

Bidirectional associations between daily subjective stress and sexual desire, arousal, and activity in healthy men and women

Hanna M. Mues, PhD^{†,1,2}, Charlotte Markert, PhD^{†,3}, Anja C. Feneberg, PhD^{1,4},
Urs M. Nater, PhD^{*,1}

¹Department of Clinical and Health Psychology, University Research Platform “The Stress of Life – Processes and Mechanisms Underlying Everyday Life Stress,” University of Vienna, 1010 Vienna, Austria,

²Department of Social and Preventive Medicine, Center for Public Health, Medical University of Vienna, 1090 Vienna, Austria,

³Department of Psychotherapy and Systems Neuroscience, Justus-Liebig-University Giessen, 35390 Giessen, Germany,

⁴Clinical Psychology for Children and Adolescents, Institute for Psychology, University of Münster, 48149 Münster, Germany

*Corresponding author: Urs M. Nater, PhD, Department of Clinical and Health Psychology, University of Vienna, Liebiggasse 5, 1010 Vienna, Austria (urs.nater@univie.ac.at).

[†]Shared first authorship.

Abstract

Background: The association between stress and sexuality, both of which are linked to health, is unclear. We examined the feasibility of an ecological momentary assessment study including time-based and event-based measurements in this context (aim 1) and investigated concurrent and time-lagged bidirectional associations between subjective stress and sexual desire/arousal/activity in the daily lives of healthy individuals over 14 days (aim 2).

Purpose: The aim of this study was to gain insight into the interplay between stress and sexual experience and behavior while considering potential gender differences.

Methods: Between May 2015 and January 2016, 59 heterosexual, healthy men and women in relationships ($M = 23.66$ years old, $SD = 2.86$, range: 18–30 years) rated subjective stress, sexual desire, and sexual arousal at 6 fixed timepoints daily as well as after sexual activity. Feasibility was investigated considering dropout rates, missing data, and representativeness of data. Data were analyzed using mixed-effects models.

Results: Higher subjective stress was associated with a lower likelihood of concurrent sexual desire and arousal, and occurrences of sexual desire and arousal were associated with lower concurrent subjective stress. Sexual desire and activity were associated with lower subsequent subjective stress, and the latter association was stronger in women than in men. Rates of dropout, missing data, and nonrepresentative data were low.

Conclusions: There appear to be bidirectional associations between higher subjective stress and a lower likelihood of concurrent sexual desire and arousal. Sexual desire and sexual activity seem to be associated with lower subsequent subjective stress. The study design appears to be feasible, although the generalizability of the findings is limited. Future studies might explore stress reduction interventions to promote sexual health.

Lay summary

Stress and sexuality are closely linked, but how exactly stress and sexuality are associated, and whether men and women are different, remains unclear. In this study, 59 heterosexual, healthy men and women aged 18–30 who were in a relationship participated. Over 14 days, they rated their subjective stress, sexual desire, and sexual arousal at 6 fixed timepoints each day and whenever they had been sexually active. The results showed that when people experienced more stress at one timepoint, then they reported less sexual desire and arousal (and vice versa) at the same time. Over two subsequent timepoints, when people experience sexual desire and engage in sexual activities, they tend to experience lower stress levels afterward. The association between being sexually active and being less stressed was stronger in women than in men. Since the researchers examined relatively young and healthy individuals, their findings may not apply to everyone. Future research should investigate whether stress reduction interventions may be a potential way to promote sexual health, ultimately contributing to improved well-being and overall health.

Key words: ecological momentary assessment; sexual activity; sexual arousal; sexual desire; stress.

Stress is experienced in daily life by many people around the world and plays a fundamental role in our mental and physical health.^{1–3} It can be defined as “any type of change that causes physical, emotional or psychological strain,”⁴ involves an activation of the sympathetic division of the autonomic nervous

system (ANS),⁵ and studies have found gender differences in perceived stress, with women reporting higher levels than men.^{6,7} Stress is commonly believed to negatively impact sexuality. Considering the Dual Control Model,^{8,9} which proposes that sexual arousal and sexual behavior depend on

a balance between processes eliciting sexual response and processes suppressing sexual response, stress may be a relevant factor in excitatory or inhibitory processes of sexual response. Sexuality can be described as “that aspect of the human condition, which is manifested as sexual desire or appetite, associated physiological response patterns, and behavior which leads to orgasm, or at least pleasurable arousal, often between two people, but not infrequently by an individual alone” (Bancroft,¹⁰ p. 18). In particular, sexual desire has been described as a motivational state and sexual arousal as involving psychological and physiological processes during the sexual response^{11,12} and requiring a coordination of the sympathetic and parasympathetic divisions of the ANS.¹³ In an ongoing discussion, evidence suggests that it is difficult to differentiate between sexual desire and sexual arousal as they appear to overlap significantly.¹⁴ At the same time, sexual desire and arousal still constitute distinct constructs¹⁵ and, thus, should be conceptualized as such,¹⁶ although the discussion appears to be ongoing.¹¹ The authors of this paper carefully considered the ongoing discussion and since the constructs appear to be overlapping but not identical, they decided to distinguish between them in this study. Gender differences in sexual experiences and behavior may be small and only slightly higher in men, or might even be nonexistent, with the exception of frequency of masturbation, pornography, and casual sex, which seem to be reported more frequently in men compared to women.¹⁷ In the context of stress and sexuality, gender differences should be considered. Taylor et al.¹⁸ suggested that women and men may show different stress response strategies, with women being more likely to show a “tend-and-befriend” response and men the better-known “fight-or-flight” response to stress. In particular, a “tend-and-befriend” stress response strategy describes “tending” to children and “befriending” people in a social group, while a “fight-or-flight” stress response strategy describes fighting or feeling a stressful situation.¹⁸ Thus, a “tend-and-befriend” stress response strategy may include sexuality as a way of bonding with a partner. Therefore, it seems logical to assume negative associations of stress with sexual experiences and behavior, as well as gender differences, although many questions remain unanswered.

Current knowledge on the sex-stress link

To date, cross-sectional studies on the relationship between stress and sexuality-related factors have yielded conflicting findings. For instance, some studies found associations between stress and lower levels of or problems with sexual desire and arousal and less frequent sexual activity,^{19–23} while others found associations between stress and more frequent sexual desire and sexual activity.²⁴ As a possible explanation for this latter finding, Morokoff and Gilliland²⁴ suggested that sexual release may act as a potential coping mechanism, or that autonomic arousal due to stress might be misinterpreted as sexual desire. In line with this, in a study examining why people engage in sexual activity, stress relief was one of the mentioned reasons.²⁵ Similarly, longitudinal studies have found associations between stress and lower desire and less frequent sexual activities in women,^{26–28} while other findings showed associations between stress and more frequent sexual intercourse in women²⁹ and higher desire in men.²⁶ Daily diary studies showed associations between stress and less frequent same-day sexual activities in women,³⁰ a higher

probability of next-day sexual activity, with a stronger effect in men than in women,³¹ and less frequent next-day sexual activities in lesbian women.³⁰ Vice versa, studies found associations between sexual activities and lower next-day stress in women and men with high relationship satisfaction and in women with shorter relationships.^{30,31} Similarly, occurrence of sexual activity during the night was associated with less stress the next day.³²

Limitations of previous studies

To date, however, the comparability of research findings in this area is limited by the differing methodology used across the studies. Moreover, the majority of the studies are questionnaire-based, and the extent to which the results reflect real-life associations is unclear. Cross-sectional studies summarize data that potentially vary over time into one general statement, and they are further limited by recall bias, as data are collected retrospectively.³³ Accordingly, their findings might not reflect the reality of everyday life. Longitudinal studies entail various advantages over cross-sectional studies, as they include not only one but several measurements over time. However, they might still be limited by recall bias if measurements refer to a longer time frame, for example, stress during the past week. Moreover, although daily measurements are less prone to recall bias, subjective stress and sexuality-related aspects may vary throughout the day. For instance, studies revealed that subjective stress decreased over the course of the day,^{34,35} and other studies have reported peaks of sexual desire between 6 AM and 9 AM as well as between 6 PM and 3 AM.^{36–38} Previous longitudinal studies on stress and sexual experiences or behavior did not account for changes over the course of the day, and therefore did not enable the investigation of diurnal patterns of effects. Both recall bias and diurnal effects can be addressed by employing several momentary assessments, for example, measuring momentary stress, per day.

The research gap in the sex-stress link

Thus, the possible bidirectional association between stress and sexuality, as well as potential gender differences, remain to be investigated. Research to date has mainly investigated the link between sex and stress in women, while gender differences have rarely been investigated, and the few available findings do not yield a clear picture. Moreover, the sex-stress link remains insufficiently investigated not only in clinical but also in healthy samples. As a starting point, empirical evidence on the sex-stress link in healthy persons is required. Insights into the associations in healthy samples could help to inform future empirical investigations into the sex-stress link in clinical samples (eg, people with sexual dysfunctions). Furthermore, a real-life setting, including several measurement timepoints throughout the day, seems appropriate to capture diurnal patterns in daily life. No previous research in this context has incorporated multiple measurements throughout the day in participants' daily lives. Additionally, in order to consider potential influences of sexual activities that occur during the study, event-based measurements after sexual activities are additionally required, which to the best of our knowledge, no study to date has assessed. Ecological momentary assessment (EMA) enables both several measurement timepoints during the day and event-based measurements in daily life,³³

and the advantages of EMA studies include the possibility of investigating associations both at one timepoint and over time (eg, from one measurement timepoint to the next) as well as high ecological validity.³³ However, the feasibility of an EMA study investigating the association between stress and sexuality, which includes several measurement timepoints each day as well as event-based measurements following sexual activity, conducted over a longer time period (ie, 2 weeks), is unclear. Furthermore, it is unknown whether participants are willing to report honestly on their sexual experiences and behavior, especially with regard to event-based measurements following sexual activity, given that sex is still seen as a taboo topic in various different contexts^{39–41} and that sexual double standards may influence the reporting of sexual experiences and behavior, as argued by Dawson and Chivers.⁴²

Current study

As a first aim, we sought to investigate the feasibility of conducting such an EMA study on perceived stress and sexual desire, sexual arousal, and sexual activity as this is the first EMA study conducted in this context that investigated both several time-based measurements daily and sexual activity in the form of event-based measurements. The second aim of the present study is to investigate whether stress is associated with sexual desire, sexual arousal, and sexual activity in daily life by examining the bidirectional association between subjective stress and the occurrence of sexual desire and arousal from a concurrent perspective (ie, at the same timepoint) and over time (ie, time-lagged from one timepoint to the next), and between

subjective stress and previous/subsequent sexual activity, considering possible gender differences. Specifically, we hypothesized that subjective stress would show a negative bidirectional association with concurrent (1a) sexual desire and (1b) sexual arousal, as well as with subsequent (2a) sexual desire and (2b) sexual arousal, and with previous/subsequent sexual activity (3). In line with the discussion regarding gender similarities in aspects relating to sexuality, we further hypothesized gender differences for time-lagged associations but not for concurrent associations (4). More specifically, according to the “fight-or-flight” vs. “tend-and-befriend” model,¹⁸ it seems reasonable to assume lower levels of sexual desire, sexual arousal, and sexual activity following perceived stress in men compared to women. Vice versa, building on these different stress response strategies, we hypothesized that desire, sexual arousal, and sexual activity would be more effective in lowering subjective stress in women compared to men.

Materials and methods

The descriptions of this paper’s method and results sections are based on the Journal article reporting standards for quantitative research in psychology: The APA Publications and Communications Board task force report (JARS-Quant).⁴³

Participants

Participants were recruited between May 2015 and January 2016 via an internal university mailing list and posters in several university buildings in Marburg, Germany (see Figure 1 for the participant flow chart). The inclusion criteria encompassed

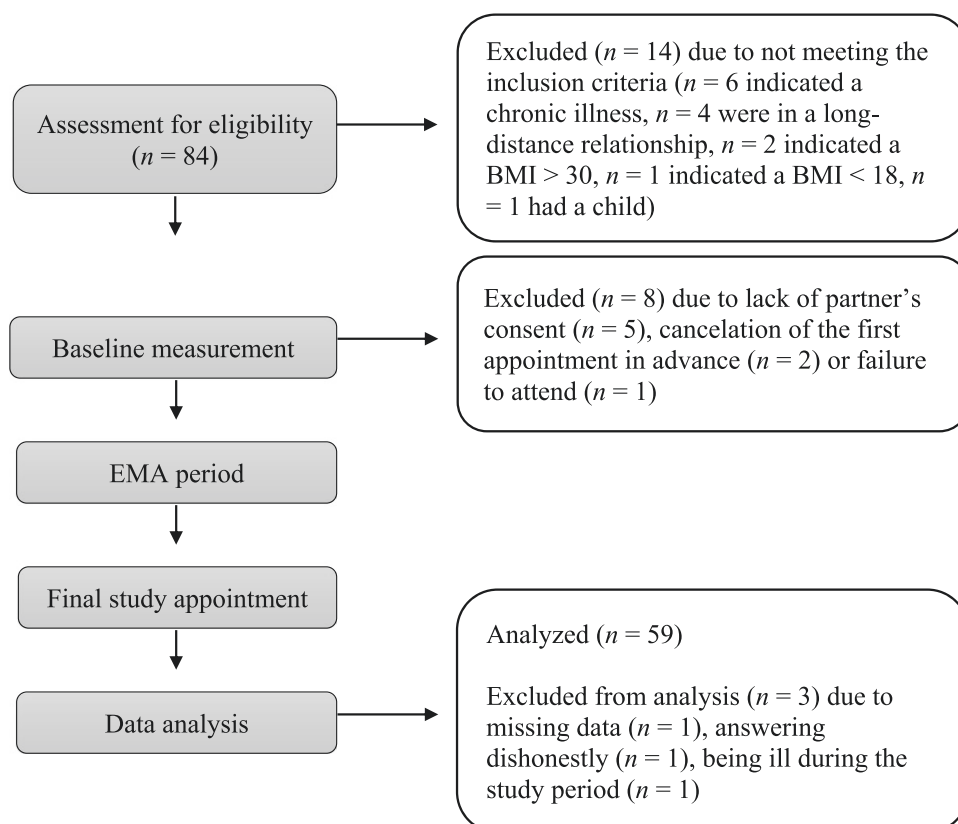


Figure 1. The participant flowchart outlining the inclusion or exclusion of participants and the path to the final sample size. Abbreviations: BMI, body mass index; EMA, ecological momentary assessment.

German-language fluency, age between 18 and 35 years (this criterion was included as sexuality and hormonal levels, eg, during menopause, may change with age⁴⁴ and to limit systematic exclusion due to the restricted inclusion and exclusion criteria outlined here that may more likely reflect the reality of the specified age group), being in a heterosexual relationship (not long distance) with a duration of at least 1 year, the absence of chronic somatic illnesses, a body mass index (BMI) between 18 and 30 (due to possible negative health consequences of under- or overweight), no history of alcoholism or other drug misuse or dependency, no acute depressive episode, no eating disorder within the past 5 years, no other mental disorder, and no intake of pharmaceuticals that might have an impact on hormones (excluding hormonal contraceptives), sexuality, or the menstrual cycle to control for potential pharmaceutical influences on sexuality or of psychiatric medications in the 14 days prior to the study. The health-related criteria ensured inclusion of healthy individuals by excluding individuals with physical or mental ill-health, which otherwise may have had an impact on sexuality. Moreover, to be eligible to participate, the partner needed to be available for the majority of nights for the duration of the study (unavailability for a maximum of 2 nights) to ensure the possibility of partnered sexual activity. Exclusion criteria were having children, lack of informed consent from the participant or their partner, and, for women, an irregular menstrual cycle, pregnancy, or breastfeeding. The partner's informed consent was required since when assessing partnered sexual activity, participants provided data that also included information on their partners' sexual activity. Women were scheduled to participate depending on their menstrual cycle (survey start within the first week after the last day of their period) to control for the cycle phase of data collection, as hormonal fluctuations during the course of the menstrual cycle may influence sexuality.

Procedure

Following a baseline measurement, participants answered brief questions on an iPod touch 6 times per day (upon awakening, at 11 AM, 2 PM, 5 PM, and 8 PM, and before going to bed) and event-based entries directly after sexual activity for 14 consecutive days. Participation was concluded with a post-monitoring questionnaire (also see [Supplementary Material](#)).

Measures

Feasibility

To assess feasibility, we recorded the dropout rate, the number of missing data entries per person during the EMA period (participants with $\geq 50\%$ missing data entries were excluded), as well as the representativeness of data following the EMA period (by asking participants to rate the following item with yes/no: "I answered questions dishonestly (e.g., because they made me uncomfortable or embarrassed)"). Based on previously reported missingness rates of EMA studies between 15% and 30%,⁴⁵ a 30% or lower total missingness rate was deemed acceptable for this study. Furthermore, participants were asked to report any illness they suffered during the study period, as this may have affected the representativeness of the data. Finally, we determined the number of participants who reported event-based measurements following sexual activity.

Baseline measures

To enable an optimal description of the sample characteristics in relation to the relevant variables, we assessed the following

at the baseline assessment and provide the respective descriptive statistics in [Supplementary Material](#): gender (0 = men, 1 = women), age (in years), first sexual contact (age), satisfaction with sex life (1 = very satisfied, 5 = very unsatisfied), personal importance of sexuality (1 = very important, 5 = unimportant), and chronic stress levels (Screening Scale for Chronic Stress [SSCS] from the Trier Inventory for Chronic Stress [TICS]⁴⁶). Furthermore, to account for potential depressive symptoms and relationship factors and to be able to control for these variables in the model calculations, we assessed depressive symptoms (Patient Health Questionnaire [PHQ-9]^{47,48}), relationship duration (in years), and relationship quality, as indicated by the 3 subscales Conflict Behavior, Tenderness, and Communality/Communication as well as a single item assessing participants' overall evaluation of their relationship satisfaction (the so-called Terman rating) from the Partnership Questionnaire (Partnerschaftsfragebogen [PFB]⁴⁹). We further calculated the total score on the PFB using the following formula: $[30 - (\text{conflict behavior score}) + (\text{tenderness score}) + (\text{communality/communication score})]^{[49]}$.

EMA measures

To measure subjective stress during the EMA period, participants rated the single item "At the moment, I feel stressed" on a 5-point scale from 0 (*not stressed at all*) to 4 (*very stressed*). We chose this single-item method in order to keep the effort of data collection as low as possible for the participants. Previous studies have confirmed that subjective stress can be validly captured using a single item,^{50,51} and single-item assessment has been implemented by the present authors in relation to various research questions.^{52–55}

During the EMA period, the occurrence of sexual desire and sexual arousal was assessed dichotomously using single questions formulated for this study ("Have you felt sexual desire since the last entry?" "Yes" or "No"; "Have you felt sexual arousal since the last entry?" "Yes" or "No"). In light of the ongoing discussion on the distinction between sexual desire and sexual arousal, definitions of sexual desire and arousal were given to participants and discussed with them prior to study participation (the definitions are provided in [Supplementary Material](#)). Both items were recoded for statistical analysis, such that 0 indicates "No" and 1 indicates "Yes." If participants reported the presence of sexual desire or sexual arousal, they were asked to indicate their intensity on a scale from 1, indicating low intensity, to 5, indicating high intensity. However, due to little available data on the intensity of sexual desire or sexual arousal, these variables were not included in the analysis. Sexual activity was recorded using event-based measurements (see [Supplementary Material](#) for details; 0 = no event/sexual activity, 1 = event/sexual activity). As part of an event-based entry, participants reported one or more of the type of sexual activity that they had just participated in (masturbation, petting, oral sex, sexual intercourse, anal sex). Any sexual activities that had not been recorded as events and which took place during the night were recorded directly after awakening and categorized into the same types of sexual activity.

Confounders from baseline and EMA measures

The following variables were controlled for: age, depressive symptoms (PHQ-9^{47,48}; this was included to account for any influences from depressive symptoms on health and sexual desire, sexual arousal or sexual activity), relationship

duration (in years) and relationship quality (PFB⁴⁹), time since awakening (in hours), previous event-based measurement, that is, previous sexual activity (0 = no event, 1 = event; except for models that included sexual activity as predictor or outcome), and autocorrelation (outcome value at previous timepoint; this was not included for models with sexual activity as the outcome).

Ethics

Participation was voluntary, and all individual participants and their partners provided written informed consent. Data were collected in pseudonymized form. As reimbursement, participants received €80 or a combination of course credits and €30. Study procedures were conducted in compliance with the Declaration of Helsinki (exception: preregistration of the study) and approved by the ethics committee at the Philipps University Marburg, Germany (2015-08k).

Statistical analysis

Data were prepared and analyzed, and tables and graphs were created using the programs Excel 2016, IBM SPSS Statistics 26, R 4.2.2,⁵⁶ and R studio⁵⁷ (R packages are listed in [Supplementary Material](#); the R code is available here: <https://osf.io/6hevu/>). For statistical analysis, we calculated binomial generalized linear mixed-effects models in the case of a binary outcome (occurrence of sexual desire or arousal or subsequent sexual activity) and linear mixed-effects models in the case of a continuous outcome (subjective stress) with 2 or 3 levels depending on intraclass correlations (see *Results*), 2- and 3-level model comparisons using ANOVAs, and sufficient random effect variation including random intercepts and slopes. Direct effects and cross-level interactions with gender were examined. The variables that were controlled for are listed above in the *Measures* section. [Supplementary Material](#) provides a detailed description of statistical analysis. According to Maas and Hox,⁵⁸ a sample size of 50 individuals is sufficient for cross-level-effect-calculations. Significance tests were carried out using Satterthwaite's method.⁵⁹ The significance level was set at $P < .05$, and marginal R^2 and conditional R^2 are reported for goodness of model fit.⁶⁰

Results

Feasibility

No participant dropped out during the EMA period. Three participants were excluded from the analyses (see [Figure 1](#)). All remaining participants showed willingness to report sexual

activities by reporting at least one activity. The final sample showed 11% missing data, with no conspicuous patterns of missing data regarding gender or measurement timepoints. Details on dropouts, honesty of answers, and missing data are provided in [Supplementary Material](#).

Descriptive statistics

Data from 59 participants (27 men, 32 women) were included in the analysis. With regard to nationality, the majority of participants reported being from Germany ($n = 54$) and the remaining participants were from Austria ($n = 1$), Croatia ($n = 1$), Peru ($n = 1$), Poland ($n = 1$), and Ukraine ($n = 1$). Information on race and ethnicity was not collected. Most of the participants had a high level of education, were currently studying or working, and did not have a high income (see [Supplementary Material](#) for more details and [Supplementary Table S1](#) for descriptive statistics and baseline measurement information).

The levels and diurnal patterns of subjective stress and the occurrence of sexual desire and arousal during the 14 consecutive days of data collection are shown in [Table 1](#) and [Figure 2](#). Subjective stress slowly increased over the course of the day, before decreasing again towards the evening, with women descriptively reporting slightly higher overall subjective stress than men. While the occurrence of sexual desire increased in both men and women towards the evening, the occurrence of sexual arousal also increased over the course of the day in women, but remained roughly on a similar level throughout the day for men. Referring to the discussion on differentiating between sexual desire and sexual arousal, the results support the decision to distinguish between these constructs based on current evidence. In particular, while participants reported both sexual desire and arousal in 464 data entries, only sexual desire but not sexual arousal in 355 data entries, and only sexual arousal but not sexual desire in 96 data entries. These results support that there is overlap between sexual desire and sexual arousal but that they still constitute separate constructs.

During the EMA period, a total of 362 sexual activities ($n = 203$, 56.1% during the first week of the study) were entered as events ($n = 181$, 50% by men). On average, 6.14 events were entered per participant over the 14 days of EMA ($SD = 3.70$, range: 1-19; men: $M = 6.70$, $SD = 4.16$, range: 1-19; women: $M = 5.66$, $SD = 3.26$, range: 2-16). Furthermore, in the morning, participants added 122 sexual activities (men: $n = 53$, 43.4%) that had taken place before going to sleep or during the night but were not entered as

Table 1. Subjective stress, occurrence of sexual desire, and occurrence of sexual arousal over 14 consecutive days across measurements, days, and individuals.

	Men		Women		Total	
	<i>n</i>	<i>M ± SD</i>	<i>n</i>	<i>M ± SD</i>	<i>n</i>	<i>M ± SD</i>
Subjective stress	1987	0.84 ± 0.92	2412	1.06 ± 1.00	4399	0.96 ± 0.97
	<i>n</i>	<i>n (%) occurred</i>	<i>n</i>	<i>n (%) occurred</i>	<i>n</i>	<i>n (%) occurred</i>
Sexual desire	1630	400 (24.5)	1979	419 (21.2)	3609	819 (22.7)
Sexual arousal	1630	310 (19.0)	1979	250 (12.6)	3609	560 (15.5)

Higher levels indicate either occurrence or higher levels of the variable. Range of subjective stress: 0-4. Sexual desire and sexual arousal: 0 indicates absence of sexual desire/arousal, and 1 indicates occurrence of sexual desire/arousal.

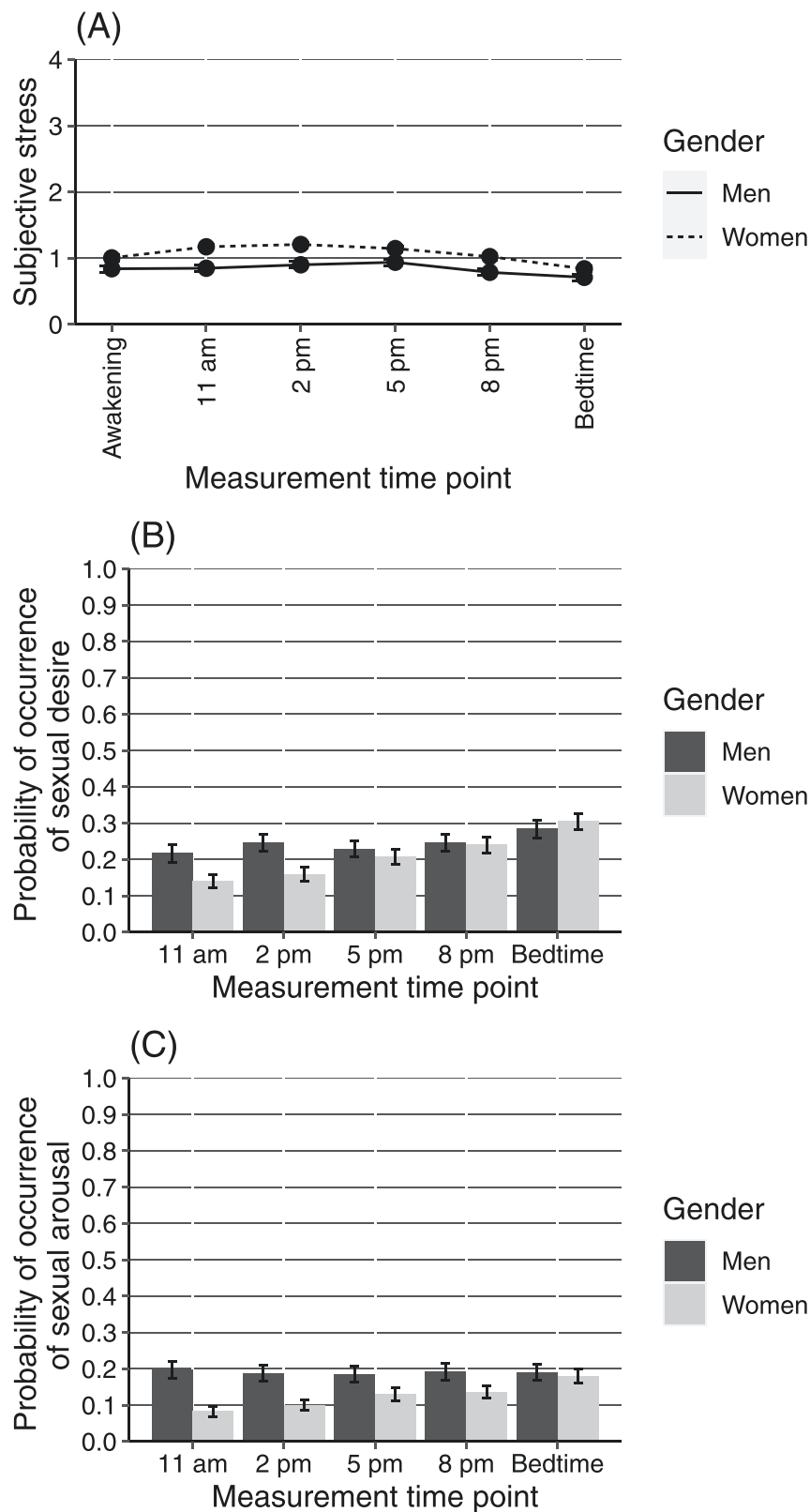


Figure 2. Diurnal patterns of (A) subjective stress, (B) occurrence of sexual desire, and (C) occurrence of sexual arousal. Higher values indicate higher probability of occurrence or higher levels of the construct. The error bars show the standard error of the mean.

events, of which 49 (40.2%) occurred during the first week of the study. Table 2 provides details on frequencies of types of sexual activity. Sexual activities mostly took place between 8 AM and 2 AM, with the highest peaks between 9 PM and

10 PM and between 11 PM and midnight for men, and between 5 PM and 6 PM and between 10 PM and 11 PM for women. The distribution of sexual activities across the days of the week was relatively equal in men and women, although

the frequency rose slightly towards the end of the week in women (for details on time of day and day of the week of sexual activity occurrences, see [Supplementary Figure S1](#) of the [Supplementary Material](#)).

Main analysis

Based on the intraclass correlation coefficients (see [Table 3](#)) as well as model fit, 3-level models were calculated for models with subjective stress and occurrence of sexual desire as outcomes and 2-level models were calculated for models with occurrence of sexual arousal as outcome due to convergence issues in 3-level models, and for models with subsequent sexual activity as outcome (see [Supplementary Tables S2–S11](#) in [Supplementary Material](#)).

Hypothesis 1a: Higher subjective stress was significantly associated with a lower probability of occurrence of concurrent sexual desire (odds ratio [OR] = 0.79, $P = .003$, *Marginal* $R^2 = .050$, *Conditional* $R^2 = .250$), irrespective of gender ($P = .198$). Vice versa, occurrence of sexual desire was associated with lower concurrent subjective stress (Unstandardized coefficient, $UC = -0.14$, $P < .001$, *Marginal* $R^2 = .087$, *Conditional* $R^2 = .328$), irrespective of gender ($P = .138$).

Hypothesis 1b: Higher subjective stress was significantly associated with a lower probability of occurrence of concurrent sexual arousal (OR = 0.74, $P = .007$, *Marginal* $R^2 = .062$, *Conditional* $R^2 = .282$), irrespective of gender ($P = .059$). Occurrence of sexual arousal was associated with lower concurrent subjective stress ($UC = -0.17$, $P < .001$, *Marginal* $R^2 = .090$, *Conditional* $R^2 = .327$), irrespective of gender ($P = .066$).

Hypothesis 2a: Previous subjective stress was not significantly associated with occurrence of sexual desire ($P = .213$) and there was no significant cross-level interaction with gender ($P = .800$). Previous occurrence of sexual desire was associated with lower subsequent subjective stress ($UC = -0.10$, $P = .034$, *Marginal* $R^2 = .089$, *Conditional* $R^2 = .302$), irrespective of gender ($P = .619$).

Hypothesis 2b: There was no significant association between previous subjective stress and subsequent occurrence of sexual arousal ($P = .941$) or vice versa ($P = .190$), irrespective of gender ($P = .347$, $P = .899$, respectively).

Hypothesis 3: Previous sexual activity was significantly associated with lower subsequent subjective stress ($UC = -0.13$, $P = .016$, *Marginal* $R^2 = .081$, *Conditional* $R^2 = .323$). However, when including a cross-level interaction with gender, the main effect was not significant, but the cross-level interaction was significant, showing that previous sexual activity was associated with lower subjective stress in women, while this trend was less clear in men ($UC = -0.26$, $P = .020$) (see [Figure 3](#)). There was no significant association between previous subjective stress and subsequent occurrence of sexual activity ($P = .289$), irrespective of gender ($P = .463$).

Discussion

The present study investigated the associations between subjective stress and sexual desire, sexual arousal, and sexual activity in healthy men and women in everyday life, considering potential variations over the course of the day using an EMA design combining high-frequency time-based and

Table 2. Frequencies of types of sexual activities (1) entered as events and (2) reported additionally in the morning.

Sexual activity	Sexual activities (events)			Additional sexual activities entered in the morning			Total
	Women	Men	Total	Women	Men	Total	
Masturbation	33	77	110	11	19	30	140
Petting	54	42	96	27	10	37	133
Oral sex	54	32	86	10	13	23	109
Penile-vaginal intercourse	132	90	222	38	26	64	286
Anal sex	4	4	8	0	0	0	8
Total	277	245	522	86	68	154	676

In sum, 362 event-based sexual activities and 122 additional sexual activities entered in the morning were reported. Multiple types of sexual activities could be reported at each entry.

Table 3. Intraclass correlation coefficients for subjective stress, occurrence of sexual desire, and occurrence of sexual arousal as outcomes.

Outcome	ICC (2-level)	ICC (3-level)	
	Participant-level	Day-level	Participant-level
Subjective stress ^a	0.23	0.13	0.22
Sexual desire occurrence ^a	0.22	0.07	0.22
Sexual arousal occurrence ^b	0.29	0.08	0.27
Subsequent sexual activity ^c	0.04	<0.01	0.04

Abbreviation: ICC, intraclass correlation coefficient. Two- or three-level models were calculated as indicated by the corresponding bold values.

^aThree-level models were calculated.

^bTwo-level models were calculated due to issues with convergence.

^cTwo-level models were calculated due to a variance component that equals zero.

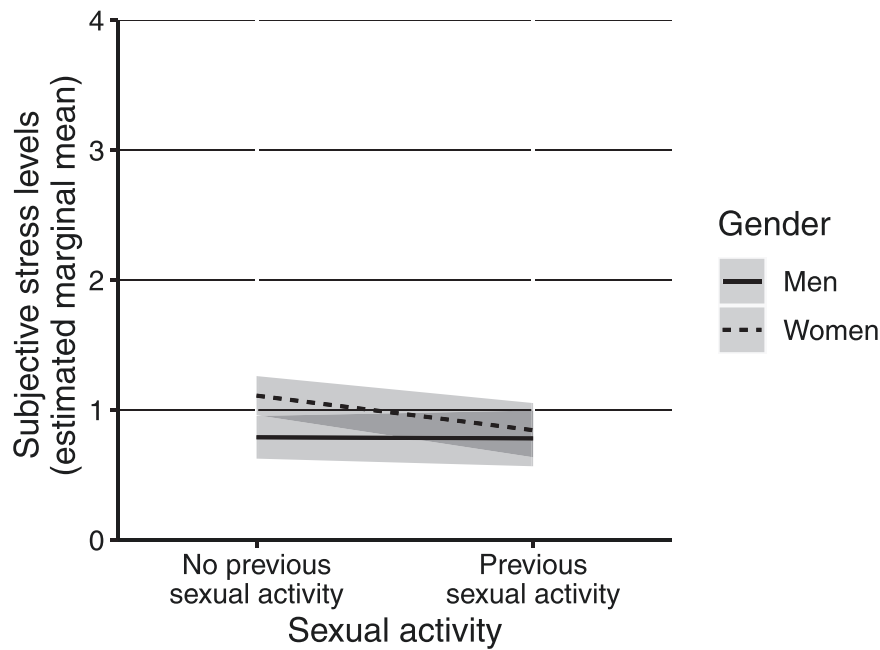


Figure 3. Three-level multilevel model on the association between sexual activity and subsequent subjective stress levels, showing the cross-level interaction of gender.

event-based measurements. Therefore, it allows an investigation into the potential role of stress in excitatory or inhibitory processes of sexual response outlined in the Dual Control Model.^{8,9} Our first aim was to investigate the feasibility of the methodological approach, which has not been applied in this context before. Given that no participants dropped out during the EMA period, the rate of missing data was low (1 person was excluded due to too many missing values; the final sample showed 11% missing data, which is a very low rate for an EMA study), only 2 individuals were excluded due to nonrepresentative data (1 participant fell ill during the study period, and 1 participant reported answering dishonestly), and participants were willing to report sexual activities during the study (all participants reported at least 1 sexual activity); it seems reasonable to conclude that the methodology is feasible in this context.

The second aim of the study was to investigate the potential bidirectional association of subjective stress with sexual desire, sexual arousal, and sexual activity in daily life from both a concurrent and time-lagged perspective, considering possible gender differences. In line with our hypotheses of negative bidirectional associations between subjective stress and concurrent occurrence of sexual desire (1a)/sexual arousal (1b), the results revealed associations between higher subjective stress and a lower probability of occurrence of concurrent sexual desire and arousal as well as vice versa. This corresponds to previous questionnaire-based studies, which likewise reported associations between higher stress and lower sexual desire or sexual arousal in women and between higher stress and more sexual problems in men and women.^{19,20} In contrast, however, another questionnaire-based study found positive associations between stress and sexual desire in men and women, and a lab-based study found no associations between stress and subjective arousal in women.^{21,24} In studies with daily, weekly, or monthly measurements, negative associations emerged between stress and sexual desire, breast and genital stimulation, sexual activity, orgasm, and satisfaction

in women,^{26,27,30} again supporting the findings of the present study. Other studies, which were based on younger samples (18–22 years), however, reported a positive association between stress and sexual desire in men and between stress symptoms and sexual intercourse frequency in women.^{26,29} Next to the difference in the age range of the study samples and as outlined in the introduction, these previous studies differed in methodological terms, which likely contributes to their conflicting findings. The method chosen for the present study has not been employed in this context before and attempts to target limitations of previous studies and to more adequately assess subjective stress and sexual desire, sexual arousal, and sexual activity, although the dichotomous assessment of sexual desire and sexual arousal is a limitation of this study. The present results may, therefore, depict associations closer to real life, although further investigations are warranted.

Furthermore, we hypothesized negative bidirectional associations between subjective stress and subsequent occurrence of sexual desire (2a)/sexual arousal (2b). The occurrence of sexual desire was associated with lower subsequent subjective stress, but the reverse association did not emerge, thus only partially supporting hypothesis 2a. Furthermore, there were no time-lagged associations between subjective stress and subsequent occurrence of sexual arousal or vice versa, in contrast to hypothesis 2b. These findings could not be discussed in light of previous research, as no studies were detected that investigated such fine-tuned next-time effects. The present results suggest that sexual desire, but not sexual arousal, may contribute to subsequent stress relief. Furthermore, the effects of subjective stress on sexual desire or sexual arousal and the effect of sexual arousal on subjective stress may be rather short-lived as same-time, but no next-time, associations were detected. More research is required to fully explain the differential effects of sexual desire and sexual arousal on stress suggested by the present findings. In the present study, sexual arousal was reported less frequently than sexual desire,

leading to fewer available data to investigate sexual arousal. Hence, associations involving sexual arousal may be underestimated in this study. At the same time, it underlines the relevance of differentiating between sexual desire and sexual arousal. Furthermore, it could hint at sexual desire having a higher likelihood of being experienced compared to sexual arousal, which may be due to the physiological aspect involved in sexual arousal as well as visible arousal not being socially accepted in certain situations, although further research is required. This finding appears to be in line with the sexual response cycle based on Masters and Johnson⁶¹ and adapted by Kaplan,⁶² which suggests sexual desire to precede arousal, although more recent literature rather suggests an interplay between sexual desire and sexual arousal.^{63,64} Moreover, the similarity between stress-related physiological arousal and sexual arousal may have influenced our findings. More specifically, similar to the stress response, sexual arousal encompasses physiological arousal. However, while the stress response activates the sympathetic division of the ANS for optimal adaptation of the body to a stressful situation, and the parasympathetic division during recovery from stress, sexual arousal already requires a coordination of the sympathetic and parasympathetic divisions at the arousal stage, independent of relaxation, which potentially follows at a later stage.¹³ If stress levels are slightly elevated, excitation transfer from stress to arousal may occur, as proposed by Zillmann,⁶⁵ consequently enhancing sexual arousal when facing a stimulus that is subjectively perceived as sexual.⁶⁶ Considering this proposed potential of an excitation transfer on the one hand and the negative association between subjective stress and same-time sexual arousal that we found in our study on the other hand, these 2 opposing trends might potentially cancel each other out over time, leading to no detected associations between subjective stress and next-time sexual arousal.

In addition, we hypothesized negative associations between subjective stress and occurrence of previous/subsequent sexual activity (hypothesis 3). Previous occurrence of sexual activity was associated with lower subsequent subjective stress, although a significant cross-level interaction showed that this was especially the case for women and was less clear for men, which is in line with the “fight-or-flight” vs. “tend-and-befriend” model.¹⁸ The reverse association did not emerge from our findings. Thus, the results only partly support hypothesis 3. These findings are in line with a study by Meston and Buss,²⁵ in which participants reported stress relief as a reason for engaging in sexual activity. Other studies that included a wider age range and, therefore, an overall older sample compared to the present study, found associations between perceived stress and a lower frequency of sexual activity in women.^{19,27,30} In contrast to this, another study on women between 18 and 20 years of age and, therefore, a younger sample, detected associations between perceived stress and a higher frequency of sexual intercourse in women with moderate to high levels of stress compared to women with low levels.²⁹ However, next to the difference in age range that could explain the differences in results, these studies did not take into account potential variations over the course of the day or gender differences.

Overall, same-time associations were found between higher subjective stress and lower sexual desire or sexual arousal and vice versa, and next-time associations were found between higher previous sexual desire or higher previous sexual

activity and lower subsequent subjective stress. Thus, in light of the Dual Control Model,^{8,9} the results may point at a potential short-term role of subjective stress in inhibitory processes of sexual response. However, subjective stress does not appear to affect sexual desire, sexual arousal, or sexual activity at a later point in time, suggesting a short-lived effect. Vice versa, the results indicate a potential of sexual desire and sexual activity to effectively lower subsequent subjective stress, hinting at a potentially longer-lasting effect. In the present study, we assumed gender differences in the aforementioned associations, insofar as following subjective stress, men would show lower levels of sexual desire, sexual arousal, and sexual activity compared to women, and vice versa, that desire, sexual arousal, and sexual activity would reduce subjective stress to a greater extent in women compared to men (hypothesis 4). With regard to subjective stress and sexual desire or sexual arousal, no significant concurrent or subsequent cross-level interactions with gender emerged, signaling no gender differences in the found associations, although sexual desire and arousal were assessed using binary items, which may have prevented a more detailed differentiation between men and women. The results may also hint at very similar processes in men and women concerning the relationship between stress and sexuality, which is in line with the discussion on gender similarities in sexuality-related aspects. Similarities are proposed, for example, by Dawson and Chivers,⁴² who argued that detected gender differences in sexuality-related aspects may be explained by sexual double standards^{42,67–71} and gender stereotypes about sexual desire, and by the fact that studies assess sexual desire as a trait rather than a state (ie, one-time vs. longitudinal assessment). Moreover, no gender differences were found in the association between subjective stress and subsequent sexual activity, although the association between previous sexual activity and lower subjective stress was stronger in women compared to men. This latter association supports our hypothesis and may point to the effectiveness of a tend-and-befriend strategy for women as suggested as part of the “fight-or-flight” vs. “tend-and-befriend” model.¹⁸ Overall, however, little support is found for the gender differences in the use of fight-or-flight or tend-and-befriend stress response strategies. Additional research is required to investigate this further.

In summary, the results hint at the potential time-dependent effects of stress on sexuality and vice versa in a relatively young and healthy sample. While stress may be involved in inhibitory processes of sexual response suggested by the Dual Control Model,^{8,9} sexual experiences and behavior may constitute a potential coping mechanism with stress. Hence, stress-reducing interventions may benefit this sample’s sexual experiences and behavior and their health and well-being in daily life. Although further research is required on the potential positive effects of stress-reducing interventions, they may pose valuable implications, for example, for couples therapy. The findings further emphasize the relevance of assessing the variables of interest as states rather than traits, as has also been suggested by Dawson and Chivers.⁴² In terms of clinical implications, further research involving clinical samples, for example, people with sexual dysfunctions or chronic stress, is required. However, if clinical studies show similar results, it could be beneficial to differentiate between different sexuality-related aspects in clinical practice and to consider this in psychoeducation. Furthermore, it could be advantageous to apply diaries or apps in clinical practice to

assess sexual experiences or behavior and subjective stress several times a day to capture daily variations. This paper provides valuable insights and the groundwork for future studies, thereby improving our understanding of underlying mechanisms and exploring opportunities to enhance positive sexuality, reduce stress, and improve health.

Limitations of the study

The sample examined in this study is not representative of the general population, as we applied very specific inclusion and exclusion criteria, as outlined in the *Methods* section. Specifically, the sample consisted of healthy heterosexual men and women aged between 18 and 35 years who were relatively satisfied with their relationship and sex life. Therefore, the generalization of the results is limited to the described specific population of healthy adults under 35 years old and no implications for treatment of clinical samples are possible. In addition, not having children was a prerequisite for study participation, thereby potentially leading to a sample with a younger age and limiting the representativeness of the sample. Moreover, sexual and gender minorities were not included in this study. Sexual and gender minorities may be exposed to additional stressors as described in the Minority Stress Model⁷² that should be explicitly taken into account. Furthermore, it is likely that the participants felt relatively comfortable and open with the topic of sexuality, as the study was described as a study on sexuality and participants contacted the study team based on this information (self-selection bias).

For this study, the authors decided to define sexual desire and arousal as overlapping but distinct construct and to differentiate between sexual desire and sexual arousal based on prior evidence and an ongoing discussion.^{15,16} To aid in differentiation between sexual desire and sexual arousal, definitions were given to and discussed with participants prior to study participation. The results show joint but also separate occurrences of sexual desire and sexual arousal in this study, thereby suggesting a possibility of differentiating between sexual desire and sexual arousal in this study. However, it may still have been challenging for some participants to differentiate between sexual desire and sexual arousal. Additionally, sexual arousal incorporates psychological and physical aspects, which may not appear simultaneously.^{73,74} Hence, not all aspects of sexual arousal are incorporated into this paper. Moreover, although the intensity of sexual desire and sexual arousal was assessed by the use of items with a continuous scale if presence of sexual desire or sexual arousal was indicated, these variables were not included in the analysis due to little available data.

Future directions

Future studies might explore the associations investigated in the present study in more detail while employing a similar methodological approach as we used in our current study, differentiating between different intensities of sexual desire and arousal and thereby taking a dimensional approach to both constructs. Moreover, future studies could gain further insights by investigating responsive and spontaneous desire. Furthermore, a multidimensional measurement approach is advantageous to capture multiple facets of stress.⁷⁵ Thus, we recommend that future studies include not only psychological stress parameters but also parameters

depicting physiological processes, including the ANS and the hypothalamic-pituitary-adrenal (HPA) axis, as both pathways may inhibit sexual processes.^{13,76} It would be beneficial for future research to further investigate the link between stress and sexual experiences and behavior over time, and to assess further sample characteristics, for example, persons with a sexual orientation not described in the present study, as they may be exposed to additional stressors including sexual minority stress.⁷² In addition, the associations described in the present study may hint at a role of stress in persons with low sexual desire and arousal, and this association could therefore be investigated in clinical samples. As participants in the present study showed low levels of chronic stress, it would be interesting to examine associations between stress and sexuality in samples with higher levels of chronic stress. Building on the detected momentary association between subjective stress and concurrent sexual desire or sexual arousal, interventions targeted at reducing stress and its potential effects on sexual experience and behavior could also be explored in healthy as well as clinical samples in future studies. Furthermore, it might be informative to include both partners in a relationship, as this would enable an investigation into dyadic aspects, which may provide valuable insights for couples therapy.

Conclusion

The present study investigated the association between subjective stress and sexual desire, sexual arousal, and sexual activity concurrently as well as over time in healthy men and women over 14 consecutive days, including time- and event-based measurements, and further assessed the feasibility of this methodological approach. The results reveal concurrent associations between stress and sexual desire and arousal as well as time-lagged associations between sexual desire and subsequent stress in both men and women. Moreover, we found an association between sexual activity and lower subsequent subjective stress in women. The results may indicate a role of stress in inhibitory processes of sexual response proposed in the Dual Control Model^{8,9} and a role of sexuality as a potentially effective coping mechanism with stress. Overall, this study shows some bidirectional associations between subjective stress and sexual experiences or behavior and, thereby, potential ways in which stress and sexual experiences or behavior may interact in daily life. In particular, the results provide some support for potential perceptions of stress as negatively affecting sexual experiences and behavior as well as of sexual experiences or behavior as reducing stress, although no causality can be assumed and further research is necessary. The findings provide valuable insights and groundwork to improve our understanding of underlying mechanisms and explore opportunities to enhance positive sexuality, reduce stress, and improve health. Further research into this topic in healthy as well as clinical samples seems appropriate, and might potentially inform stress interventions, potentially leading to additional treatment possibilities to enhance sexual health and its positive effects.

Supplementary material

Supplementary material is available at *Annals of Behavioral Medicine* online.

Author contributions

Hanna M. Mües (Conceptualization, Methodology, Software, Validation, Formal analysis, Data curation, Writing—original draft, Writing—review & editing, Visualization, Funding acquisition), Charlotte Markert (Conceptualization, Methodology, Software, Validation, Investigation, Resources, Data curation, Writing—original draft, Writing—review & editing, Project administration), Anja C. Feneberg (Conceptualization, Methodology, Software, Validation, Formal analysis, Writing—review & editing), and Urs Nater (Conceptualization, Methodology, Software, Validation, Investigation, Resources, Writing—original draft, Writing—review & editing, Supervision, Project administration, Funding acquisition)

Funding

HM was supported by a VDS CoBeNe final fellowship of the Vienna Doctoral School Cognition, Behaviour and Neuroscience of the University of Vienna.

Conflicts of interest

None declared

Ethics statement

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Transparency statements

Study registration: The study was not formally registered.

Analytic plan preregistration: The analysis plan was not formally preregistered.

Data availability

De-identified data from this study are not available in a public archive. De-identified data from this study will be made available (as allowable according to institutional IRB standards) by emailing the corresponding author.

Analytic code availability: Analytic codes used to conduct the analyses presented in this study are available on the Open Science Framework (OSF) under the following link: <https://osf.io/6hevu>.

Materials availability: Materials used to conduct the study are not publically available. Study materials will be made available by emailing the corresponding author.

References

- Gallup, Inc. *Global Emotion Report 2022*. 2022. <https://www.gallup.com/analytics/349280/gallup-global-emotions-report.aspx>. Accessed February 10, 2023.
- Cohen S, Murphy MLM, Prather AA. Ten surprising facts about stressfullife events and disease risk. *Annu Rev Psychol*. 2019;70:577–597. <https://doi.org/10.1146/annurev-psych-010418-102857>
- McEwen BS. Protective and damaging effects of stress mediators. *N Engl J Med*. 1998;338:171–179. <https://doi.org/10.1056/NEJM199801153380307>
- World Health Organization (WHO). *Stress 2021* [cited February 14, 2023]. <https://www.who.int/news-room/questions-and-answers/item/stress>. Accessed February 14, 2023.
- Chrousos GP. Stress and disorders of the stress system. *Nat Rev Endocrinol*. 2009;5:374–381. <https://doi.org/10.1038/nrendo.2009.106>
- Costa C, Briguglio G, Mondello S, et al. Perceived stress in a gender perspective: a survey in a population of unemployed subjects of southern Italy. *Front Public Health*. 2021;9:640454. <https://doi.org/10.3389/fpubh.2021.640454>
- Graves BS, Hall ME, Dias-Karch C, Haischer MH, Apter C. Gender differences in perceived stress and coping among college students. *PLoS One*. 2021;16:e0255634. <https://doi.org/10.1371/journal.pone.0255634>
- Bancroft J, Janssen E. The dual control model of male sexual response: a theoretical approach to centrally mediated erectile dysfunction. *Neurosci Biobehav Rev*. 2000;24:571–579. [https://doi.org/10.1016/s0149-7634\(00\)00024-5](https://doi.org/10.1016/s0149-7634(00)00024-5)
- Janssen E, Bancroft J. The dual-control model: the role of sexual inhibition & excitation in sexual arousal and behavior. In: Janssen E, ed. *The Psychophysiology of Sex*. Indiana University Press; 2007:197–222.
- Bancroft J. *Human Sexuality and Its Problems*. 3rd ed. Churchill Livingstone; 2009: IX, 546 S.
- Chivers ML, Brotto LA. Controversies of women's sexual arousal and desire. *Eur Psychol*. 2017;22:5–26. <https://doi.org/10.1027/1016-9040/a000274>
- Chivers ML, Suschinsky K, Timmers A, Bossio J. Experimental, neuroimaging, and psychophysiological methods in sexuality research. In: Tolman DL, Diamond LM, Bauermeister JA, George WH, Pfaus JG, Ward LM, eds. *APA Handbook of Sexuality and Psychology*, Vol 1: Person-based approaches (pp. 99–119). American Psychological Association; 2014.
- Pfaus JG. Pathways of sexual desire. *J Sex Med*. 2009;6:1506–1533. <https://doi.org/10.1111/j.1743-6109.2009.01309.x>
- Graham CA. Reconceptualising women's sexual desire and arousal in DSM-5. *Psychol Sex*. 2015;7:34–47. <https://doi.org/10.1080/19419899.2015.1024469>
- Parish SJ, Goldstein AT, Goldstein SW, et al. Toward a more evidence-based nosology and nomenclature for female sexual dysfunctions—Part II. *J Sex Med*. 2016;13:1888–1906. <https://doi.org/10.1016/j.jsxm.2016.09.020>
- McCabe MP, Sharlip ID, Atalla E, et al. Definitions of sexual dysfunctions in women and men: a consensus statement from the Fourth International Consultation on Sexual Medicine 2015. *J Sex Med*. 2016;13:135–143. <https://doi.org/10.1016/j.jsxm.2015.12.019>
- Petersen JL, Hyde JS. A meta-analytic review of research on gender differences in sexuality, 1993–2007. *Psychol Bull*. 2010;136:21–38. <https://doi.org/10.1037/a0017504>
- Taylor SE, Klein LC, Lewis BP, Gruenewald TL, Gurung RA, Updegraff JA. Biobehavioral responses to stress in females: tend-and-befriend, not fight-or-flight. *Psychol Rev*. 2000;107:411–429. <https://doi.org/10.1037/0033-295x.107.3.411>
- Abedi P, Afrazeh M, Javadifar N, Saki A. The relation between stress and sexual function and satisfaction in reproductive-age women in Iran: a cross-sectional study. *J Sex Marital Ther*. 2014;41:384–390. <https://doi.org/10.1080/0092623X.2014.915906>
- Bodenmann G, Ledermann T, Blattner D, Galluzzo C. Associations among everyday stress, critical life events, and sexual problems. *J Nerv Ment Dis*. 2006;194:494–501. <https://doi.org/10.1097/01.nmd.00000228504.15569.b6>
- Hamilton LD, Meston CM. Chronic stress and sexual function in women. *J Sex Med*. 2013;10:2443–2454. <https://doi.org/10.1111/jsm.12249>
- Delcea C, Scaunas A. The impact of daily stress on sexual activity in stable couples in Romania. *Int J Adv Stud Sexol*. 2022;4:68–73. <https://doi.org/10.46388/ijass.2022.4.7>

23. Ter Kuile MM, Vigeveno D, Laan E. Preliminary evidence that acute and chronic daily psychological stress affect sexual arousal in sexually functional women. *Behav Res Ther.* 2007;45:2078–2089. <https://doi.org/10.1016/j.brat.2007.03.006>
24. Morokoff PJ, Gilliland R. Stress, sexual functioning, and marital satisfaction. *J Sex Res.* 1993;30:43–53. <https://doi.org/10.1080/00224499309551677>
25. Meston CM, Buss DM. Why humans have sex. *Arch Sex Behav.* 2007;36:477–507. <https://doi.org/10.1007/s10508-007-9175-2>
26. Raisanen JC, Chadwick SB, Michalak N, van Anders SM. Average associations between sexual desire, testosterone, and stress in women and men over time. *Arch Sex Behav.* 2018;47:1613–1631. <https://doi.org/10.1007/s10508-018-1231-6>
27. Bodenmann G, Atkins DC, Schär M, Poffet V. The association between daily stress and sexual activity. *J Fam Psychol.* 2010;24:271–279. <https://doi.org/10.1037/a0019365>
28. Tan PL. Stress, fatigue, and sexual spontaneity among married couples in a high-stress society: evidence from sex diary data from Singapore. *Arch Sex Behav.* 2021;50:2579–2588. <https://doi.org/10.1007/s10508-020-01848-y>
29. Hall KS, Kusunoki Y, Gatny H, Barber J. Stress symptoms and frequency of sexual intercourse among young women. *J Sex Med.* 2014;11:1982–1990. <https://doi.org/10.1111/jsm.12607>
30. Burleson MH, Trevathan WR, Todd M. In the mood for love or vice versa? Exploring the relations among sexual activity, physical affection, affect, and stress in the daily lives of mid-aged women. *Arch Sex Behav.* 2007;36:357–368. <https://doi.org/10.1007/s10508-006-9071-1>
31. Ein-Dor T, Hirschberger G. Sexual healing: daily diary evidence that sex relieves stress for men and women in satisfying relationships. *J Soc Pers Relat.* 2012;29:126–139. <https://doi.org/10.1177/0265407511431185>
32. Park Y, Gordon AM, Prather AA, Mendes WB. Better sleep, lower blood pressure, and less stress following sex: findings from a large-scale ecological momentary assessment study. *Health Psychol.* 2024;43:904–912. <https://doi.org/10.1037/hea0001423>
33. Shiffman S, Stone AA, Hufford MR. Ecological momentary assessment. *Annu Rev Clin Psychol.* 2008;4:1–32. <https://doi.org/10.1146/annurev.clinpsy.3.022806.091415>
34. Zawadzki MJ, Scott SB, Almeida DM, et al. Understanding stress reports in daily life: a coordinated analysis of factors associated with the frequency of reporting stress. *J Behav Med.* 2019;42:545–560. <https://doi.org/10.1007/s10865-018-00008-x>
35. Feneberg AC, Forbes PAG, Piperno G, et al. Diurnal dynamics of stress and mood during COVID-19 lockdown: a large multinational ecological momentary assessment study. *Proc Biol Sci.* 2022;289:20212480. <https://doi.org/10.1098/rspb.2021.2480>
36. Jankowski KS, Díaz-Morales JF, Randler C. Chronotype, gender, and time for sex. *Chronobiol Int.* 2014;31:911–916. <https://doi.org/10.3109/07420528.2014.925470>
37. Jocz P, Stolarski M, Jankowski KS. Similarity in chronotype and preferred time for sex and its role in relationship quality and sexual satisfaction. *Front Psychol.* 2018;9:443. <https://doi.org/10.3389/fpsyg.2018.00443>
38. Ozdemiroglu F. The effects of chronotype on sexual satisfaction and quality of life in couples. *Eur Rev Med Pharmacol Sci.* 2022;26:7333–7343. https://doi.org/10.26355/eurrev_202210_30002
39. Dyer K, das Nair R. Why don't healthcare professionals talk about sex? A systematic review of recent qualitative studies conducted in the United Kingdom. *J Sex Med.* 2013;10:2658–2670. <https://doi.org/10.1111/j.1743-6109.2012.02856.x>
40. Jay T. The utility and ubiquity of taboo words. *Perspect Psychol Sci.* 2009;4:153–161. <https://doi.org/10.1111/j.1745-6924.2009.01115.x>
41. Traumer L, Jacobsen MH, Laursen BS. Patients' experiences of sexuality as a taboo subject in the Danish healthcare system: a qualitative interview study. *Scand J Caring Sci.* 2019;33:57–66. <https://doi.org/10.1111/scs.12600>
42. Dawson SJ, Chivers ML. Gender differences and similarities in sexual desire. *Curr Sex Health Rep.* 2014;6:211–219. <https://doi.org/10.1007/s11930-014-0027-5>
43. Appelbaum M, Cooper H, Kline RB, Mayo-Wilson E, Nezu AM, Rao SM. Journal article reporting standards for quantitative research in psychology: the APA Publications and Communications Board task force report. *Am Psychol.* 2018;73:3–25. <https://doi.org/10.1037/amp0000191>
44. Roberts H, Clark A, Sherman C, Heitzeg MM, Hicks BM. Age, sex, and other demographic trends in sexual behavior in the United States: initial findings of the sexual behaviors, internet use, and psychological adjustment survey. *PLoS One.* 2021;16:e0255371. <https://doi.org/10.1371/journal.pone.0255371>
45. Stone AA, Schneider S, Smyth JM. Evaluation of pressing issues in ecological momentary assessment. *Annu Rev Clin Psychol.* 2023;19:107–131. <https://doi.org/10.1146/annurev-clinpsy-080921-083128>
46. Schulz P, Schlotz W, Becker P. TICS: Trierer Inventar zum Chronischen Stress. Manual. Hogrefe Verlag; 2004.
47. Löwe B, Spitzer RL, Zipfel S, Herzog W. Gesundheitsfragebogen für Patienten (PHQ-D). Manual und Testunterlagen. 2nd ed. Pfizer; 2002.
48. Spitzer RL, Kroenke K, Williams JB. Validation and utility of a self-report version of PRIME-MD: the PHQ primary care study. *JAMA.* 1999;282:1737–1744. <https://doi.org/10.1001/jama.282.18.1737>
49. Hahlweg K. Konstruktion und Validierung des Partnerschaftsfragebogens PFB. *Z Klin Psychol.* 1979;8:17–40.
50. Elo AL, Leppänen A, Jahkola A. Validity of a single-item measure of stress symptoms. *Scand J Work Environ Health.* 2003;29:444–451. <https://doi.org/10.5271/sjweh.752>
51. Lesage FX, Berjot S, Deschamps F. Clinical stress assessment using a visual analogue scale. *Occup Med.* 2012;62:600–605. <https://doi.org/10.1093/occmed/kqs140>
52. Strahler J, Nater UM. Differential effects of eating and drinking on wellbeing—an ecological ambulatory assessment study. *Biol Psychol.* 2018;131:72–88. <https://doi.org/10.1016/j.biopsycho.2017.01.008>
53. Linnemann A, Ditzen B, Strahler J, Doerr JM, Nater UM. Music listening as a means of stress reduction in daily life. *Psychoneuroendocrinology.* 2015;60:82–90. <https://doi.org/10.1016/j.psyneuen.2015.06.008>
54. Doerr JM, Fischer S, Nater UM, Strahler J. Influence of stress systems and physical activity on different dimensions of fatigue in female fibromyalgia patients. *J Psychosom Res.* 2017;93:55–61. <https://doi.org/10.1016/j.jpsychores.2016.12.005>
55. Fischer S, Doerr JM, Strahler J, Mewes R, Thieme K, Nater UM. Stress exacerbates pain in the everyday lives of women with fibromyalgia syndrome—the role of cortisol and alpha-amylase. *Psychoneuroendocrinology.* 2016;63:68–77. <https://doi.org/10.1016/j.psyneuen.2015.09.018>
56. R Core Team. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing; 2022. <https://www.R-project.org/>. Accessed December 9, 2022.
57. RStudio Team. RStudio: Integrated Development Environment for R. RStudio, PBC; 2022. <http://www.rstudio.com/>. Accessed February 16, 2022.
58. Maas CJ, Hox J. Sufficient sample sizes for multilevel modeling. *J Res Methods Behav Soc Sci.* 2005;1:86–92. <https://doi.org/10.1027/1614-2241.1.3.86>
59. Kuznetsova A, Brockhoff PB, Christensen RHB. lmerTest package: tests in linear mixed effects models. *J Stat Softw.* 2017;82:1–26. <https://doi.org/10.18637/jss.v082.i13>
60. Nakagawa S, Schielzeth H. A general and simple method for obtaining R² from generalized linear mixed-effects models. *Methods Ecol Evol.* 2013;4:133–142. <https://doi.org/10.1111/j.2041-210x.2012.00261.x>
61. Masters WH, Johnson VE. *Human Sexual Response*. Little, Brown; 1966.
62. Kaplan HS. *Disorders of Sexual Desire and Other New Concepts and Techniques in Sex Therapy*. Brunner/Mazel; 1979.
63. Basson R. The female sexual response: a different model. *J Sex Marital Ther.* 2000;26:51–65. <https://doi.org/10.1080/009262300278641>

64. Basson R. Human sex-response cycles. *J Sex Marital Ther.* 2001;27:33-43. <https://doi.org/10.1080/00926230152035831>
65. Zillmann D. Transfer of excitation in emotional behavior. In: Cacioppo JT, Petty RE, eds. *Social Psychophysiology: A Sourcebook*. Guilford; 1983:215-240.
66. Bancroft J, Janssen E, Strong D, Carnes L, Vukadinovic Z, Long JS. The relation between mood and sexuality in heterosexual men. *Arch Sex Behav.* 2003;32:217-230. <https://doi.org/10.1023/a:1023409516739>
67. Reiss IL. *Premarital Sexual Standards in America*. The Free Press; 1960.
68. Gentry M. The sexual double standard: the influence of number of relationships and level of sexual activity on judgements of women and men. *Psychol Women Q.* 1998;22:505-511. <https://doi.org/10.1111/j.1471-6402.1998.tb00173.x>
69. Brown NR, Sinclair RC. Estimating number of lifetime sexual partners: men and women do it differently. *J Sex Res.* 1999;36:292-297. <https://doi.org/10.1080/00224499909551999>
70. Milhausen RR, Herold ES. Reconceptualizing the sexual double standard. *J Psychol Human Sex.* 2002;13:63-83. https://doi.org/10.1300/j056v13n02_05
71. Jonason P, Fisher T. The power of prestige: why young men report having more sex partners than young women. *Sex Roles.* 2009;60:151-159. <https://doi.org/10.1007/s11199-008-9506-3>
72. Meyer IH. Prejudice, social stress, and mental health in lesbian, gay, and bisexual populations: conceptual issues and research evidence. *Psychol Bull.* 2003;129:674-697. <https://doi.org/10.1037/0033-2909.129.5.674>
73. Hodgson B, Kukkonen TM, Binik YM, Carrier S. Using the dual control model to investigate the relationship between mood, genital, and self-reported sexual arousal in men and women. *J Sex Res.* 2016;53:979-993. <https://doi.org/10.1080/00224499.2015.1110107>
74. Meston CM, Stanton AM. Understanding sexual arousal and subjective-genital arousal desynchrony in women. *Nat Rev Urol.* 2019;16:107-120. <https://doi.org/10.1038/s41585-018-0142-6>
75. Nater UM. The multidimensionality of stress and its assessment. *Brain Behav Immun.* 2018;73:159-160. <https://doi.org/10.1016/j.bbi.2018.07.018>
76. Sapolsky RM, Romero LM, Munck AU. How do glucocorticoids influence stress responses? Integrating permissive, suppressive, stimulatory, and preparative actions. *Endocr Rev.* 2000;21:55-89. <https://doi.org/10.1210/edrv.21.1.0389>