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REGULAR ARTICLE

Fear of Cancer Recurrence and Sleep in Couples Coping With Early-Stage Breast Cancer

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Abstract

Background Fear of cancer recurrence (FCR) and sleep disturbance are common in cancer survivors. Yet, little research has examined their relationship, and even less is known about what links may exist between these variables among the intimate partners of cancer survivors.

Purpose This study examines the relationship between FCR and sleep disturbance in breast cancer survivors and their partners. Using daily sleep data collected at two distinct periods early in survivorship—the completion of adjuvant treatment and the first post-treatment mammogram—higher survivor and partner FCR was hypothesized to predict greater sleep disturbance.

Methods Breast cancer survivors and intimate partners (N = 76 couples; 152 individuals) each reported sleep duration, sleep quality, sleep onset latency, and wake after sleep onset each morning of two 21-day sleep diary bursts during the first year post-diagnosis. Three validated measures formed latent FCR factors for survivors and partners, which were used to predict average daily sleep.

Results Across both sleep diary bursts, survivor FCR was associated with their own reduced sleep duration, reduced sleep quality, and greater sleep onset latency. Survivor FCR was also associated with their partners' reduced sleep quality and greater sleep onset latency. Partner FCR was associated with their own reduced sleep duration, reduced sleep quality, and greater sleep onset latency. Partner FCR was also associated with survivors' reduced sleep quality.

Conclusions Findings revealed intrapersonal and interpersonal associations between FCR and sleep disturbance, addressing gaps in knowledge on FCR and an outcome with known short- and long-term implications for health and mortality.

Keywords Fear of cancer recurrence · Sleep · Breast cancer · Couples · Mammogram

Since 1975, breast cancer mortality has decreased by 40% [1], resulting in a population of 3.8 million breast cancer survivors in the USA today [2]. As many as 40% of these survivors report clinically significant levels of fear of cancer recurrence (FCR) [3], or the "fear, worry, or concern relating to the possibility that cancer will come back or progress" [4]. Theoretical models of FCR outline consequences including excessive body checking for cancer and avoidance of cancer-related triggers [5]. However, models have neglected sleep disturbance as a potential consequence of pathological FCR [5].

Sleep in Breast Cancer Survivorship

Sleep disturbance is an umbrella term referring to insufficient sleep duration, poor perceived sleep quality, difficulty falling asleep, and/or difficulty staying asleep. Insomnia disorder is diagnosed when one or more sleep disturbance

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facets occur ≥3 days per week, for ≥3 months, and cause distress and impairment [6]. Breast cancer survivors have a two-fold risk for insomnia relative to the general population [7]. Sixty-nine percent of breast cancer survivors report sleep disturbance at surgery, and as many as 42% experience sleep disturbance 18 months later. Interestingly, insomnia rates are higher in breast cancer than in other cancers, and this effect is not fully explained by gender differences [8]. Sleep has known implications for mental and physical health in the general population and cancer survivors. Regarding mental health implications, short-term sleep deprivation/loss is associated with impairments in emotional reactivity, recognition, and expression and sleep disturbance is both causally and bidirectionally related to mood and anxiety disorders [9]. Physical health implications of sleep disturbance include heightened risk for cardiovascular disease [10], a particularly relevant outcome for cancer survivors who already demonstrate elevated rates of cardiovascular disease-related mortality [11]. Among breast cancer survivors, sleep disturbance also has been implicated in compromised recovery from adjuvant treatment [12] and both all-cause and breast cancer mortality [13, 14].

Most research on sleep in cancer survivors has focused on treatment side effects and associated physiological changes [15]. FCR may be another cancer-specific contributor to sleep disturbance in survivorship. Indeed, accepted psychosocial conceptualizations of insomnia, including the 3 Ps [16–18] and cognitive models [19], provide theoretical support for a relationship between FCR and sleep disturbance: these models propose that stressful life events and associated cognitions (e.g., worry, rumination) serve as precipitating factors for sleep disturbance. Acute sleep disturbance may become chronic as worries expand to include those about sleep itself and as individuals develop wake-bed associations and maladaptive compensatory sleep behaviors (e.g., spending large amounts of time in bed). Drawing on these well-established theoretical frameworks, it is possible that cancer (including diagnosis, treatment, and follow-up mammograms) and associated FCR (particularly intrusive thoughts and worry) may contribute to the elevated rates of insomnia observed in breast cancer survivors.

In support of this hypothesis, cancer-related intrusive thoughts—a core component of FCR [20]—predict current and future sleep disturbance in breast cancer survivors [21, 22]. A small literature has directly examined the relationship between FCR and sleep disturbance. In separate studies of ovarian and prostate cancer survivors, FCR showed cross-sectional associations with global sleep disturbance [23, 24]. Another study found that cancer survivors with mixed diagnoses who reported frequent problems falling/staying asleep on a single item were more likely to report FCR than those with better sleep [25]. In another mixed sample of cancer survivors, FCR and global sleep quality, both measured cross-sectionally with single items, were positively associated [26]. Lastly, in a qualitative study, six of ten mixed-diagnosis cancer survivors described as having clinical FCR also reported difficulty sleeping [27].

These studies provide preliminary support for an association between FCR and sleep disturbance in cancer survivors. However, several questions remain. First, no studies have examined FCR and sleep disturbance specifically in breast cancer survivors, despite evidence that this population experiences increased sleep disturbance relative to other cancer survivors [7]. Second, evidence for associations between FCR and sleep disturbance is based solely on global, retrospective sleep measures, which correlate only moderately with daily sleep logs [28]. Global assessments are susceptible to recall bias, which may be magnified in individuals with insomnia who misperceive their sleep [29]. Moreover, FCR and sleep disturbance have often been measured with single items, overlooking the multi-faceted nature of both constructs. For example, sleep disturbance was often measured with a single sleep quality item, which neglects the number of other and unique ways (insufficient sleep duration, difficulty falling asleep, etc.) that sleep can be disturbed.

In addition to survivors, intimate partners of cancer survivors also report FCR [30, 31] and survivor and partner FCR are significantly associated [32, 33]. Sleep disturbance in intimate partners of cancer survivors has received relatively little empirical attention, but some data suggest that partners in fact demonstrate rates of sleep disturbance comparable to those seen in survivors [34, 35]. More generally, sleep is a shared activity for most couples, and thus, partners' sleep, wake, and movements are interdependent [36]. Furthermore, dyadic effects of one partner's psychological distress impacting the other's sleep have been demonstrated in both the general population [37] and in couples coping with cancer [38, 39]. Taken together, there is value in studying the association between FCR and sleep in both survivors and their partners.

The Current Study

This study builds on this prior work by examining links between *global* FCR and *daily* sleep disturbance in breast cancer survivors and their partners during two important periods in the first year of survivorship: (a) the completion of adjuvant treatment and (b) the first post-treatment mammogram. Both periods are clinically significant in the FCR trajectory, but in different ways—the completion of adjuvant treatment marks the typical *onset* of FCR, as this is when survivors are declared "cancer-free," lose regular contact with oncology providers, and

often report a drop in other cancer-related supports [40]. In contrast, the post-treatment mammogram is conceptualized as a real-world, short-term *trigger* of FCR [30, 41, 42]. Given the different characteristics of these two periods and about a 6-month gap between them, questions concerning links with sleep were examined independently. A global, one-time measure of FCR was obtained immediately before each of two 21-day sleep diary bursts, during which participants reported on four aspects of sleep: sleep duration, sleep quality, difficulty falling asleep (*sleep onset latency*), and difficulty staying asleep (*wake after sleep onset*).

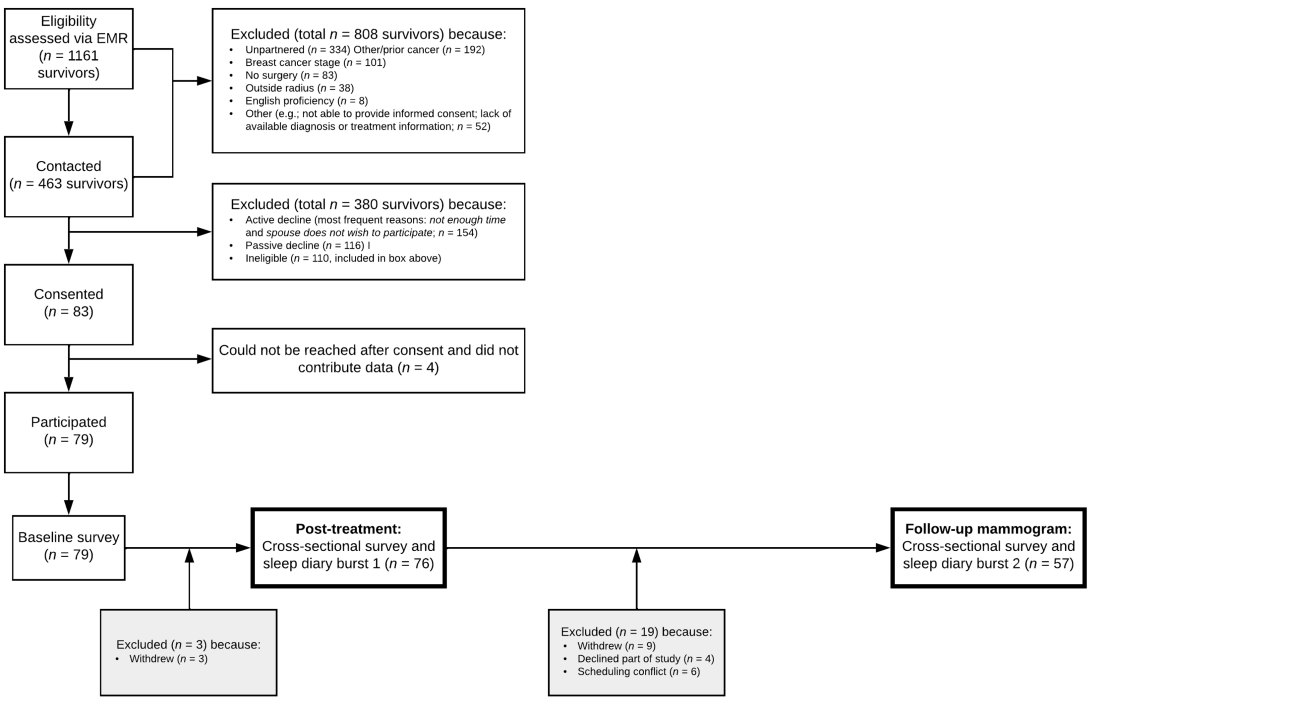
In separate analyses for the two periods, we examined links between global FCR and the four indices of daily sleep averaged across each diary burst. FCR and sleep were assessed in survivors and partners, allowing for the examination of both *actor* and *cross-partner* effects. We hypothesized that survivors and partners with more FCR would report more daily sleep disturbance themselves (actor effects), as indicated by lower sleep duration, poorer subjective sleep quality, and greater sleep onset latency and wake after sleep onset. Given prior evidence for cross-partner effects of distress and sleep, we hypothesized that survivors with more FCR would have partners (and vice versa) with more daily sleep disturbance (cross-partner effects).

Methods

Participants

Data came from a larger longitudinal study (IRB approval; FWA00006557; CCC# 33026), whose purpose was to examine the interpersonal context of FCR [30, 31, 42–45]. Seventy-nine couples provided informed consent for the larger study. Eligibility criteria for survivors included: (a) Stage 0-IIIA breast cancer treated by surgery; (b) female; (c) in a committed, cohabiting relationship with a partner also willing to participate; (d) lived <1 hr from recruiting site; (e) no prior cancers; and (f) English-speaking. See Fig. 1 for a detailed participant flow diagram. Seventy-six couples completed sleep diary burst 1, which took place at the end of adjuvant treatment, and 57 couples also completed sleep diary burst 2, which overlapped with the first post-treatment mammogram (M = 6 months later). Between bursts, nine couples withdrew, four declined part of the study, and six had a scheduling conflict.

The average survivor age was 57.2 years (range = 35–75; SD = 9.5) and partner age was 59.3 years (range = 36–79; SD = 10.5). All but two partners were men. The mean relationship length was 28.7 years (range = 1–57; SD = 14.1). Most survivors (88%) and partners (84%)



Note: EMR = electronic medical record. Unless otherwise specified, numbers reported here reflect numbers of *couples* (not individuals). The boxes with the thick borders reflect data examined in the current report. *The refusal rate (including both passive and active decliners, n = 270) was 58%, which is identical to the average response rate documented in a review of 83 studies of couples with cancer (Dagan & Hagedoom, 2014).

Fig. 1. Participant flow diagram.

identified as non-Hispanic White. The modal family income was >$80,000. About 14% of survivors had Stage 0 cancer, 47% I, 37% II, and 2% IIIA. All had breast cancer surgery (77% breast-conserving, 23% mastectomy). About 35% received chemotherapy, 70% radiation, and 77% hormonal therapy; 59% and 19% received two and three of these modalities, respectively.

Procedure

The parent study followed couples starting shortly after initial breast cancer surgery until the first annual post-treatment mammogram (months post-diagnosis: $M = 11$, $SD = 1.7$). The present analyses focused on two important periods during this first year of survivorship: the completion of adjuvant treatment and the first post-treatment mammogram. *Sleep diary burst 1* occurred as soon as possible after survivors completed adjuvant treatment (with exception of long-term hormonal treatment). Survivors and their partners independently completed an online panel survey once before beginning a 21-day sleep diary period. This online panel survey included several validated global FCR measures. Immediately after couples completed this panel survey, they began the 21-day sleep diary period ($M = 5$ months post-surgery, 20 days post-treatment), during which they independently completed four sleep disturbance items online daily within 1 hr of waking (diary completion rates: survivors 86%; partners 83%).

Sleep diary burst 2 overlapped with each survivor's first post-treatment mammogram (typically the first mammogram since their diagnostic mammogram). As in sleep diary burst 1, a one-time panel survey including validated global FCR measures was immediately followed by a 21-day sleep diary period. For burst 2, this 21-day sleep diary period was scheduled to start approximately 2 weeks before each survivor's mammogram appointment ($M = 12$ days pre-mammogram) and conclude 1 week after. As in the first diary burst, participants independently completed four online sleep disturbance items within 1 hr of waking (diary completion rates: survivors 92%; partners 87%). All but one survivor received negative results on the same day as their mammogram (excluding this couple's data did not affect the results reported here).

Measures

Fear of cancer recurrence

Immediately before each sleep diary period, global FCR was assessed with three validated scales. Survivors and partners both reported concerns regarding the possibility of the survivor's cancer recurrence. The 9-item *Fear of Cancer Recurrence Inventory* (FCRI) *Severity subscale* [46] assessed intrusive thoughts and perceived risk of cancer recurrence over the past month. The 4-item *FCRI Distress subscale* assessed emotional reactivity to thoughts about recurrence over the past month. The 4-item *Concerns about Recurrence Scale* (CARS) *Overall Fear subscale* [47] assessed the frequency and intensity of FCR and associated distress. All items were rated on a Likert-type scale and summed, with higher scores indicating more FCR. Coefficient alpha for each FCR scale reflected acceptable to good internal consistency reliability for survivors and partners at both burst 1 (α's =.78–.91) and burst 2 (α's =.71–.91).

Sleep disturbance

Within 1 hr of waking each morning during each of the sleep diary bursts, participants reported on sleep duration, subjective sleep quality, sleep onset latency, and wake after sleep onset. The *sleep duration, subjective sleep quality, sleep onset latency,* and *wake after sleep onset* (sleep disturbance) items were modeled after subscales of the Pittsburgh Sleep Quality Index (PSQI) [48]. For *sleep duration*, participants reported the number of hours and minutes they slept the previous night. For *sleep onset latency* and *wake after sleep onset*, participants indicated whether (0 = *No*, 1 = *Yes*) they had "difficulty getting to sleep" and "woke up in the middle of the night or early morning when they did not mean to," respectively. *Subjective sleep quality* was defined as "feeling refreshed or rested in the morning," a characterization of good sleep quality used in prior research [49]. This item ("*How refreshed or rested do you feel right now after last night's sleep?*") used a Likert-type response scale ranging from 0 = *Not at all* to 4 = *Extremely*. The four items were examined as separate outcomes due to (a) the unique characteristics of each measure (e.g., scalar vs. binary) and (b) each measure tapping unique sleep disturbances.

Statistical methods

Primary analyses consisted of dyadic path models using structural equation modeling (SEM) with maximum likelihood estimation, which provides valid inferences assuming that data are missing at random. SEM was used to examine the relationship between an underlying FCR construct and each of the sleep outcomes at the two sleep diary bursts. The three manifest indicators (FCRI-Severity, FCRI-Distress, and CARS-Overall) were used to create latent FCR factors free of measurement error for both survivors and partners. To achieve identification and scale the latent factors, the FCRI-Severity subscale served as the scaling variable (i.e., its loading was fixed to one). The latent FCR factors for survivors and partners were allowed to covary. Actor-partner interdependence

modeling [50] was used to capture the interdependence of sleep outcomes—associations between one participant's FCR and their own sleep (actor effects) and with their partner's sleep (cross-partner effects) were estimated simultaneously in each model (depicted in Fig. 2). For several models, the actor and/or cross-partner effects for survivors and partners were similar in magnitude. When supported by chi-square difference tests, these effects were constrained to be equal across survivors and partners and the results of the more parsimonious, constrained models are reported.

We present results for sleep burst 1 followed by burst 2. The main results reflect links between latent FCR and each of the four sleep outcomes averaged across all days within each burst. For all models, actor and cross-partner effects were estimated for survivors and partners.

Results

Table 1 contains descriptive statistics and bivariate correlations for all variables. The observed range for the FCR indicators at burst 1 were as follows (shown as survivor/partner): FCRI Severity 2-20/1-17; FCRI Distress 0-8/0-10; CARS Overall 4-22/4-22. At burst 2, they were as follows: FCRI Severity 1-17/1-14; FCRI Distress 0-6/0-8; CARS Overall 4-19/4-18. Additionally, we examined bivariate correlations and mean differences between variables measured at diary burst 1 versus diary burst 2. Each of the four sleep variables showed significant bivariate correlations from diary burst 1 to diary burst 2, for survivors and partners (r's range:.68–.89, all p's < .001). The same was true for each of the three FCR indicator variables (r's range:.50–.72, all p's < .001). Paired samples t-tests failed to reveal statistically significant differences between mean levels of any of the sleep variables at diary burst 1 versus diary burst 2, for survivors or partners (all p's > .09). However, all three FCR indicator variables, for both survivors and partners, were significantly higher at diary burst 1 compared to diary burst 2 (all p's < .009; see Table 1), indicating consistent decreases in FCR for both partners over time.

Attrition Analysis

We tested whether the 57 couples who completed both sleep diary bursts differed from the 19 who only completed burst 1 in terms of the following: age, relationship length, income, survivor breast cancer stage, survivor adjuvant treatment type, FCR, and averaged daily sleep disturbance. Only one significant difference emerged: survivors who completed both diary bursts reported significantly greater sleep onset latency (p = .031) as compared to survivors who did not complete burst 2. Otherwise, there were no significant differences between these groups.

Estimated Levels of Clinical Dysfunction

Using burst 1 data, we estimated the extent of sleep disturbance and clinical FCR observed in this sample. On average, 27% of survivors and 52% of partners slept less

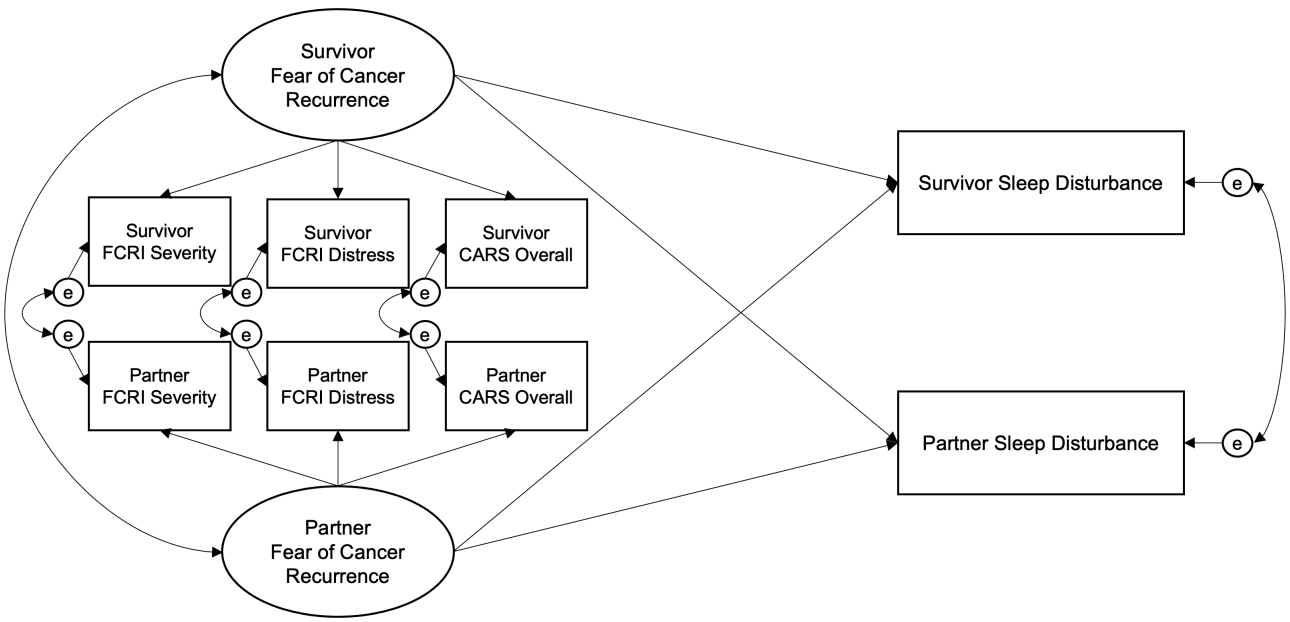


Fig. 2. Full dyadic structural model estimated at both sleep diary bursts. *FCRI* Fear of Cancer Recurrence Inventory; *CARS* Concerns about Recurrence Scale.

Table 1. Descriptive Statistics and Bivariate Correlations for Key Variables From Sleep Diary Bursts 1 and 2

	1	2	3	4	5	6	7
1. FCRI-Severity	(.26)/(.28)	.65/.68	.79/.79	−.25/−.32	−.31/−.22	.11/.03	.28/.05
2. FCRI-Distress	.71/.62	(.15)/(.11)	.68/.56	−.26/−.36	−.16/−.16	.06/.19	.14/.22
3. CARS	.76/.71	.60/.45	(.22)/(.35)	−.22/−.35	−.26/−.21	.20/.10	.25/.12
4. Sleep duration	−.38/−.25	−.30/−.26	−.21/−.12	(.26)/(.36)	.43/.55	−.34/−.36	−.25/−.43
5. Sleep quality	−.39/−.56	−.31/−.47	−.17/−.44	.52/.52	(.23)/(.37)	−.45/−.25	−.31/−.27
6. Sleep onset latency[a]	.37/.08	.31/.16	.41/.22	−.49/−.43	−.34/−.56	(−.17)/(−.01)	.24/.29
7. Wake after sleep onset[a]	.15/.16	.17/.24	−.01/−.07	−.33/−.18	−.43/−.43	.34/−.04	(.13)/(.36)
M Burst 1 (Survivor/Partner)	8.08/6.64	1.36/1.60	10.17/10.35	7.45/6.97	2.16/2.24	0.22/0.17	0.59/0.52
SD Burst 1 (Survivor/Partner)	4.72/4.37	1.85/2.53	3.88/4.66	0.79/1.01	0.71/0.73	0.25/0.23	0.31/0.33
M Burst 2 (Survivor/Partner)	7.19/4.91	1.04/0.54	9.51/8.49	7.48/7.07	2.24/2.28	0.27/0.15	0.63/0.58
SD Burst 2 (Survivor/Partner)	4.16/3.59	1.57/1.43	3.58/3.84	1.47/1.37	0.97/0.99	0.28/0.21	0.32/0.34

FCRI Fear of Cancer Recurrence Inventory; *CARS* Concerns about Recurrence Scale.

[a]Reflects the proportion of days on which participants responded affirmatively. Sleep variables were derived by averaging each participant's daily sleep. Top panel: Bivariate correlations among variables, with inter-correlations among Burst 1 variables shown before the slash and inter-correlations among Burst 2 variables shown after the slash (i.e., Burst 1/Burst 2). Correlations among survivors' variables are below the diagonal (shaded light gray), correlations among partners' variables are above the diagonal (shaded dark gray), and correlations between survivors' and partners' variables are in parentheses along the diagonal. Bottom panel: Means and SDs for survivors' and partners' variables are shown before and after the slash, respectively (i.e., survivor/partner). For Burst 1, all $r > .23$, $p < .05$. For Burst 2, all $r > .28$, $p < .05$. Burst 1 $N = 76$ couples. Burst 2 $N = 57$ couples. Correlations and mean differences between variables measured at burst 1 vs. burst 2 are not shown above but described in the main text.

than the consensus-recommended 7 hr for healthy adults [51]. To approximate the extent of clinical sleep disturbance (symptoms consistent with insomnia), we examined how many participants had difficulty falling/staying asleep (answering "yes" to sleep onset latency/wake after sleep onset) on ≥3 nights/week on average (diagnostic criterion for insomnia disorder; American Psychiatric Association et al., 2013). Thirteen percent of survivors and 10% of partners met this threshold for sleep onset latency; 62% and 54% for wake after sleep onset, respectively. Taken together, 10%–50% of the sample may have had clinically significant sleep disturbance *potentially* indicative of insomnia. Using an empirically supported cutoff of FCRI-Severity ≥13 [3], 20% of survivors and 18% of partners had clinical FCR. Of all sleep variables, only duration significantly differed between survivors and partners (*M* difference = 0.48 hr, $t(71) = 3.14$, $p = .002$), with survivors sleeping longer. FCR levels did not differ between survivors and partners (p's > .05).

Sleep Diary Burst 1 (Completion of Adjuvant Treatment)

Latent FCR measurement model

The measurement model specifying latent survivor and partner FCR factors had good fit [$\chi^2(5) = 10.78$, $p = .056$]. The three factor loadings were then constrained to be equal across survivors and partners but revealed somewhat poorer fit [$\Delta\chi^2(2) = 6.35$, $p = .042$]. A model with two of three loadings constrained (the exception being the CARS-Overall) had acceptable fit, supporting partial metric invariance [$\Delta\chi^2(1) = 3.81$, $p = .051$]. All standardized factor loadings were above 0.66 and statistically significant (p's < .001). Coefficient omega indicated strong internal consistency of the latent variables for survivors and partners (both $\omega = .90$). Survivor and partner factors were moderately positively correlated ($r = .30$, $p = .030$).

Full structural equation models

Across all four models, fit was similar after constraining actor and cross-partner effects to be equal for survivors and partners [sleep duration: $\Delta\chi^2(2) = 0.31$; subjective sleep quality: $\Delta\chi^2(2) = 2.43$; sleep onset latency: $\Delta\chi^2(2) = 2.26$; wake after sleep onset: $\Delta\chi^2(2) = 1.33$; all p's >.05]. These constraints were maintained in the final models, results of which are shown below and in Table 2. Sleep duration model fit was acceptable: $\chi^2(16) = 20.02$, $p = .219$; RMSEA = 0.01; CFI = 0.98; SRMR = 0.07. The actor effect—the effect of a participant's FCR on their *own* sleep duration—was significant and negative (unstandardized $b = -0.06$, $p = .001$): a one-unit increase in latent FCR (scaled to range ~1–20) was associated with about 4 min less sleep each night, corresponding to a moderate-sized effect

Table 2. Sleep Diary Burst 1: Results of Structural Regression of Survivor and Partner Average Daily Sleep Disturbance Outcomes on FCR Factors

Outcome/Effect	Estimate	*SE*	*p*	95% *CI*		Standardized β	
				Lower	Upper	Survivors	Partners
Sleep duration (hours)							
Actor effect	−0.064	0.019	.001	−0.100	−0.027	−0.343	−0.264
Cross-partner effect	−0.003	0.019	.882	−0.040	0.035	−0.015	−0.012
Subjective sleep quality							
Actor effect	−0.041	0.014	.004	−0.069	−0.013	−0.250	−0.285
Cross-partner effect	−0.051	0.015	.001	−0.080	−0.022	−0.239	−0.320
Sleep onset latency							
Actor effect	0.017	0.006	.003	0.006	0.029	0.305	0.295
Cross-partner effect	−0.002	0.006	.702	−0.013	0.009	−0.036	−0.039
Wake after sleep onset							
Actor effect	0.011	0.007	.123	−0.003	0.025	0.150	0.140
Cross-partner effect	0.009	0.007	.223	−0.005	0.023	0.116	0.113

FCR fear of recurrence. Because all actor and cross-partner effects were constrained to be equal across survivors and partners, a single set of effects is shown for each sleep outcome (note that the standardized estimates remain unique). $N = 76$ couples.

(β ≈ −0.30, see Table 2 for β's for survivors and partners). The cross-partner effect—the effect of a person's FCR on their partner's sleep duration—did not differ from zero.

Subjective sleep quality model fit was adequate: $\chi^2(16) = 30.93$, $p = 014$; RMSEA = 0.02; CFI = 0.95; SRMR = 0.08. The actor effect of FCR on subjective sleep quality was significant, negative, and moderately sized ($b = -0.04$, $p = .004$). A one-unit increase in FCR was associated with a 0.04-unit decrease in sleep quality each night on average. A one-standard deviation (*SD*) increase in FCR predicted about a 0.25-*SD* decrease in subjective sleep quality each night. Here, the cross-partner effect was significant and negative ($b = -0.05$, $p = .001$) and corresponded to a moderate-sized effect (β ≈ −0.28). Compared to participants partnered with someone with lower FCR, participants partnered with someone with higher FCR reported poorer sleep quality each morning on average (controlling for effects of their own FCR).

Sleep onset latency model fit was adequate: $\chi^2(16) = 23.27$, $p = .107$; RMSEA = 0.02; CFI = 0.97; SRMR = 0.09. There was a significant and positive effect of FCR on sleep onset latency ($b = 0.02$, $p = .003$), corresponding to a moderate-sized effect (β ≈ −.30). Participants with higher FCR had difficulty falling asleep a greater proportion of nights than participants with lower FCR. The cross-partner effect of FCR on sleep onset latency was not significant.

Wake after sleep onset model fit was acceptable: $\chi^2(16) = 22.47$, $p = .129$; RMSEA = 0.02; CFI = 0.97; SRMR = 0.08. Neither actor nor cross-partner effects were significant.

Sleep Diary Burst 2 (First Post-Treatment Mammogram)

Latent FCR measurement model

To start, the measurement model was examined in which the factor loadings for the latent FCR factors for survivors and partners were freely estimated [$\chi^2(8) = 5.38$, $p = .716$]. The three factor loadings were then constrained to be equal across survivors and partners [$\chi^2(10) = 7.48$, $p = .680$]. The deviances of the model with constrained factor loadings did not significantly differ from the model where loadings were unconstrained [$\Delta\chi^2(2) = 2.17$, $p = .338$], supporting partial metric invariance. All standardized factor loadings were above 0.65 and statistically significant (p's < .001). Omega revealed good reliability for both survivors (ω = .86) and partners (ω = .89). Survivor and partner factors were moderately positively correlated ($r = .33$, $p = .018$).

Full structural equation models

Results of the final models are shown in Table 3. For sleep duration, the survivor and partner actor effects were similar in magnitude and so were constrained to be equal. The fit of the constrained model was similar to that of the unconstrained model [$\Delta\chi^2(1) = 0.025$, $p = .874$] and model fit was adequate, $\chi^2(19) = 11.74$, $p = .896$; RMSEA = 0.00; CFI = 1.00; SRMR = 0.06. The actor effect was significant and negative ($b = -0.07$, $p = .004$). Specifically, participants with a one-unit greater latent FCR score slept an average of about 4 min less per night, which corresponds to a moderate-sized effect (β ≈ −0.30,

Table 3. Sleep Diary Burst 2: Structural Regression of Survivor and Partner Average Daily Sleep Disturbance Outcomes on FCR Factors

Outcome	Estimate	*SE*	*p*	95% CI		
				Lower	Upper	Standardized β
Survivors						
Sleep duration						
FCR actor effect	−0.072[b]	0.025	.004	−0.121	−0.024	−0.30
FCR cross-partner effect	0.036	0.034	.280	-0.030	0.103	0.15
Subjective sleep quality						
FCR actor effect	−0.103	0.023	<.001	−0.149	−0.057	−0.64
FCR cross-partner effect	0.020	0.022	.360	−0.023	0.062	0.12
Onset latency[a]						
FCR actor effect	0.139	0.112	.214	−0.080	0.359	0.24
FCR cross-partner effect	−0.025	0.098	.801	−0.217	0.167	−0.04
Wake after sleep onset[a]						
FCR actor effect	0.056	0.116	.629	−0.172	0.284	0.09
FCR cross-partner effect	0.068	0.102	.505	−0.132	0.269	0.11
Partners						
Sleep duration						
FCR actor effect	−0.072[b]	0.025	.004	−0.121	−0.024	−0.31
FCR cross-partner effect	−0.032	0.026	.207	−0.083	0.018	−0.14
Subjective sleep quality						
FCR actor effect	−0.017	0.027	.514	−0.070	0.035	−0.09
FCR cross-partner effect	−0.085	0.027	.001	−0.137	−0.033	−0.45
Onset latency[a]						
FCR actor effect	0.019	0.094	.843	−0.165	0.202	0.03
FCR cross-partner effect	0.230	0.100	.022	0.033	0.427	0.37
Wake after sleep onset[a]						
FCR actor effect	−0.002	0.094	.980	−0.187	0.182	−0.01
FCR cross-partner effect	0.099	0.123	.421	−0.143	0.341	0.14

FCR fear of recurrence.

[a]Binary outcome.

[b]Coefficients constrained to be equal for survivors and partners. $N = 57$ couples.

see Table 3 for β's for survivors and partners). None of the cross-partner effects of FCR on sleep duration were statistically significant.

When modeling subjective sleep quality, the survivor and partner actor and cross-partner effects were freely estimated. Model fit was adequate $\chi^2(18) = 14.71$, $p = .682$; RMSEA = 0.00; CFI = 1.00; SRMR = 0.06. FCR reported by survivors was significantly and negatively associated with their own sleep quality ($b = -0.10$, $p < .001$). A one-unit increase in survivor FCR was associated with a 0.10-unit decrease in their own subjective sleep quality each night. A one-*SD* increase in FCR predicted a −0.65-*SD* decrease in sleep quality each night on average, a moderate-to-large effect. Partners' FCR was not significantly associated with their own sleep quality. A significant ($b = -0.85$, $p = .001$) cross-partner effect emerged such that survivors' FCR was negatively associated with partners' sleep quality (controlling for effects of their own FCR). This cross-partner effect corresponds to a moderately-sized effect (β = −0.45). The association between partners' FCR and survivors' sleep quality was not statistically significant.

When modeling sleep onset latency, the actor and cross-partner effects for survivors and partners were left unconstrained. Model fit was adequate, $\chi^2(18) = 14.38$, $p = .704$.; RMSEA = 1.00; CFI = 1.00; SRMR = 0.06. There was a significant and positive cross-partner effect− survivors' FCR was associated with partners' sleep onset latency ($b = 0.23$, $p = .022$), a moderate-sized effect (β = 0.37). Survivors with higher FCR had partners who had difficulty falling asleep a greater proportion of nights than did survivors with lower FCR. Neither the actor effects nor links between partners' FCR and survivors' sleep onset latency were significant.

For wake after sleep onset, the actor and cross-partner effects for survivors and partners were freely estimated. Model fit was acceptable $\chi^2(18) = 24.76$, $p = .132$; RMSEA = 0.02; CFI = 0.95; SRMR = 0.08. There were no significant actor or cross-partner effects of FCR found.

Discussion

Despite reports of elevated FCR and sleep disturbance in cancer survivors, this is the first known study of links between FCR and *daily* reports of sleep disturbance in cancer survivors. Furthermore, no prior studies have examined these links in cancer survivors' intimate partners or the reciprocal effects of one partner's FCR on the other's sleep. The current study focused on two important periods during the first year of breast cancer survivorship: the completion of adjuvant treatment (typical onset of FCR) [40] and the first post-treatment mammogram (typical trigger of FCR) [41, 42, 46, 52]. Results from both periods supported the hypothesis that FCR may contribute to survivor and partner sleep disturbance.

In the first sleep diary burst, actor effects of FCR on sleep (i.e., effect of a person's FCR on their own sleep) were significant and in the expected direction for three of the four sleep outcomes (wake after sleep onset being the exception). There was also a significant cross-partner effect such that participants' FCR was associated with their partner's reduced sleep quality. For sleep diary burst 1, actor and cross-partner effects for survivors and partners did not differ.

Results from the second sleep diary burst, which overlapped with survivors' first post-treatment mammogram, also supported the hypothesis that FCR is associated with greater sleep disturbance. Survivors' FCR was significantly associated with their own reduced sleep duration and sleep quality. Partners' FCR was significantly associated with their own reduced sleep duration. There were also significant cross-partner effects, such that survivors' FCR was associated with partners' reduced sleep quality and greater sleep onset latency.

The standardized coefficients (see Tables 2 and 3) for the FCR-sleep links reported here were moderate to large in magnitude, highlighting the potential clinical significance of these findings. For example, among the most interesting findings, a four-unit increase in FCR—roughly equal to one *SD* in the FCRI-Severity scale—predicted about 15 min of sleep loss each night (1.75 hr less/week) and 17 min of sleep loss each night (~2 hr less/week) during sleep diary burst 1 and 2, respectively. Effects for survivors and partners did not differ.

Across both bursts, there were more robust actor than cross-partner effects, suggesting that the experience of FCR is more closely linked with one's own versus one's partner's compromised sleep. Among the four significant cross-partner effects observed, three were only found for partners, not survivors, such that survivors' FCR may have had a stronger impact on partners' sleep than vice versa. This pattern of results is somewhat inconsistent with a few prior studies that have shown significant cross-partner effects of psychological distress on sleep for both survivors and their partners [38, 39]. Although speculative, it is possible that while in the stressful cancer survivorship trajectory, partners may be more emotionally and physiologically responsive to the survivor's experience rather than vice versa. While beyond the scope of the current study, future research should examine potential mechanisms by which survivor FCR impacts partner sleep (and vice versa). Relationship functioning has been hypothesized as one such mechanism [38].

Of the four sleep outcomes examined, FCR was most consistently related to subjective sleep quality and these effect sizes were often large. For example, the model for sleep diary burst 2 predicted that survivors with a one-*SD* higher FCR score would have a 0.65-*SD* lower average daily sleep quality score. Poor perceived sleep quality is one of the main diagnostic criteria for insomnia [6]. Poor sleep quality can co-occur with other insomnia symptoms or be a standalone complaint, even among those reporting typical sleep duration [53]. Furthermore, sleep quality has a stable course [54] and is uniquely associated with important health outcomes, including cancer [55]. Therefore, each of the sleep outcomes examined here are independently clinically relevant for health.

Despite 62% of survivors reporting significant wake after sleep onset, no associations emerged between FCR and this dimension. Given the uniqueness of the sleep disturbance facets measured, it is possible that FCR impacts sleep duration, quality, and onset latency, but not wake after sleep onset. The wake after sleep onset item was binary and assessed whether or not participants unintentionally woke up in the middle of the night or early morning. This operationalization does not probe whether nocturnal awakenings were *prolonged* (difficulty falling back to sleep), which is an important feature of insomnia, particularly for older adults who experience increased awakenings as their sleep changes with age [56]. Therefore, it is also possible that this operationalization may have obscured relationships between FCR and wake after sleep onset because it is worry about recurrence during these awakenings that would be expected to result in *prolonged* awakenings and thereby, impaired sleep for this population. Future studies should explore other methods for brief, daily assessment of this aspect of sleep disturbance.

Taken together, the current findings highlight critical gaps in existing theoretical models of the antecedents and consequences of FCR, none of which have commented on the potential role of sleep. While a causal relation between

FCR and sleep disturbance cannot be ascertained from this observational study, results suggest that further attention to sleep's role in the etiology, maintenance, and/or consequences of FCR is warranted. The role of stressful life events and associated worry in insomnia is well-established [16–19]. Indeed, negative health-related events, including medical illness, are among the most common precipitating factors for insomnia [57]. Therefore, stressful cancer-related events such as the completion of adjuvant treatment and the first post-treatment mammogram and associated FCR (particularly pre- and mid-sleep) may result in acute sleep disturbance. This sleep disturbance may become chronic for those who begin to worry about sleep itself and/or develop wake-bed associations and maladaptive compensatory sleep behaviors. Therefore, this mechanism may in part explain the elevated insomnia rates in cancer survivors and partners compared to the general population. While this hypothesis is based on well-established theory and supported by empirical data pointing to similar mechanisms operating with other forms of psychological distress, it cannot be directly tested in the context of the current observational study.

Published FCR interventions trials have not monitored or targeted sleep disturbance [58]. Given the current findings, FCR interventions may provide an opportunity to address sleep disturbance in this population known to be at elevated risk for insomnia, thereby also offering short- and long-term health benefits. Given the current evidence for cross-partner effects, *couple*-focused interventions for FCR should be considered. To the authors' knowledge, neither couple- nor partner-focused interventions of FCR have been developed or tested.

Limitations of this study may inform future work on FCR and sleep. As previously mentioned, sleep disturbance is more prevalent in breast cancer than other cancers and this effect is not fully explained by gender [8]. Menopausal vasomotor symptoms (e.g., hot flashes) resulting from adjuvant treatment and/or the discontinuation of hormone replacement therapy may be unique contributors for this population [59–61]. Nevertheless, treatment side effects are also implicated theoretically as antecedents and consequences of FCR [5]. Survivors may erroneously interpret somatic symptoms as evidence of their cancer recurring, triggering FCR. Conversely, survivors with elevated FCR may become hypervigilant, excessively checking for and becoming preoccupied with somatic symptoms. Given the role of somatic symptoms in FCR, removing the variance associated with side effects may inadvertently remove part of the phenomenon of interest [62]; therefore, treatment side effects were not covariates in this study.

Additionally, due the observational nature of this study, the direction of effects cannot be determined. Thus, it is possible that, contrary to hypotheses, sleep disturbance causally influences FCR and future research should examine these within-person links. Like other studies of *couples* (vs. patient-only) coping with cancer, the response rate for the parent study was modest. This response rate is reflective of two challenges unique to studies of couples coping with cancer: couples were lost if either partner was unwilling to participate (indeed one of the most frequent reasons for declining) and indirect recruitment of partners—researchers were initially unable to contact partners directly [63]. Therefore, the modestly sized sample, which was also homogeneous regarding sociodemographic characteristics, limits generalizability and the ability to detect smaller effects. Future studies should attempt to recruit not only larger but also more diverse or distressed samples. Finally, sleep was measured via self-report. Future work should replicate and extend these results using well-powered designs with objective measures of sleep (e.g., actigraphy or polysomnography).

In conclusion, relationships between FCR and sleep are a critical gap in theoretical models and interventions for FCR. The present findings indicate that FCR experienced by both early-stage breast cancer survivors and their intimate partners is associated with their own as well as their partner's sleep disturbance. These links highlight the need for more research on FCR and other health-related behaviors (e.g., adherence to adjuvant hormone therapy, physical activity) that are modifiable and have known associations with health and mortality. Such research could inform interventions for improving FCR and thereby health outcomes for the growing population of breast cancer survivors and their partners.

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Compliance with Ethical Standards

Authors' Statement of Conflict of Interest and Adherence to Ethical Standards Authors Christine Perndorfer, Emily C. Soriano, Scott D. Siegel, Rebecca M. C. Spencer, Amy K. Otto, and Jean-Philippe Laurenceau declare that they have no conflict of interest.

Ethical Approval 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.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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