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## COVID-19

# Changes in Frequency and Patterns of Marital Sexual Activity During COVID-19: Evidence From Longitudinal Data Prior to, During and After Lockdown in Singapore



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## ABSTRACT

**Background:** The literature suggests that the pandemic has affected sexual activity and sexual desire around the world, potentially due to increased levels of stress, movement restrictions under lockdown conditions, and changes in relationship quality.

**Aim:** To investigate changes in frequency and patterns of marital sexual activity and the role of potential factors underlying these changes, during and after COVID-19 lockdown.

**Methods:** This longitudinal study followed 409 heterosexual married female participants who completed a baseline survey in April–July 2018 and biweekly online surveys over the next 14 weeks; an online survey in May 2020 during the lockdown in Singapore; and an online survey in June 2020 after the lockdown was lifted. Participants were recruited in 2018 using street intercept and screened for inclusion and exclusion criteria. Logistic fixed-effects models were used to test for changes in frequency and patterns of marital sexual activity and assess underlying factors. Pseudo-design-based sample weights were applied.

**Outcomes:** The 2018 in-person baseline survey collected information on demographic characteristics and ideal frequency of marital sex, while follow-up online questionnaires in May–June 2020 included items on exact dates of marital sexual activity of previous weeks; stress and fatigue levels; both spouses' stay-at-home statuses during lockdown; and marital satisfaction.

**Results:** 409 heterosexual married women were included in this study. Compared to pre-pandemic levels, the proportion of participants not having marital sex within a week remained stable while weekly sexual frequency increased, with more evenly distributed sexual activity on weekdays and weekends. Stress, fatigue, and marital satisfaction levels predicted probability of non-activity and sexual frequency.

**Clinical Translation:** The increase in weekly sexual frequency has implications for sexual and reproductive health, including sexual satisfaction and prevalence of infertility and low birth weight associated with waiting time to pregnancy.

**Strengths & Limitations:** The longitudinal nature of the dataset provides unique insights into differences in frequency of marital sexual activity during compared to before the pandemic. Unlike previous studies, detailed data on exact dates of sexual activity allow for detection of differences in sexual activity by day of the week. However, dates of sexual activity were recorded retrospectively and may contain recall errors. Data were collected only from wives and hence dates of marital sexual activities were not cross-validated with husbands.

**Conclusion:** Results point to more active and flexible marital sex lives during the pandemic, with effects that persisted after the lockdown ended. **Tan PL. Changes in Frequency and Patterns of Marital Sexual Activity During COVID-19: Evidence From Longitudinal Data Prior to, During and After Lockdown in Singapore. J Sex Med 2022;19:188–200.**

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**Key Words:** COVID-19; Sexual Behavior; Sexual Frequency; Stress; Lockdown; Relationship Satisfaction

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## INTRODUCTION

The literature suggests that the COVID-19 pandemic has affected sexual activity and sexual desire around the world. In

China, 37% of survey respondents aged 18–45 ( $n = 459$ ) reported lower levels of sexual activity, while 25% reported a decline in sexual desire.<sup>1</sup> In the U.K., 33% of respondents aged 18–32 ( $n = 565$ ) reported decreased frequency in sexual intercourse with partners during lockdown, as well as a decline in sexual desire among women<sup>2</sup>; in an unpublished survey, 20% of adults aged 18 and above ( $n = 11,936$ ) reported having a lot or a little less sex during the March 2020 lockdown.<sup>3</sup> Almost half of U.S. respondents aged 18–81 ( $n = 1,559$ ) reported decreased sexual activity, including masturbation.<sup>4</sup> While studies point to an overall decline in sexual activity and sexual desire in the general population, subsets of the population experienced the opposite.<sup>1,2,3</sup> In particular, respondents in serious relationships or cohabiting with a partner were more likely to report increased sexual activity compared to those who were not dating or dating casually,<sup>2,3</sup> consistent with surveys of respondents living with partners in China and married respondents aged 20 and above in Bangladesh, India, and Nepal ( $n = 120$ ) that report overall increases in sexual frequency and quality of sexual life.<sup>5,6</sup>

Understanding the changes in sexual practice brought on by the pandemic is important due to the links between sexual frequency and sexual and relationship satisfaction.<sup>7,8,9,10</sup> Sexual inactivity has also been associated with health issues, including greater risk of cardiovascular events in later life, cancer, bladder and bowel problems, diabetes, hypertension, and high cholesterol, as well as mental health conditions.<sup>11</sup> In addition, sexual frequency affects probability of conception in fertile cycles, which is estimated to decline by more than half from 0.37 under intercourse on a daily basis to 0.15 under intercourse once a week,<sup>12</sup> increasing risks of infertility, pregnancy, and birth complications, and congenital defects associated with delayed childbearing, which can in turn affect the quality of relationships and mental health.<sup>13,14</sup> As access to reproductive clinics was curtailed during public movement restrictions,<sup>15</sup> these problems may be underreported and thus undertreated.

## UNDERLYING FACTORS

The literature has identified a number of potential factors underlying changes in sexual behavior. First, the COVID-19 crisis led to a rise in stress and anxiety, especially among women.<sup>2,11</sup> Exposure to stress can reduce genital arousal through interference with the functioning of the hypothalamic-pituitary-gonadal axis, which forms part of the sexual response regulatory system; inhibit blood flow to the genitals; and increase cognitive distraction.<sup>16</sup> During the pandemic, financial hardship and fear of unemployment due to economic disruptions, unexpected changes in work and household responsibilities, social distancing requirements and reduced opportunities for physical exercise brought on by lockdowns have led to stressful conditions and undermined individuals' sense of security and stability.<sup>2,15,17</sup> Longitudinal studies suggest that sexual activity tends to be lower during periods of higher stress.<sup>18,19</sup> Similarly, recently collected

data suggest that the correlation between self-reported stress and desire for sex was overall negative during the pandemic.<sup>4</sup> However, researchers have argued that such environments may also increase interest in sexual activity to generate immediate pleasurable relief from stress, anxiety, or boredom.<sup>11,17</sup>

A second potential factor is the mass movement towards working from home under lockdown conditions. Telecommuting may result in time savings from reduced commuting, part of which may hypothetically be spent on sexual interactions.<sup>11</sup> However, both men and women took on additional household and childcare obligations during the pandemic, with a disproportionate burden placed on women.<sup>20,21,22</sup> While the literature does not show a consistent statistical relationship between women's employment status and sexual frequency,<sup>7,23,24</sup> studies consistently find that couples are most sexually active on nights preceding weekends,<sup>18,19,25</sup> suggesting that the structure of the workweek may influence weekly patterns of sexual activity.

Third, the COVID-19 crisis may have affected quality of relationships between partners, which has been shown to predict sexual frequency.<sup>23,24,26</sup> On the one hand, researchers have hypothesized that the pandemic may facilitate closer emotional bonding between family members, allowing for more intimate activities.<sup>5,11</sup> On the other hand, studies have noted that stressors and fatigue generated by the pandemic can affect interpersonal relationships, leading to negative communication patterns, attributions about others' behavior, and evaluations of relationships, exacerbated by reduced access to counseling or therapy services.<sup>15,27</sup> Empirically, COVID-related stressors predicted lower relationship quality,<sup>27</sup> while conflict with partners predicted lower solo or partnered sexual activity.<sup>15</sup>

## AIMS OF THE PRESENT STUDY

While the emerging evidence suggests that the pandemic has affected even the most intimate forms of human interaction, there are still major gaps in our understanding: whether COVID-19 lockdowns may have affected not only frequency but also patterns of sexual activity throughout the week, consistent with evidence that sleep duration has evened out between weekdays and weekends<sup>28</sup>; whether changes in sexual activity only appear during lockdowns and movement restrictions, and tend to dissipate as these are lifted; and the role of underlying factors explaining the observed changes. In addition, the current evidence is largely based on cross-sectional surveys which ask respondents about their levels of sexual activity prior to the pandemic, which may be subject to cognitive biases and measured with low precision.

This study examines changes in frequency and patterns of sexual activity using data collected from 409 heterosexual married female Singaporean residents aged 25–34, the subgroups at highest risk of childbearing,<sup>29</sup> prior to the pandemic in 2018, during the lockdown in May 2020 and after the lockdown ended

in June 2020. Following the literature, it tests the hypothesis that there was a decline in frequency of sexual activity, using longitudinal data which allows for controlling for observed and unobserved confounders. Unlike previous literature, however, it also considers whether patterns of activity have evened out between weekdays and weekends with the mass shift to telecommuting during the lockdown and whether these observed effects dissipated after the lockdown was lifted. Finally, it tests the associations between the observed changes in sexual behavior and 3 potential underlying factors: stress and fatigue, working from home, and marital satisfaction.

## METHODS

### Overview

The study follows a cohort of 409 heterosexual married female Singaporean residents aged 25–34 using 3 waves of data collection: a baseline survey, which was conducted in April–July 2018 followed by 7 biweekly online surveys over the next 14 weeks; a follow-up survey conducted online in May 2020 during the lockdown in Singapore; and a follow-up survey conducted online in June 2020 after the lockdown was lifted.

### Participants

Female participants were recruited in 2018 using street intercept at public central locations such as Mass Rapid Transit (MRT) train station exits, walkways of bus interchanges, spaces outside shopping malls and Housing Development Board (HDB) town centers, stratified by the 5 main geographical regions of Singapore: Central, North, Northeast, West and East. Of the 3,038 potential participants who were targeted for recruitment on the street, 660 (22%) fulfilled the inclusion criteria and were recruited, 558 (18%) did not fulfil the inclusion criteria, 677 (22%) declined to participate after being introduced to the study, and 1,143 (38%) declined prior to any introduction. The inclusion criteria were as follows: currently married; aged 25–34; a citizen or married to a citizen; and able to communicate in English. Data collected from three recruited participants were discarded due to failure to meet the age criterion. Participants received up to SGD120 for participating in the study.

Of the 657 participants interviewed in the baseline survey, 500 who consented to be re-contacted for follow-up surveys were invited to complete online surveys in May and June 2020. 416 (83%) completed the survey in May 2020, and 399 (80%) completed the survey in June 2020. Only respondents who completed the second wave were invited to complete the third wave. Participants who completed both surveys in 2020 received SGD25 for their participation. The final sample size is 409, excluding data from 7 participants due to changes in marital status between 2018 and 2020 and missing diary data from 2018.

### Procedure

The 2018 baseline interview collected data on household demographics, including both spouses' ages, educational

attainments, employment statuses, income levels, length of marriage, and birth dates of all children. In addition, they were asked about their level of satisfaction with their marriage and ideal frequency of marital sexual activity. All interviews were administered face-to-face in English. Sensitive information, for example, income, marital satisfaction and ideal sexual frequency, was collected through computerized self-administered questionnaires in order to avoid discomfort and encourage honest responses.

At the end of the baseline interview, respondents were invited to submit biweekly online diaries over the following 14 weeks, which collected data on of the first day of their last menstrual period, exact dates of marital sexual activity, and average levels of stress and fatigue in the past 2 weeks.<sup>1</sup> On the last biweekly entry, respondents were also asked about their pregnancy status. Respondents were reminded to submit their responses through e-mail and short message service (SMS) notifications. 642 of 657 respondents (98%) submitted at least 1 entry of the online diary, and 618 participants (94%) completed all entries.

In 2020, all respondents who consented to be re-contacted for follow-up surveys were invited to complete surveys in May and June 2020 through online links. Respondents were asked to record the date of the first day of their last menstrual period, dates of all days with sexual activity, average levels of stress and fatigue, both spouses' employment and work-from-home status, and marital satisfaction level over the past week. In June 2020, respondents were also asked about pregnancy status and both spouses' income levels in both May and June 2020.<sup>2</sup> Participants were reminded to respond via email and SMS. Survey items on ideal sexual frequency, dates of sexual activity, and the first day of menstruation, and underlying factors are provided in [Appendix A](#). The study was approved by the [anonymized] Institutional Review Board and obtained informed consent from all included participants.

### Variables

The two key dependent variables of interest are weekly sexual inactivity, coded as a binary variable for whether the respondent did not have sex on all 7 days, and daily probability of sexual activity, coded as a binary variable for whether the respondent had sex on that day.

In addition to binary indicators for 2020 and each day of the week to capture changing patterns in marital sexual activity, 3 sets of underlying factors were explored. Perceived stress and fatigue were measured on 5-point scales

<sup>1</sup>Approximately 50% of respondents were randomly chosen to receive ovulation test kits for an unrelated research question. Any effects of this intervention on marital sexual activity are fully accounted for through individual fixed effects ([anonymized]).

<sup>2</sup>For 17 respondents who completed the survey in May 2020 but not in June 2020, income levels are based on data from the baseline survey.

(very, quite, neither, not, not at all) and were both recoded as 4-point scales (very, quite, neither, not/not at all) due to the low proportions of responses for the final category. Stay-at-home status was coded as a binary variable for whether both spouses were either not employed or working fully from home. Data on marital satisfaction was collected using a 5-point scale (very dissatisfied, dissatisfied, neutral, satisfied, very satisfied) and similarly recoded as 4 binary variables (very dissatisfied/dissatisfied, neutral, satisfied, very satisfied). Single item measures were used for stress, fatigue and marital satisfaction in order to keep the online questionnaires short and elicit a higher response rate in the context of data collection during an unanticipated pandemic. Previous validity studies using similarly worded single-item measures for all three of these items were found to be valid with reliability levels similar to longer measures, and may be appropriate for surveys with limited space.<sup>30,31,32</sup>

Control variables included both spouses' age measured in integer years, income levels measured as a dichotomous variable for whether reported income on a 11-point scale (none, less than S\$1,000, . . . , \$10,000 or more) was above or below the national median level of S\$4,000, length of marriage measured in integer years, dichotomous indicators for pregnancy status and presence of young children aged 6 and below measured based on dates of birth and weeks of pregnancy, if any, and a vector of dichotomous indicators for day of menstrual cycle,<sup>25,33</sup> estimated using date of the first day of the most recent period.<sup>3</sup> Values were taken from the start of the period, that is, at the weekly or daily level. Observations for which pregnancy status was unknown were retained in the analysis using categorical values for missing data.

## Data Analysis

T-tests, Pearson's chi-squared tests and logistic fixed effects regression models were used to test for changes in frequency and patterns of marital sexual activity and assess underlying factors. A cut-off value of  $P < .05$  is used for statistical significance.

For regression models where sexual inactivity was the dependent variable, the key independent variables of interest were a dichotomous term for 2020 and underlying factors; for regression models where sexual frequency was the dependent variable, key independent variables of interest were a dichotomous term for 2020, a vector of dichotomous indicators for each day of the week, the interaction terms, and underlying factors. In some additional specifications, the dichotomous term for 2020 was replaced by two terms for May 2020 and June 2020 to compare effects during and after the lockdown. The overall effects on

patterns of sexual activity were computed using linear combinations of the coefficients of the dichotomous indicators for day of the week and the interaction terms.

Regression models controlled for individual and month fixed effects, as well as the above control variables identified by the literature, including both spouses' ages, incomes, length of marriage, pregnancy status and presence of young children.<sup>7,23,26,34,35,36</sup> Educational attainment, contraceptive use and whether the respondent was currently trying to conceive (asked only in the first wave) were fully accounted for by individual fixed effects, employment status was not included as a control following lack of significant statistical associations,<sup>23,24</sup> and no measures of general health were collected. Errors were clustered at the individual level.

Pseudo design-based sample weights were constructed among respondents who completed the May 2020 follow-up survey based on distributions by age, race and educational attainment of married female residents in this age range using published statistics from the General Household Survey.<sup>37</sup>

## Bias

To address concerns of bias caused by attrition between 2018 and 2020 either due to lack of consent to re-contact for follow-up studies or refusal to the invitation to participate in the May 2020 online survey, the background characteristics of the final sample of 409 participants included in this study — both spouses' ages and income levels, length of marriage, presence of young children aged 6 or below, and wife's pregnancy status in 2018 — were tested for significant differences compared to summary statistics for the original sample of 657 participants using one-sample t-tests and Pearson's chi-squared tests.

Robustness checks were also conducted to ensure that estimates are robust to the comparison of biweekly surveys in 2018 with monthly surveys in May–June 2020. To account for possible differences by year due to calendar month of data collection, the statistics were computed for May–June 2018 only. In addition, proportions of non-activity and weekly sexual frequency were computed for responses recorded in odd weeks (up to 14 days before the online survey) and even weeks (up to 7 days before the online survey) in 2018.

## RESULTS

### Descriptive Statistics

Demographic features and underlying factors are summarized for 2018, May 2020 during the lockdown, and June 2020 after the lockdown (Table 1). During the COVID-19 pandemic, the proportions of married women who reported having average stress ( $P = .031$ ) or average fatigue ( $P = .015$ ) increased, but the proportions who reported being quite stressed ( $P = .018$ ) or quite tired ( $P < .001$ ) declined (proportions who reported being very stressed or very tired increased, but the change is statistically

<sup>3</sup>In cases where income level for 2020 were not reported, data from 2018 baseline data were used instead. Cycle days for entries preceding the first menses was estimated using average cycle length. Cycles longer than 28 days were truncated to 28.



**Table 1.** Demographics and underlying factors

	2018	2020	DiffP-value	May 2020	June 2020	DiffP-value
<b>Demographics</b>						
Wife’s age	30.49	32.46	< .001	32.44	32.47	.9
Husband’s age	33.63	35.59	< .001	35.59	35.59	1
Wife earns SGD4,000 or more (%) *	34.31	32.68	.7	31.65	33.77	.7
Husband earns SGD4,000 or more (%) *	52.24	51.16	.8	50.77	51.57	.9
Duration of marriage in years	4.36	6.32	< .001	6.32	6.33	1
Has a child 6 y old or younger (%)	76.51	79.49	.5	77.99	81.09	.6
Pregnant (%) **	10.27	7.67	.2	7.67	7.67	1
<b>Underlying Factors (%)</b>						
<b>Stressed</b>						
Very	12.69	15.07	.4	17.76	12.23	.3
Quite	41.59	34.31	.018	33.57	35.09	.8
Average	35.06	41.28	.031	39.19	43.50	.4
Not/not at all	10.66	9.34	.4	9.49	9.18	.9
<b>Tired</b>						
Very	27.44	32.94	.090	35.83	29.89	.3
Quite	48.22	37.83	< .001	35.03	40.79	.3
Average	20.34	25.96	.015	25.31	26.64	.8
Not/not at all	4.00	3.27	.3	3.82	2.68	.4
Both spouses staying at home	2.90	24.86	< .001	30.74	18.64	.004
<b>Marital satisfaction</b>						
Very satisfied	34.31	19.67	.002	22.14	17.05	.3
Satisfied	40.61	41.94	.8	40.88	43.06	.7
Neutral	19.91	28.38	.052	28.07	28.71	.9
Very/dissatisfied	5.17	10.02	.2	8.91	11.18	.6
N (individuals)	409	409		409	392	

Notes: Stress and fatigue in 2018 and 2020 were averaged across online survey entries. All estimates were adjusted for sample weights. P-values of t-tests (mean) or Pearson chi-squared tests (%) reported in “Diff P-value” column.

\*For 17 participants who completed the May 2020 but not June 2020 survey, 2020 income level was based on 2018 baseline data.

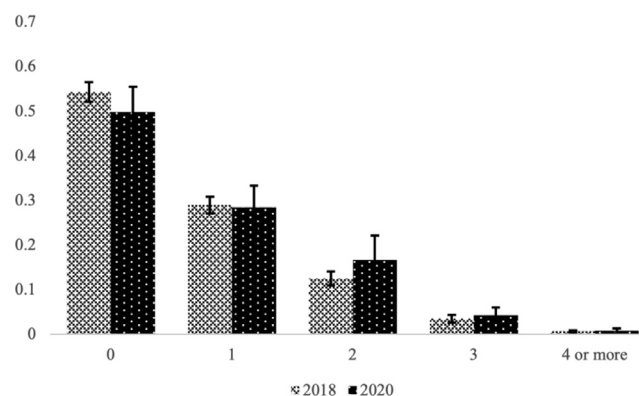
\*\*For 17 participants who completed the May 2020 but not June 2020 survey, pregnancy status in May and June 2020 was coded as missing.

insignificant). As expected, a much higher proportion of married couples either only worked from home or were unemployed during the lockdown in May 2020 ( $P < .001$ ), which fell significantly in June with the lifting of restrictions when the lockdown ended ( $P = .004$ ). Fewer married women reported that they were very satisfied with their marriage ( $P = .002$ ) in 2020 relative to 2018.

**Frequency of Marital Sexual Activity**

Although most married women continued to have no sex or sex once a week in 2020, there was a relative shift towards having sex twice a week or more (Figure 1).

Table 2 lists the proportions who reported not having sex within a week, which fell insignificantly from 54.30% in 2018 to 49.79% in 2020 ( $P = .15$ ). Weekly sexual frequency rose from an average of 0.68 to 0.78 times per week ( $P = .065$ ). Although average sexual frequency in 2020 still stood well below the average ideal level of 1.36 based on the 2018 baseline survey, the proportion who exceeded their ideal levels of sexual activity changed



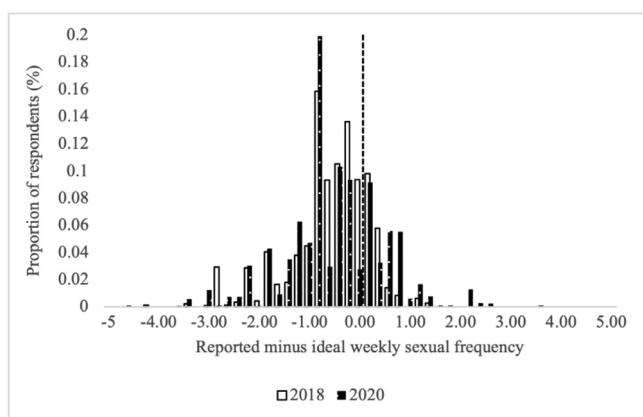
**Figure 1.** Weekly frequency of marital sexual activity.

Distribution of weeks by marital sexual activity level were computed after adjusting for sample weights. The proportion of weeks with no sex was lower during the COVID-19 pandemic than in 2018, while the proportion of weeks with two or more instances of sexual activity was higher in the former than the latter.

**Table 2.** Weekly and daily probability of sexual activity in 2018 and 2020

	2018	2020	DiffP-value	May 2020	June 2020	DiffP-value
Weekly probability of sex						
Non-activity (%)	54.30	49.79	.15	50.78	48.74	.7
Sexual frequency	0.68	0.78	.065	0.78	0.78	1
N (individual-weeks)	5,622	801	-	409	392	-
Daily probability of sex (%)						
Monday	5.58	11.45	< .001	13.05	9.76	.4
Tuesday	6.48	10.60	.033	9.32	11.94	.6
Wednesday	6.87	12.06	.013	11.23	12.93	.7
Thursday	7.05	7.93	.6	10.37	5.35	.2
Friday	13.10	8.54	.009	7.16	9.99	.3
Saturday	16.70	14.86	.3	15.44	14.26	.7
Sunday	11.80	12.79	.6	11.55	14.10	.5
N (individual-days)	39,354	5,607	-	2,863	2,744	-

Notes: All estimates were adjusted for sample weights. *P*-values of *t*-tests (mean) or Pearson chi-squared tests (%) reported in “Diff *P*-value” column.



**Figure 2.** Deviation between ideal and reported weekly sexual frequency.

Differences between respondent’s ideal sexual frequency per week, collected in 2018, and reported sexual frequency, collected in 2018 and 2020, were computed and grouped into bins of 0.2. Data on ideal sexual frequency were collected only in 2018. Estimates were adjusted for sample weights. The proportion of respondents who met or exceeded their ideal levels of sexual activity increased from 18.66% in 2018 to 28.58% during the pandemic.

from less than 20% in 2018 to almost 30% during the pandemic (Figure 2). Comparing May and June 2020, the probability of sexual non-activity within a week was slightly lower in June, although the difference was statistically insignificant at the 5% level (Table 2).

Regression results were consistent with these findings, showing a negative and insignificant coefficient for 2020 (OR = 0.92, *P* = .9, 95% CI = 0.15 ~ 5.57) where sexual inactivity was the dependent variable (column 1, Table 3), and a positive and significant coefficient (OR = 3.66, *P* = .042, 95% CI = 1.05 ~ 12.72) where sexual frequency

was the dependent variable (column 1, Table 4). Further regression analysis using separate indicators for May and June of 2020 showed qualitatively similar results (Appendix Table A.1).<sup>4</sup>

### Patterns by Day of Week

Prior to the pandemic, there was a clear pattern of sexual activity by day of the week, with the lowest probability on Mondays, gradually rising towards the weekend and peaking on Saturdays (Figure 3 Panel A). This pattern was weakened during the pandemic, with significant increases in sexual activity on Mondays, Tuesdays, and Wednesdays (*P* < .001, *P* = .033, *P* = .013 respectively) and a decrease in activity on Fridays (*P* = .009), as shown in Table 2. Both Figure 3 Panel B and Table 2 show that the more uniform probabilities of sexual activity throughout the week persisted from May 2020, during the lockdown, to June, after the lockdown ended.

Regression results in column 1 of Table 4 also showed that in 2018, probability of sexual activity was significantly higher on Fridays to Sundays (OR = 2.79, 3.87, 2.48 respectively, all *P* < .001). In 2020, differences in sexual activity by day of the week relative to Mondays were insignificant (all *P* > .05). Analysis using separate indicators for May and June of 2020 show that weekly patterns did not emerge in either period (Appendix Table A.1).

### Role of Underlying Factors

After controlling for stress and fatigue, stay-at-home status, and marital satisfaction, regression coefficients for 2020 remained negative (OR = 0.85, *P* = .9) where sexual inactivity

<sup>4</sup>The absolute size of the coefficient is smaller and insignificant for June, which is likely to be an artifact of the relatively low frequency on the omitted weekday (Monday) relative to May, as can be seen in Figure 3 Panel B.

**Table 3.** Predictors of weekly probability of sexual non-activity

	(1)	(2)
2020	-0.085 (0.920)	-0.168 (0.895)
<i>Underlying factors</i>		
Very stressed		0.583 (0.444)
Quite stressed		0.441 <sup>†</sup> (0.242)
Not/not at all stressed		1.250** (0.429)
Very tired		1.045* (0.410)
Quite tired		0.282 (0.281)
Not/not at all tired		-1.135 (0.706)
Both spouses at home		-0.116 (0.254)
Very satisfied with marriage		-0.512 (0.439)
Satisfied		-0.905** (0.320)
Dissatisfied/very dissatisfied		-0.359 (0.757)
<i>Demographics</i>		
Wife's age	-0.171 (0.235)	-0.166 (0.239)
Husband's age	-0.002 (0.279)	0.029 (0.270)
Wife earns SGD4,000 or more	0.382 (0.379)	0.334 (0.475)
Husband earns SGD4,000 or more	-0.632 (0.442)	-0.403 (0.393)
Length of marriage	0.053 (0.379)	0.036 (0.358)
Has a child 6 y old or younger	1.595*** (0.446)	1.301** (0.416)
Pregnant	0.658 <sup>†</sup> (0.367)	0.869* (0.337)
Constant	4.575	2.695
N (individual-weeks)	5,726	5,726
Pseudo R-squared	0.239	0.248

Notes: Estimates were generated using a logistic model adjusted for sample weights, controlling for individual and month fixed effects, and a dichotomous indicator for unknown pregnancy status. Standard errors (in parentheses) were clustered at the individual level.

<sup>†</sup>*P* < .10.

\**P* < .05.

\*\**P* < .01.

\*\*\**P* < .001.

was the dependent variable, and positive (OR = 3.28, *P* = .050) where sexual frequency was the dependent variable (column 2 of Tables 3 and 4).

**Table 4.** Predictors of daily probability of sexual activity

	(1)	(2)
2020	1.296* (0.636)	1.187 <sup>†</sup> (0.606)
Tuesday	0.180 (0.146)	0.180 (0.147)
Wednesday	0.238 (0.148)	0.237 (0.148)
Thursday	0.278 <sup>†</sup> (0.166)	0.278 <sup>†</sup> (0.166)
Friday	1.024*** (0.197)	1.024*** (0.197)
Saturday	1.353*** (0.186)	1.353*** (0.187)
Sunday	0.907*** (0.183)	0.906*** (0.183)
2020 * Tuesday + Tuesday	-0.094 (0.450)	-0.092 (0.455)
2020 * Wednesday + Wednesday	0.082 (0.406)	0.089 (0.412)
2020 * Thursday + Thursday	-0.456 <sup>†</sup> (0.250)	-0.452 <sup>†</sup> (0.253)
2020 * Friday + Friday	-0.344 (0.337)	-0.332 (0.341)
2020 * Saturday + Saturday	0.390 (0.286)	0.411 (0.293)
2020 * Sunday + Sunday	0.181 (0.279)	0.198 (0.283)
Very stressed		-0.406 <sup>†</sup> (0.210)
Quite stressed		-0.305** (0.117)
Not/not at all stressed		-0.448* (0.229)
Very tired		-0.339 <sup>†</sup> (0.194)
Quite tired		-0.224 (0.160)
Not/not at all tired		0.158 (0.300)
Both spouses at home		0.108 (0.121)
Very satisfied with marriage		0.247 (0.247)
Satisfied		0.316 <sup>†</sup> (0.174)
Dissatisfied/very dissatisfied		-0.240 (0.333)
Demographics	Included	Included
Constant	-4.357	-4.204
N (individual-days)	41,825	41,825
Pseudo R-squared	0.145	0.147

Notes: Estimates were generated using a logistic model adjusted for sample weights, controlling for individual and month fixed effects, and a dichotomous indicator for unknown pregnancy status. Standard errors (in parentheses) were clustered at the individual level.

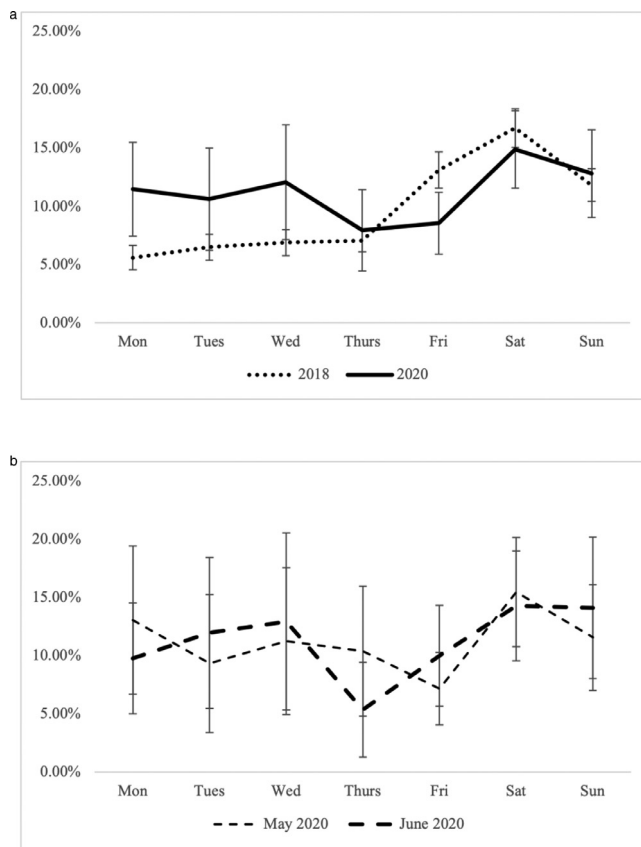
<sup>†</sup>*P* < .10.

\**P* < .05.

\*\**P* < .01.

\*\*\**P* < .001.





**Figure 3.** Probability of sexual activity by day of week.

Probability of sexual activity was computed for each day of the week among respondents who had nonzero sexual activity in each timeframe, adjusted for sample weights. Panel A compares 2018 against 2020. Panel B compares May and June 2020. Weekly patterns of activity evened out between weekdays and weekends during the COVID-19 lockdown in May, and these effects persisted after the lockdown was lifted in June.

Of the 3 sets of underlying factors which may contribute to the increase in sexual frequency, stress and fatigue were consistently significant predictors. Feeling quite stressed, not stressed, and very tired were associated with higher probability of non-activity (OR = 1.55,  $P = .068$ ; OR = 3.49,  $P = .004$ ; OR = 2.84,  $P = .011$  respectively) (Table 3) as well as lower sexual frequency (OR = 0.74,  $P = .010$ ; OR = 0.64,  $P = .050$ ; OR = 0.71,  $P = .081$ , respectively) (Table 4). Being satisfied with the marriage was associated with lower probability of non-activity (OR = 0.40,  $P = .005$ ) (Table 3) and higher sexual frequency (OR = 1.37,  $P = .069$ ) (Table 4). Coefficients for both spouses staying at home were statistically insignificant in all specifications.

### Robustness Checks

To address concerns of bias caused by attrition between 2018 and 2020, participants' background characteristics in 2018 were compared for the baseline sample ( $n = 657$ ) and final sample

( $n = 409$ ). No significant differences were found for any of the background characteristics, including age, income levels, marriage length, presence of young children and pregnancy status (Appendix Table A.2), suggesting a broadly similar demographic profile between the 2 samples.

To check that the results are likely to be robust to the comparison of surveys in 2018 with monthly surveys in May–June 2020, the key dependent variables of interest were generated for data collected only in May–June of 2018. Weekly probability of non-activity and sexual frequency are similar for the restricted sample and the full 2018 sample, with no significant differences (Appendix Table A.3). Differences in probabilities of sexual activity by day of the week were all insignificant. In further support of the robustness check, results in Table 2 are consistent with regression results in Table 3 and 4, which control for month fixed effects.

To check that differences in sexual non-activity and sexual frequency during the pandemic could not be attributed to bias caused by differences in responses recorded in odd weeks (up to 14 days before the online survey) and even weeks (up to 7 days before the online survey), the key dependent variables of interest were generated for data collected only in odd weeks and only in even weeks in 2018. The two samples yield similar weekly probability of non-activity and sexual frequency, with no significant differences (Appendix Table A.3). Probabilities of sexual activity by day of the week were also statistically insignificant on all days except for Wednesdays, which was higher on odd weeks ( $P = .003$ ). Nevertheless, this outlier statistic cannot explain the higher sexual frequency or more uniform weekly patterns observed during the pandemic, since the 2020 waves collected data on sexual activity up to 7 rather than 14 days prior to the survey.

## DISCUSSION

Using longitudinal data which allows for controlling for observed and unobserved confounders, this paper tests the following hypotheses: that there was an overall decline in frequency of sexual activity in Singapore during the COVID-19 lockdown; that patterns of activity have evened out between weekdays and weekends, and that these effects dissipated after the lockdown was lifted; and that 3 underlying factors—stress and fatigue, working from home and marital satisfaction—were significant predictors of sexual activity during the lockdown.

### Frequency of Marital Sexual Activity

During the COVID-19 pandemic, the proportion of married women who reported not having sex within a week remained stable while weekly sexual frequency significantly increased. The results do not support the hypothesis that the lockdown led to an overall decline in frequency of sexual activity during the COVID-19 lockdown. Although international studies in China, the U.K. and the U.S. consistently find an overall decline in

sexual activity among adults aged 18 and above,<sup>1,2,4</sup> those in serious relationships or living with a partner were an important exception,<sup>2,3</sup> in line with studies which found increases in marital sexual activity in Asian countries.<sup>5,6</sup>

### Patterns by Day of Week

In a contribution to the existing literature, this study provides support for the hypothesis that the pandemic affected not only frequency but also patterns of sexual activity throughout the week. Probability of activity was significantly higher on weekends relative to weekdays prior to but not during the pandemic, suggesting more flexibility in the timing of sexual activity. While past studies have focused on overall activity levels, there is evidence that biological rhythms, including sleep cycles, as well as subjective experiences of time also shifted during the prolonged confinements to home environments,<sup>38,39</sup> which may in turn disrupt timing of sexual behavior.

In contrast to the hypothesis that changes in patterns of sexual activity dissipated after the lockdown was lifted, the changes in weekly patterns of marital sexual behavior continued to be observed in June of 2020 when movement restrictions were gradually being lifted. This finding has implications for the role of underlying factors, as discussed below.

### Role of Underlying Factors

Of the 3 potential underlying factors: stress and fatigue, working from home and marital satisfaction explored in this paper, there is, perhaps surprisingly, least evidence that the changes in sexual frequency are attributable to working from home. Couples' stay-at-home status was not associated with outcomes of interest. Moreover, as shown above, the lifting of the lockdown did not lead to a reversion in sexual behavior even though significantly fewer couples continued to remain at home ( $P = .004$ ), suggesting a limited role for this factor.

Stress and fatigue were consistently significant predictors of sexual activity, suggesting that this set of factors may help to explain the observed changes in sexual activity during the pandemic. As expected, feeling very tired was associated with higher probability of non-activity and lower sexual frequency. However, the associations between stress and sexual activity do not appear to be strictly linear: feeling quite stressed or not stressed were both associated with higher probability of non-activity and lower sexual frequency. To reconcile these findings, it may be observed that while previous studies suggest that stress generally has a negative association with sexual desire and activity,<sup>4,18,19</sup> there is also some evidence that stress from daily hassles are positively associated with sexual desire,<sup>40</sup> suggesting that mild to moderate levels of stress may be more optimal for increased sexual frequency relative to either very low or high levels of stress.

In this study, although the proportions of married women in this sample who reported being very stressed or very tired increased (insignificant at the 5% level), there was a decline in

the proportions who reported being quite stressed or quite tired, and almost no change in the proportions who reported being not stressed or not tired (Table 1). Hence, the unexpected association between low stress and low sexual activity, which applied to around 10% of respondents, is less relevant for explaining changes in sexual behavior in this timeframe, relative to the changes in proportions who were quite stressed.

Similarly, a positive statistical association between marital satisfaction and sexual activity was also observed. Being satisfied with the marriage was associated with lower probability of non-activity and higher sexual frequency. However, there was little change in the proportions who reported being satisfied with their marriage between 2018 and 2020, suggesting a weaker role for changes in marital satisfaction during the pandemic.

Understanding changes in sexual activity brought on by the pandemic is especially important in the case of Singapore, where sexual frequency and satisfaction are lower than international averages,<sup>41,42</sup> with one study estimating coital frequency to be around 3 times per month among married women in this age range,<sup>19</sup> compared to an average of around 6 and 7 times among married and cohabitating couples with female partners under age 45 in the U.S.<sup>43</sup> These low levels have been linked to stress and fatigue driving sexual activity below ideal levels.<sup>19,34</sup> An unpublished local survey ( $n = 1,000$ ) found that almost 40% of married couples trying to conceive were not satisfied with their progress, and that low sexual frequency due to stress and long working hours was the most common obstacle mentioned by respondents.<sup>44</sup> Women tend to be disproportionately allocated care work and household chores, resulting in role overload and physical, mental and emotional exhaustion.<sup>45,46</sup> The pressures may have intensified during the pandemic, with evidence that gender inequalities in time expenditures on childcare and housework widened in Singapore, especially among low-income households.<sup>47</sup> The findings of this study, which show an overall increase in volume as well as greater flexibility in timing of sexual activity, suggest that the disruptions caused by the COVID-19 lockdown did not lead to a further deterioration in marital sexual activity, although longer term studies are needed to assess the full impact of the pandemic.

### Limitations and Conclusion

The longitudinal nature of the dataset provides unique insights which allow for detection of differences in sexual activity by day of the week as well as for controlling for observed and unobserved confounders. However, the dataset is still subject to some notable weaknesses. Although data were collected prior to and during the pandemic, providing more objective measures of sexual activity, dates of sexual activity in the past weeks may still suffer from recall errors, although this issue is likely to be somewhat ameliorated by controls for individual fixed effects. Data were collected only from wives and hence reported dates of sexual activities could not be cross-validated with husbands. The questionnaire did not provide a definition of sexual activity, for

example, whether only referring to penetrative intercourse, and respondents may interpret this question differently. One study found increased diversity of sexual acts during the pandemic,<sup>4</sup> which may help to account for the increase in sexual frequency. Data on stress, fatigue and marital satisfaction were based on single-item measures in the survey questionnaires, rather than on more reliable multi-item scales. Data on medical conditions were not collected, which does not allow for assessing whether worsening of conditions such as chronic illness and mental illness linked to sexual functioning<sup>48,49</sup> could have contributed to changes in sexual activity. The sample was restricted to heterosexual married respondents in a relatively narrow age band of ages 25–34 in 2018, and is proportionally more Chinese and highly educated than the national statistics for this demographic subgroup, thus limiting the generalizability of the results to the wider national or international population. In particular, the results cannot be extrapolated to individuals who had no or casual partners, especially given the evidence that individuals who were married experienced smaller declines in sexual activity during the pandemic,<sup>2,3,6</sup> likely due to the difficulty of soliciting physical contact with new partners under social gathering restrictions. Moreover, the survey excluded women who cannot speak, read or write in English. Although the vast majority of women aged 25–34 are likely to be able to meet this criterion as the local bilingual educational system is mainly based on English, the sample may underrepresent couples with foreign-born wives.

While the international literature points to a picture of overall decline in sexual activity during the pandemic, the results are consistent with increases in frequency within some subsets of the population, with evidence of more active and flexible marital sex lives. Questions to be addressed in further research include whether these trends are likely to be observed in the intermediate term of 6 months to the longer term of 1 year or more, especially as the populations around the world adjust to full-time telecommuting or hybrid work arrangements. More research is needed to understand whether these patterns differ by type of partnered sexual activity.

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## STATEMENT OF AUTHORSHIP

Poh Lin Tan: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Writing – Original draft, Writing – Review & editing, Visualization, Project administration, Funding acquisition

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## APPENDIX A. SEXUAL ACTIVITY, MENSTRUAL CYCLE DATES AND ITEMS RELATED TO UNDERLYING FACTORS IN THE SURVEY INSTRUMENT

### A. Baseline Face-to-Face Interview

A1. What is your ideal frequency of sexual activity per month?

Options: Numerical value

A2. Overall, how satisfied are you with your marriage?

Options: “Very dissatisfied”, “Dissatisfied”, “Neutral”, “Satisfied”, “Very satisfied”

### B. Online Diary Survey in 2018

B1. Did you have your period in the past 2 weeks?

Options: “Yes” or “No”

**Table A.1.** Predictors of weekly sexual non-activity and daily probability of sexual activity, comparing May and June 2020

	Sexual non-activity	Daily probability
May 2020	-0.245 (0.944)	1.603* (0.670)
June 2020	0.026 (0.931)	1.045 (0.682)
May 2020* Tuesday + Tuesday		-0.418 (0.522)
May 2020 * Wednesday + Wednesday		-0.188 (0.522)
May 2020 * Thursday + Thursday		-0.315 (0.311)
May 2020 * Friday + Friday		-0.681 (0.440)
May 2020 * Saturday + Saturday		0.284 (0.390)
May 2020 * Sunday + Sunday		-0.080 (0.454)
June 2020 * Tuesday + Tuesday		0.256 (0.493)
June 2020 * Wednesday + Wednesday		0.381 (0.530)
June 2020 * Thursday + Thursday		-0.700 (0.492)
June 2020 * Friday + Friday		0.006 (0.423)
June 2020 * Saturday + Saturday		0.521 (0.384)
June 2020 * Sunday + Sunday		0.466 (0.433)
Demographics	Included	Included
Constant	4.673	-4.439
N (individual-weeks/days)	5,726	41,825
Pseudo R-squared	0.239	0.145

Notes: Estimates were generated using a logistic model adjusted for sample weights, controlling for individual and month fixed effects, and day of week fixed effects (for daily probability only). Standard errors (in parentheses) are clustered at the individual level.

\* $P < .05$ .

B2. [If “Yes” to B1] When was the first day of your last menstrual period?

Options: [List of dates]

B3. Please indicate the days on which you had sex with your husband in the week of Date A to Date B Month 2018.

Options: [List of dates, multiple selection]

B4. Kindly indicate the days on which you had sex with your husband in the week of Date C to Date D Month 2018 (+1 week) [Multiple selection]

Options: [List of dates, multiple selection]

B5. In general, how would you rate how tired you are in the past 2 weeks?

Options: “Very tiring”, “Tiring”, “Average”, “Not tiring” or “Not tiring at all”

B6. In general, how would you rate how stressed you were in the past 2 weeks?

Options: “Very stressed”, “Stressed”, “Average”, “Not stressed” or “Not stressed at all”

**Table A.2.** Demographics in 2018 among baseline sample and final sample

	Baseline sample in 2018	Final sample	Diff $P$ -value
Wife’s age	30.17	30.17	1
Husband’s age	33.16	32.98	.4
Wife earns SGD4,000 or more (%)	38.81	38.14	.8
Husband earns SGD4,000 or more (%)	61.04	64.06	.2
Duration of marriage in years	4.38	3.37	.9
Has a child 6 y old or younger (%)	71.84	72.86	.6
Pregnant in 2018 (%)	11.11	11.49	.8
N (individuals)	657	409	-

Notes: Demographics measured at the point of the 2018 baseline survey.  $P$ -values of one-sample  $t$ -tests (mean) or Pearson one-sample chi-squared tests (%) reported in “Diff  $P$ -value” column.



**Table A.3.** Weekly and daily probability of sexual activity in 2018, by odd and even weeks

	May–June 2018	All 2018	Diff <i>P</i> -value	Odd weeks	Even weeks	Diff <i>P</i> -value
Weekly probability of sex						
Non-activity (%)	54.90	54.30	.8	54.42	54.19	.9
Sexual frequency	0.67	0.68	1	0.70	0.66	.3
N (individual-weeks)	1,472	5,622	-	2,811	2,811	-
Daily probability of sex (%)						
Monday	6.55	5.58	.4	5.80	5.36	.7
Tuesday	5.45	6.48	.3	6.11	6.86	.5
Wednesday	7.21	6.87	.8	8.44	5.30	.003
Thursday	6.98	7.05	.9	7.64	6.47	.2
Friday	13.80	13.10	.7	13.33	12.86	.8
Saturday	16.94	16.70	.9	16.81	16.59	.9
Sunday	10.07	11.80	.3	11.48	12.12	.7
N (individual-days)	9,930	39,354	-	19,677	19,677	-

Notes: All estimates were adjusted for sample weights. *P*-values of t-tests (mean) or Pearson chi-squared tests (%) reported in “Diff *P*-value” column.

**C. Online Diary Survey in May 2020**

- C1. When was the first day of your last menstrual period?  
Options: [List of dates]
- C2. Please indicate the days on which you had sex with your husband in the week of Date A to Date B May 2020.  
Options: [List of dates, multiple selection]
- C3. In general, how would you rate how tired you are in the past two weeks?  
Options: “Very tiring”, “Quite tiring”, “Average”, “Not tiring” or “Not tiring at all”
- C4. In general, how would you rate how stressed you were in the past 2 weeks?  
Options: “Very stressed”, “Quite stressed”, “Average”, “Not stressed” or “Not stressed at all”
- C5. Have you been working from home or outside of home in the past 2 weeks?  
Options: “I work only from home”, “I work mostly from home”, “I work half from home and half outside home”, “I work mostly outside of home”, “I work only outside of home”
- C6. Has your husband been working from home or outside of home in the past 2 weeks?  
Options: “He works only from home”, “He works mostly from home”, “He works half from home and half outside home”, “He works mostly outside of home”, “He works only outside of home”
- C7. Overall, how satisfied are you with your marriage?  
Options: “Very dissatisfied”, “Dissatisfied”, “Neutral”, “Satisfied”, “Very satisfied”

**D. Online Diary Survey in June 2020**

- D1. When was the first day of your last menstrual period?  
Options: [List of dates]
- D2. Please indicate the days on which you had sex with your husband in the week of Date A to Date B June 2020.  
Options: [List of dates, multiple selection]
- D3. In general, how would you rate how tired you are in the past 2 weeks?  
Options: “Very tiring”, “Quite tiring”, “Average”, “Not tiring” or “Not tiring at all”
- D4. In general, how would you rate how stressed you were in the past 2 weeks?  
Options: “Very stressed”, “Quite stressed”, “Average”, “Not stressed” or “Not stressed at all”
- D5. Have you been working from home or outside of home in the past 2 weeks?  
Options: “I work only from home”, “I work mostly from home”, “I work half from home and half outside home”, “I work mostly outside of home”, “I work only outside of home”
- D6. Has your husband been working from home or outside of home in the past 2 weeks?  
Options: “He works only from home”, “He works mostly from home”, “He works half from home and half outside home”, “He works mostly outside of home”, “He works only outside of home”
- D7. Overall, how satisfied are you with your marriage?  
Options: “Very dissatisfied”, “Dissatisfied”, “Neutral”, “Satisfied”, “Very satisfied”