxidative stress and inflammation: in vitro and in vivo. Clin. Transl. Sci. 4 (1), 32–37.
Felger, J.C., Mun, J., Kimmel, H.L., Nye, J.A., Drake, D.F., Hernandez, C.R., Miller, A.H., 2013. Chronic interferon-α decreases dopamine 2 receptor binding and striatal dopamine release in association with anhedonia-like behavior in nonhuman primates. Neuropsychopharmacology 38 (11), 2179–2187.
Frederick, D.A., Lever, J., Gillespie, B.J., Garcia, J.R., 2017. What keeps passion alive? Sexual satisfaction is associated with sexual communication, mood setting, sexual variety, oral sex, orgasm, and sex frequency in a national US study. J. Sex Res. 54 (2), 186–201.
Frederick, D.A., John, H.K.S.T., Garcia, J.R., Lloyd, E.A., 2018. Differences in orgasm frequency among gay, lesbian, bisexual, and heterosexual men and women in a US national sample. Arch. Sex. Behav. 47 (1), 273–288.
Gable, S.L., 2006. Approach and avoidance social motives and goals. J. Pers. 74 (1), 175–222.
Gable, S.L., Impett, E.A., 2012. Approach and avoidance motives and close relationships. Soc. Pers. Psychol. Compass 6, 95–108. https://doi.org/10.1111/j.1751-9004.2011.00405.x.
Gable, S.L., Poore, J., 2008. Which thoughts count? Algorithms for evaluating satisfaction in relationships. Psychol. Sci. 19 (10), 1030–1036.
Gable, S.L., Reis, H.T., Elliot, A.J., 2000. Behavioral activation and inhibition in everyday life. J. Pers. Soc. Psychol. 78 (6), 1135.
Gasparini, A., Callegari, C., Lucca, G., Bellini, A., Caselli, I., Ielmini, M., 2022. Inflammatory biomarker and response to antidepressant in major depressive disorder: a systematic review and meta-analysis. Psychopharmacol. Bull. 52 (1), 36.
Gold, P.E., Vogt, J., Hall, J.L., 1986. Glucose effects on memory: Behavioral and pharmacological characteristics. Behav. Neural Biol. 46 (2), 145–155. https://doi.org/10.1016/S0163-1047(86)90626-6.
Grahek, I., Shenhav, A., Musslick, S., Krebs, R.M., Koster, E.H., 2019. Motivation and cognitive control in depression. Neurosci. Biobehav. Rev. 102, 371–381.
Grello, C.M., Welsh, D.P., Harper, M.S., 2006. No strings attached: The nature of casual sex in college students. J. Sex Res. 43 (3), 255–267.
Gruenewald, T.L., Cohen, S., Matthews, K.A., Tracy, R., Seeman, T.E., 2009. Association of socioeconomic status with inflammation markers in black and white men and women in the Coronary Artery Risk Development in Young Adults (CARDIA) study. Soc. Sci. Med. 69 (3), 451–459.
Hamer, M., Batty, G.D., Marmot, M.G., Singh-Manoux, A., Kivimäki, M., 2011. Anti-depressant medication use and C-reactive protein: results from two population-based studies. Brain Behav. Immun. 25 (1), 168–173.
Haning, R.V., O'Keefe, S.L., Randall, E.J., Kommor, M.J., Baker, E., Wilson, R., 2007. Intimacy, orgasm likelihood, and conflict predict sexual satisfaction in heterosexual male and female respondents. J. Sex Marital Ther. 33 (2), 93–113.
Hennessy, M.B., Deak, T., Schiml, P.A., 2014. Sociality and sickness: have cytokines evolved to serve social functions beyond times of pathogen exposure? Brain Behav. Immun. 37, 15–20.
Herbenick, D., Fu, T.C., Wasata, R., Coleman, E., 2023. Masturbation prevalence, frequency, reasons, and associations with partnered sex in the midst of the COVID-19 pandemic: Findings from a US nationally representative survey. Arch. Sex. Behav. 52 (3), 1317–1331.
Hill, C.A., 1987. Affiliation motivation: people who need people… but in different ways. J. Pers. Soc. Psychol. 52 (5), 1008.
Hill, C.A., Preston, L.K., 1996. Individual differences in the experience of sexual motivation: Theory and measurement of dispositional sexual motives. J. Sex Res. 33 (1), 27–45.
Hughes, A., Kumari, M., McMunn, A., Bartley, M., 2017. Unemployment and inflammatory markers in England, Wales and Scotland, 1998–2012: Meta-analysis of results from 12 studies. Brain Behav. Immun. 64, 91–102.
Impett, E.A., Peplau, L.A., Gable, S.L., 2005. Approach and avoidance sexual motives: Implications for personal and interpersonal well-being. Pers. Relat. 12 (4), 465–482.
Impett, E.A., Strachman, A., Finkel, E.J., Gable, S.L., 2008. Maintaining sexual desire in intimate relationships: the importance of approach goals. J. Pers. Soc. Psychol. 94 (5), 808.
Inagaki, T.K., Muscatell, K.A., Irwin, M.R., Moieni, M., Dutcher, J.M., Jevtic, I., Eisenberger, N.I., 2015. The role of the ventral striatum in inflammatory-induced approach toward support figures. Brain Behav. Immun. 44, 247–252.
Jackowska, M., Kumari, M., Steptoe, A., 2013. Sleep and biomarkers in the English Longitudinal Study of Ageing: associations with C-reactive protein, fibrinogen, dehydroepiandrosterone sulfate and hemoglobin. Psychoneuroendocrinology 38 (9), 1484–1493.

Jakubiak, B.K., Feeney, B.C., 2017. Affectionate touch to promote relational, psychological, and physical well-being in adulthood: A theoretical model and review of the research. Pers. Soc. Psychol. Rev. 21 (3), 228–252.
Joëls, M., 2006. Corticosteroid effects in the brain: U-shape it. Trends Pharmacol. Sci. 27 (5), 244–250. https://doi.org/10.1016/j.tips.2006.03.007.
Johnson, T.V., Abbasi, A., Master, V.A., 2013. Systematic review of the evidence of a relationship between chronic psychosocial stress and C-reactive protein. Mol. Diagn. Ther. 17, 147–164.
Jolink, T.A., Algoe, S.B., 2024. What happens in initial interactions forecasts relationship development: Showcasing the role of social behavior. Social psychological and personality science 15 (2), 142–156. https://doi.org/10.1177/19485506231153438.
Jolink, T.A., Chang, Y.P., Algoe, S.B., 2022a. Perceived partner responsiveness forecasts behavioral intimacy as measured by affectionate touch. Pers. Soc. Psychol. Bull. 48 (2), 203–221.
Jolink, T.A., Fendinger, N.J., Alvarez, G.M., Feldman, M.J., Gaudier-Diaz, M.M., Muscatell, K.A., 2022b. Inflammatory reactivity to the influenza vaccine is associated with changes in automatic social behavior. Brain Behav. Immun. 99, 339–349.
Jolink, T.A., Way, B.M., Younge, A., Oveis, C., Algoe, S.B., 2023. Everyday copresence with a romantic partner is associated with lower C-reactive protein. Brain, Behavior, and Immunity 107, 132–139. https://doi.org/10.1016/j.bbi.2022.09.007.
Jolink, T.A., West, T.N., Alvarez, G.M., Cardenas, M.N., Feldman, M.J., Algoe, S.B., Muscatell, K.A., 2024. Higher interleukin-6 is associated with greater momentary social connection in close relationships in daily life. Psychoneuroendocrinology 164, 107020. https://doi.org/10.1016/j.psyneuen.2024.107020.
Kelley, K.W., Bluthé, R.M., Dantzer, R., Zhou, J.H., Shen, W.H., Johnson, R.W., Broussard, S.R., 2003. Cytokine-induced sickness behavior. Brain Behav. Immun. 17 (1), 112–118.
Kenny, D.A., Kashy, D.A., Bolger, N., 1998. Data analysis in social psychology. In D. Gilbert, S. T. Fiske, & G. Lindzey (Eds.), The handbook of social psychology (4th ed., Vol. 1, pp. 223–265). New York: McGraw-Hill.
Kornienko, O., Riis, J., Davila, M., White, N.S., Garner, P.W., 2022. Preliminary insights into associations between C-reactive protein and social network dynamics. Psychoneuroendocrinology 139, 105690.
Kurtz, L.E., Algoe, S.B., 2015. Putting laughter in context: Shared laughter as behavioral indicator of relationship well-being. Pers. Relat. 22 (4), 573–590.
Kuster, M., Backes, S., Brandstätter, V., Nussbeck, F.W., Bradbury, T.N., Sutter-Stickel, D., Bodenmann, G., 2017. Approach-avoidance goals and relationship problems, communication of stress, and dyadic coping in couples. Motiv. Emot. 41, 576–590.
Lasselin, J., Treadway, M.T., Lacourt, T.E., Soop, A., Olsson, M.J., Karshikoff, B., Lekander, M., 2017. Lipopolysaccharide alters motivated behavior in a monetary reward task: A randomized trial. Neuropsychopharmacology 42 (4), 801–810. https://doi.org/10.1038/npp.2016.191.
Lavie, C.J., Church, T.S., Milani, R.V., Earnest, C.P., 2011. Impact of physical activity, cardiorespiratory fitness, and exercise training on markers of inflammation. J. Cardiopulm. Rehabil. Prev. 31 (3), 137–145.
Lawrance, K.A., Byers, E.S., 1995. Sexual satisfaction in long-term heterosexual relationships: The interpersonal exchange model of sexual satisfaction. Pers. Relat. 2 (4), 267–285.
Lee, D.S., Jiang, T., Crocker, J., Way, B.M., 2023. Can inflammation predict social media use? Linking a biological marker of systemic inflammation with social media use among college students and middle-aged adults. Brain Behav. Immun. 112, 1–10.
Lockwood, K.G., Jennings, J.R., Matthews, K.A., 2017. Psychophysiological correlates of systemic inflammation in black and white men. Brain Behav. Immun. 59, 93–102.
Lorenz, T.K., 2019. Interactions between inflammation and female sexual desire and arousal function. Curr. Sex. Health Rep. 11, 287–299.
Lorenz, T.K., Worthman, C.M., Vitzthum, V.J., 2015. Links among inflammation, sexual activity and ovulation: Evolutionary trade-offs and clinical implications. Evol., Med., Public Health 2015 (1), 304–324.
Lorenz, T.K., Demas, G.E., Heiman, J.R., 2017. Partnered sexual activity moderates menstrual cycle–related changes in inflammation markers in healthy women: an exploratory observational study. Fertil. Steril. 107 (3), 763–773.
Lorenz, T.K., Heiman, J.R., Demas, G.E., 2018. Interactions among sexual activity, menstrual cycle phase, and immune function in healthy women. J. Sex Res. 55 (9), 1087–1095.
Lorenz, T., van Anders, S., 2014. Interactions of sexual activity, gender, and depression with immunity. J. Sex. Med. 11 (4), 966–979.
Majd, M., Saunders, E.F., Engeland, C.G., 2020. Inflammation and the dimensions of depression: a review. Front. Neuroendocrinol. 56, 100800.
McDade, T.W., Burhop, J., Dohnal, J., 2004. High-sensitivity enzyme immunoassay for C-reactive protein in dried blood spots. Clin. Chem. 50 (3), 652–654.
Meston, C.M., Buss, D.M., 2007. Why humans have sex. Arch. Sex. Behav. 36, 477–507.
Miller, A.H., Raison, C.L., 2016. The role of inflammation in depression: from evolutionary imperative to modern treatment target. Nat. Rev. Immunol. 16 (1), 22–34.
Muise, A., Boudreau, G.K., Rosen, N.O., 2017. Seeking connection versus avoiding disappointment: An experimental manipulation of approach and avoidance sexual goals and the implications for desire and satisfaction. J. Sex Res. 54 (3), 296–307.
Murray, H.A., 1938. Explorations in Personality. Oxford University Press, New York.
Muscatell, K.A., Dedovic, K., Slavich, G.M., Jarcho, M.R., Breen, E.C., Bower, J.E., Eisenberger, N.I., 2015. Greater amygdala activity and dorsomedial prefrontal–amygdala coupling are associated with enhanced inflammatory responses to stress. Brain Behav. Immun. 43, 46–53. https://doi.org/10.1016/j.bbi.2014.06.201.
Muscatell, K.A., Inagaki, T.K., 2021. Beyond social withdrawal: new perspectives on the effects of inflammation on social behavior. Brain, Behav., Immun.-Health 16, 100302.
O'Connor, M.F., Bower, J.E., Cho, H.J., Creswell, J.D., Dimitrov, S., Hamby, M.E., et al., 2009. To assess, to control, to exclude: Effects of biobehavioral factors on circulating inflammatory markers. Brain Behav. Immun. 23, 887–897. https://doi.org/10.1016/j.bbi.2009.04.005.
Pearson, T.A., Mensah, G.A., Alexander, R.W., Anderson, J.L., Cannon III, R.O., Criqui, M., et al., 2003. Markers of inflammation and cardiovascular disease: application to clinical and public health practice: a statement for healthcare professionals from the Centers for Disease Control and Prevention and the American Heart Association. Circulation 107 (3), 499–511.
Pepys, M.B., Hirschfield, G.M., 2003. C-reactive protein: a critical update. J. Clin. Invest. 111 (12), 1805–1812.
Prather, A.A., Epel, E.S., Cohen, B.E., Neylan, T.C., Whooley, M.A., 2013. Gender differences in the prospective associations of self-reported sleep quality with biomarkers of systemic inflammation and coagulation: findings from the Heart and Soul Study. J. Psychiatr. Res. 47 (9), 1228–1235.
Sarason, I.G., Sarason, B.R., Shearin, E.N., Pierce, G.R., 1987. A brief measure of social support: Practical and theoretical implications. J. Soc. Pers. Relat. 4 (4), 497–510.
Schwartz, P., Young, L., 2009. Sexual satisfaction in committed relationships. Sex. Res. Soc. Policy 6, 1–17.
Stepanikova, I., Bateman, L.B., Oates, G.R., 2017. Systemic inflammation in midlife: race, socioeconomic status, and perceived discrimination. Am. J. Prev. Med. 52 (1), S63–S76.
Uchino, B.N., Trettevik, R., Kent de Grey, R.G., Cronan, S., Hogan, J., Baucom, B.R., 2018. Social support, social integration, and inflammatory cytokines: A meta-analysis. Health Psychol. 37 (5), 462.
Więdłocha, M., Marcinowicz, P., Krupa, R., Janoska-Jaździk, M., Janus, M., Dębowska, W., Szulc, A., 2018. Effect of antidepressant treatment on peripheral inflammation markers–A meta-analysis. Prog. Neuropsychopharmacol. Biol. Psychiatry 80, 217–226.
Yabiku, S.T., Gager, C.T., 2009. Sexual frequency and the stability of marital and cohabiting unions. J. Marriage Fam. 71 (4), 983–1000. https://doi.org/10.1111/j.1741-3737.2009.00648.x.
Yao, F., Huang, Y., Zhang, Y., Dong, Y., Ma, H., Deng, C., Lu, K., 2012. Subclinical endothelial dysfunction and low-grade inflammation play roles in the development of erectile dysfunction in young men with low risk of coronary heart disease. Int. J. Androl. 35 (5), 653–659.
Yirmiya, R., Avitsur, R., Donchin, O., Cohen, E., 1995. Interleukin-1 inhibits sexual behavior in female but not in male rats. Brain Behav. Immun. 9 (3), 220–233.