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Sexual Intimacy in Couples is Associated with Longer Telomere Length

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Abstract

High-quality relationships have been shown to be beneficial for physical and mental health. This study examined overall relationship satisfaction and perceived stress as well as daily reports of partner support, partner conflict, and physical intimacy obtained over the course of one week in a sample of 129 high and low stress mothers. Telomere length was examined in whole blood, as well as the two cell subpopulations: peripheral blood mononuclear cells (PBMCs) and granulocytes. Telomerase activity was measured in PBMCs. Analyses revealed no statistically significant associations of telomere length with current relationship satisfaction, daily support or conflict, or perceived stress. In contrast, women who reported any sexual intimacy during the course of the week had significantly longer telomeres measured in whole blood and PBMCs, but not in granulocytes. These relationships held covarying for age, body mass index, perceived stress, the relationship indices, and caregiver status. Sexual intimacy was not significantly related to PBMC telomerase activity. These data provide preliminary data that sexual intimacy is associated with longer telomere length. Future studies investigating these associations are warranted.

Keywords

Intimacy; Sexual relationships; Telomere length; Health; Couples

1. Introduction

High-quality intimate relationships are good for health. A recent meta-analysis found that better physical functioning and longevity is present in adults who report greater relationship quality (Robles et al., 2014). Research further suggests that social support from high-quality relationships may be the protective mechanism against mortality (Holt-Lunstad et al., 2010). Similarly, frequency of sexual intimacy for individuals in relationships has been linked to greater mental and physical health outcomes, such as more general happiness and greater life satisfaction (Muise et al., 2016), greater heart variability (Costa & Brody, 2012), lower daily somatic symptoms (Stadler et al., 2012), reduced daily diurnal cortisol (Ditzen et al.,

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2008), and a more robust immune response (Charnetski & Brennan, 2004). However, to date, no studies have examined biomarkers of long-term health status such as telomere length. Telomere length indicates the replicative potential of the immune system and has emerged as a robust marker for risk of diseases of aging (Blackburn, Epel, & Lin, 2016).

1.1. Telomere Length and relationships

Telomeres are repeated nucleoprotein sequences (TTAGGG) that provide protection against replication and degradation in DNA material by stabilizing the ends of chromosomes (Chan & Blackburn, 2004). Through normative chronological aging, repeated cellular replication, and/or pervasive exposure to stress, telomere length decreases, producing cellular apoptosis or physiological senescence in the organism (Franceschi et al., 2000). In order to combat these decreases in telomere length, cells produce the enzyme telomerase (Chan & Blackburn, 2004), which maintains the telomere by adding nucleoprotein sequences to telomeres (Blackburn, 2005). Shorter telomere length prospectively predicts early morbidity (Brouilette et al., 2007; Demissie et al., 2006) and mortality (Cawthon et al., 2003).

Social support and positive relationships may slow the rate of telomere attrition; however, this has been rarely studied. Preliminary evidence suggests that higher social support is associated with longer telomere length in a sample of older adults (Carroll et al, 2013). Additionally, ambivalent relationships, characterized by both high positivity and high negativity, have been related to shorter telomere length (Uchino et al., 2012). This may suggest that one way in which lower-quality relationships affect health is through an influence on telomeres. Partner status is also associated with telomere length (Mainous et al., 2011; Yen et al., 2013). Compared to married/never married individuals, divorced/separated individuals show shorter telomeres, when controlling for sociodemographic and health confounds (Whisman et al., 2016). Lastly, no studies have examined associations between romantic relationships with telomerase activity.

1.2. Current Study

The present study was a preliminary examination to ascertain whether relationship quality indices (satisfaction, weekly interactions) and sexual intimacy were associated with telomere length and telomerase activity in a sample of healthy high and low stress mothers. Based on the previous literature, we hypothesized that greater relationship quality and the presence of sexual intimacy would be associated with longer telomere length and lower telomerase activity.

2. Method

2.1. Participants and Procedure

The present sample was a subset derived from the Stress, Aging, and Emotions (SAGE) study, which was designed to longitudinally investigate parental stress in women raising children with autism spectrum disorder and women raising neurotypical children. For detailed information on this sample, see Prather et al., 2015. Analyses were performed on 129 heterosexual women who were currently in a relationship (married/partnered) and had available data on telomere length. Study participants were recruited via social and print

media within the San Francisco Bay area. In order to participate, women had to be between the ages of 20 and 50 years with at least one child between 2 and 16 years old. Women classified as *high-stress maternal caregivers* had a child diagnosed with an autism spectrum disorder and reported a score of >13 on the Perceived Stress Scale (PSS; Cohen & Williamson, 1988). *Low-Stress Maternal caregivers* were caregivers of a neurotypical child and scored <19 on the PSS. Participants were premenopausal and healthy, reporting no current or history of major physical or mental disease.

Data collection was approved by the UCSF Institutional Review Board and informed consent was obtained from all participants. Data from the larger study were collected over 4 study time points (baseline, +9 months, +18 months, and +24 months); however, this analysis focuses exclusively on data from the +18 month time point as it included data on relationship quality, recent sexual intimacy, and concurrent measures of telomere length and telomerase activity. For one week during the +18 month survey period, women were instructed to complete morning and nightly diaries pertaining to stress, their health (e.g., health behaviors, presence of illness symptom), and relationship (positive and negative partner interactions). Sexual intimacy data were collected through a morning diary where women were asked to indicate if they were sexually intimate the night before. At the midpoint of this diary collection period, participants came to clinic to complete psychosocial questionnaires and undergo fasting blood draw, which was used to measure telomere length and telomerase activity.

The data were screened for missingness prior to analysis (Schlomer et al., 2010). There were eleven missing cases for whole blood telomere length. The other telomere outcomes (PBMC, granulocyte, and telomerase activity) all were missing one case. Missing cases on predictors ranged from 6 cases for negative partner interactions to 1 for sexual intimacy. We did not detect any significant differences between the missing and non-missing groups.

2.2. Measures

2.2.1. Relationship Quality—Relationship quality was assessed through two measures: (1) an average relationship adjustment score on the Dyadic Adjustment Scale (Spainer, 1976; Busby et al., 1995) and (2) a weekly aggregate of reported positive and negative partner interactions from the nightly diary questionnaire created for the study. The dyadic adjustment scale (α = .88) is a 14-item short-form scale that indexes the level of relationship functioning and adjustment between romantic couples. The negative partner (α = .87; 6 items) and positive partner interaction (α = .70; 3 items) subscales assessed the women's positive and negative interactions with their partner for the day. Example items include "To what extent were you satisfied with your partner today" and "to what extent did you experience tension with your partner today?" The response range for both subscales was from 0 (not at all) to 100 (a lot).

2.2.2. Sexual Intimacy—Sexual intimacy data were collected through the morning diary. Every morning participants were asked to answer the following question, "Did you have sexual relations last night?" indicating whether or not they had been sexually intimate with their partner the night prior. Reports were aggregated over the week and dichotomized as 0

for no reported sexual activity in the week (N=81) and 1 for any sexual activity (N=47) as recommended when there is limited variability in frequency of positive responses (MacCallum et al., 2002).

2.2.3. Perceived Stress—The 10-item version of the Perceived Stress Scale (α = .87; Cohen & Williamson, 1998) was administered to assess feelings of being overwhelmed, anxious, stressed, and not in control experienced over the previous month. An example item from the scale was “How often have you felt nervous or stressed?” Participants rated the frequency of their experiences on a 5-point scale, from 0 (Never) to 4 (Very Often). The items were averaged to yield a mean score.

2.2.4. Telomere Length and Telomerase Activity—Telomere length was quantified in whole blood, peripheral blood mononuclear cells (PBMCs), and granulocytes at the UCSF Blackburn Laboratory. PBMCs were isolated from whole blood by Ficoll Hypaque density gradient centrifugation within 6h of blood drawing, cryopreserved in liquid nitrogen, and stored at −80°C until assay. DNA was purified in batches using the QIAamp® DNA Mini Kit (QIAGEN, Hilden, Germany, Cat. Number 51104). Quantitative PCR procedures outlined by Cawthon (2002) were used to assay telomere length. Eight DNA samples were included in each run to control for interassay variability. A normalizing factor was computed for each batch by dividing the T/S ratio for each control DNA by the mean T/S for the same DNA at 10 runs. A mean normalizing factor was computed for the 8 samples as a correction and used to get the final T/S ratio, which was measured twice. If the duplicate T/S value varied by >7% than the initial value, an extra sample was run and the closest values reported. Granuolcytes were processed following Ficoll processing of PBMCs and the red blood granuloctye pellet mixed with 3 volumes of ACK lysis buffer (QIAGEN, cat #158902) to lyse the red blood cells. The pellet was then incubated at room temperature for 10 min with inversion every 2 min. Cells were rinsed in PBS twice, pelleted, and stored at −80°C until telomere length quantification. Finally, PBMC telomerase activity was processed with a commercial kit produced by Trapeze, Chemicon. Telomerase repeat amplification protocol described by Kim and Wu (1997) was used to obtain quantitative values for telomerase activity. There was no skew or kurtosis on the outcomes except telomerase activity. Telomerase activity was natural log-transformed to induce normality as commonly seen with this measure.

2.2.5. Covariates—The statistical models included confounders previously associated with telomere length, such as baseline measures of chronological age (in years), body mass index, caregiver status (0, low-stress caregiver; 1, high-stress caregiver), and perceived stress. We additionally included nightly diary week-summations of health behaviors (e.g., opportunities to be physically active, eat healthy, and take time for one’s self) and presence of illness symptoms (e.g., body/joint pain, headache, stomachache, and nausea) as potential confounders of sexual intimacy.

2.3. Statistical Analyses

Analyses were performed in SAS 9.3. Bivariate correlations between study variables and telomere length were examined. Next, multiple regression analyses were performed to

examine whether relationship quality and sexual intimacy predicted telomere length and PBMC telomerase activity. Two regression models were computed for each predictor and outcome. The first model was designed to account for basic demographic and health covariates consistently associated with telomere length and may potentially confound with sexual intimacy; Model 1 included age, BMI, weekly health behaviors, illness symptoms, and caregiver status. The second model included covariates from Model 1 as well as an additional adjustment for perceived stress; prior studies indicate that perceived stress is a significant predictor of telomere length irrespective of caregiver status (e.g., Epel et al., 2004). To determine whether our measures of relationship quality and sexual intimacy were independent predictors of telomere length and telomerase activity, we computed additional models that simultaneously included measures of relationship quality and sexual intimacy, along with all model 2 covariates. In order to account for multicollinearity, Variance Inflation Ratio (>10) and Tolerance (<1) were inspected for the individual models and failed to detect multicollinearity. Statistical significance was denoted by $p < .05$. Multiple regression models were computed in Proc Calis, to handle missing data through Full Information Maximum Likelihood (FIML) estimation modeling (Enders, 2006; Schlomer et al., 2010).

3. Results

Table 1 presents demographic information and predictor means and standard deviations for women who participated in the study. Of the 129 participants (aged 28 to 51; $M = 42.26$, $SD = 4.83$), 78.1 % were Caucasian, and 88.4% were college-educated. Table 2 displays bivariate correlations between the predictors, covariates, and outcomes. Higher levels of dyadic adjustment were associated with increased positive partner interactions ($r = .62$) and decreased negative partner interactions ($r = -.56$). There was a negative association between positive and negative partner interactions across the week ($r = -.75$). Measures of telomere length were highly correlated (r range = .66 to .77). Telomerase activity measured in PBMCs was not significantly correlated with the telomere length measures. Table 3 displays the partial correlations between our predictor variables and telomere and telomerase activity, accounting for age. In this regard, measures of relationship quality were largely unrelated to telomere length and telomerase activity in study participants. However, recent sexual intimacy was significantly associated with longer telomere length in whole blood ($r = .21$, $p = .03$) and PBMCs ($r = .30$, $p = .001$) but not granulocytes($r = .10$, $p = .31$) or with telomerase activity ($r = -.14$, $p = .13$).

In multivariate analyses, reports of sexual intimacy continued to be associated with longer telomere length in whole blood and PBMCs, adjusting for age, BMI, caregiver status, weekly health behaviors, and weekly presence of illness symptoms, and perceived stress. Furthermore, these associations remained significant after including indices of relationship quality (relationship satisfaction and negative partner interactions), shown in Table 4. Surprisingly, parameter estimates for sexual intimacy varied very little between models 1, 2 and 3 with the inclusion of other covariates. Models substituting positive partner interactions in place of negative partner interactions yielded similar results (data not shown). In contrast, our measures of relationship satisfaction were not statistically related to telomere length.

Please see supplemental Table S1 for parameter estimates for all predictors and covariates in models 3 for all outcomes.

4. Discussion

Telomere length tends to be shorter with chronic stress and longer with positive health behaviors. Few studies have examined social relationships and intimacy with telomere length. Here, indices of relationship quality relationship satisfaction and positive and negative partner interactions and sexual intimacy were examined for their associations with telomere length and telomerase activity in healthy women. Results showed no significant association between relationship satisfaction and partner interactions with telomere length or telomerase activity; however, recent sexual intimacy was positively associated with whole blood and PBMC telomere length, remaining significant when controlling for perceived stress and health characteristics. Consistent with past findings, our results suggest positive relationships confer a beneficial effect on health.

The mechanisms through which physical intimacy benefits health are unknown. It may deliver these benefits by previously observed effects of dampening stress response, such as decreasing daily salivary cortisol, and buffering against workplace stressors (Ditzen et al., 2008). Humans are social animals oriented toward fostering and maintaining bonds with other individuals, particularly romantic partners for survival and reproduction (Baumeister & Leary, 1995). Pair-bond maintenance within romantic relationships requires interpersonal cooperation and satisfaction, but may include sexual intimacy to evoke physiological changes that facilitate romantic attachment and pair-bonding (Fletcher et al., 2015). Experimental evidence suggests neuroendocrine and immune changes following sexual activities. Arousal and post-masturbatory orgasm in men increased proliferation of select natural killer cells associated with innate immune response (CD3 CD16+CD56+; Haake et al., 2004). Over time, the dynamics and processes within relationships and its underlying physiological consequences may positively or negatively impact long-term health (Farrell & Simpson, 2017).

Oxytocin-release following sexual intimacy may be another potential mechanism of health maintenance in sexually-active and partnered women. The neuropeptide hormone oxytocin has been documented to modulate social behaviors between romantic partners and between parents and their children by facilitating bonding and other vital maternal behaviors like lactation (Campbell, 2008). Sexually intimate behaviors and orgasm elicit increases in oxytocin (Coria-Avila et al., 2016; Light et al., 2005; Robinson, 2015) that potentially foster a cycle of social bonding via encoding of positive interactions (e.g., Guastella et al., 2008). Mechanistically, oxytocin's neurophysiological role in sexual intimacy is plausible. Evidence in lactating mothers suggests that increases in oxytocin primed by attachment thoughts decreases cortisol (Krause et al., 2016). Similar mechanisms should exist in women for romantic partners. Partnered women with lower circulating baseline oxytocin had *higher* systolic and diastolic blood pressure compared to partnered women with high circulating baseline oxytocin (Light et al., 2005). These findings suggest that oxytocin plays a transactional role with other key markers of the autonomic nervous system (Carter, 2014).Another consideration (see below) is that sexual intimacy is an indicator of overall

general health. Cardiometabolic risk factors implicated in health deterioration and death have also been associated with sexual dysfunction in women (Martelli et al., 2012; Ponholzer et al., 2008). Limited blood flow or vascular damage resulting from cardiovascular disease (Hill et al., 2003) or other ailments (e.g., diabetes) impedes sexual function in men (Foresta et al., 2005); it is possible that diminished sexual intimacy in women, as in men, may signify a systemic problem.

While these findings are intriguing, several questions remain. First, given the large literature on relationships and health, why was relationship quality unrelated to telomere length? This was surprising since relationship quality is an important factor in daily life and tends to correlate to intimacy. Larger studies have found small, significant effect sizes between sexual intimacy and relationship quality (Muise et al, 2016; McFarland, 2011). These associations may have missed significance given our small sample. Next, the dyadic adjustment scale is reliable, well-validated, and generalizable (Graham et al., 2006), but associations have been inconsistent with indices of physical health (Robles et al., 2014). Non-association between relationship quality and our markers of health may also be conceptual. Uchino and colleagues (2001; 2007) posit that aspects of positive and negative relationship functioning must be concurrently and separately examined. Shortened telomere length has indeed been found in women reporting ambivalent relationships characterized by high positivity and high negativity but not when positivity and negativity were examined separately (Uchino et al., 2012). Relationship ambivalence measures were not included and, hence, this question could not be examined. Relatedly, future research should incorporate a validated measure of sexual satisfaction when investigating the role of sexual intimacy on aging markers. Although measured prospectively, sexual intimacy was dichotomized given its limited variability in reported frequency (McCallum et al., 2002), disallowing use of advanced statistics such as multilevel modeling to test the incremental effects of sexual intimacy on markers of aging. Despite dichotomization, the measure was robust to covariates and results converged with prior research using more advanced modes of measurement and statistics. Prevalence of sexual intimacy (37%) also appears to be slightly lower than previous research using larger samples have reported (Call et al., 1995; Schneidewind-Skibbe et al., 2008).Our caregiver sample may report decreased sexual intimacy, given their parental responsibilities. Sexual intimacy may also be underestimated compared to other survey methods that use retrospective measures reporting a longer duration of time. Although unlikely, the possibility must be entertained that telomere length reflects underlying aspects of robust health, influencing sexual activity. If this is the case, our results may suggest that sexually active women may have inherent social and physical characteristics that differ than non-sexually active adults. This difference may be further amplified should these women select romantic partners with concordant characteristics as them (Meyler et al., 2007).

We must also consider the impact of the non-significant findings of sexual intimacy on telomerase activity measured in PBMCs. In general, associations are more reliably seen between psychosocial processes and telomere length than is the case with telomerase activity (Lin et al., 2010). It is much more difficult to accurately measure telomerase, and as such, many fewer studies have examined the links between telomerase activity and psychosocial processes. There is also evidence that telomerase activity is much more dynamic than

telomere length. For instance, it has been found that telomerase activity can be modulated by acute psychological stress (Epel et al., 2010). It is very plausible the lack of an association between sexual intimacy and telomerase activity is a consequence of these dynamics and the fact that we relied on weekly averages. Future studies measuring variables in closer temporal proximity will help clarify these associations.

Secondly, why did different patterns emerge when comparing PBMCs vs. granulocytes? Few studies have separately examined PBMC and granulocyte telomere length; however, many differences exist between these two cell type lineages that suggest different patterns of associations. PBMCs circulate in blood from years to decades, possibly reflecting a history of accumulated environmental exposures and immune function (shortening with repeated virus exposures and biochemical stressors such as inflammation, oxidative stress, and stress hormones). Circulating granulocytes, on the other hand, live only a few days and more directly reflect the health of bone marrow stem cells. Future research should continue to disentangle telomere length across different cell types to further examine the impact of psychosocial stressors on these different systems. While differential effects may exist across these systems, there is a relatively high degree of synchrony across telomere cell types (Kimura et al., 2010) and tissues (Daniali et al., 2013), suggesting an overall somatic coherence to environmental perturbations.

The generalizability of these findings is unclear. The sample was composed of educated, healthy women with children. Thus it is important to note that our sample may not fully generalize toward other populations; however, this is an important preliminary finding. Future research should consider examining the association between sexual intimacy in committed relationships and biological indices markers of health and aging in lower SES and racial/ethnic minority samples. While our analyses revealed non-significant associations between relationship functioning and sexual intimacy, future research should consider the impact of short-term or uncommitted sex on health. The context of high relationship satisfaction, coupled with sexual intimacy, may produce a physiological milieu that bolsters health.

In summary, the present results provide novel evidence that sexual intimacy within the context of long-term relationship provides health-enhancing benefits, as indexed by whole blood and PBMC telomere length.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Highlights

- High-quality relationships are beneficial for physical and mental health
- Frequency of sex has also been linked to greater mental and physical health
- Sexual intimacy was associated with longer telomere length in whole blood and PBMCs
- Sexual intimacy was not associated with granulocyte telomere length and telomerase

Table 1

Sociodemographic Characteristics.

	Total Sample
Sage Grouping, *%*	
Low-Stressed Caregivers	55.04
High-Stressed Caregivers	44.96
Baseline Age (in years), *M (SD)*	42.26(4.83)
Race, %	
White	78.13
Black	4.69
Asian	9.38
Latino	7.03
Native American	0.78
Baseline Body Mass Index, *M (SD)*	24.98(4.78)
Education, %	
High School	2.33
Some College	9.30
College+	88.37
Health Behavior, *M (SD)*	12.60(3.75)
Illness Symptomology, *M (SD)*	3.13(3.01)
Perceived Stress Scale, *M (SD)*	1.79(0.54)
Relationship satisfaction, *M (SD)*	3.33(0.61)
Positive Partner interactions, *M (SD)*	67.43(13.83)
Negative Partner interactions, *M (SD)*	20.29(12.62)
Recent Sexual Intimacy, %	
No	63.28
Yes	36.72

Table 2

Bivariate Correlations between Predictors, Covariates, and Outcomes.

	1	2	3	4	5	6	7	8	9	10	11
1. Health behavior	--										
2. Illness Symptomology	0.01	--									
3. Perceived Stress	-0.08	0.16†	--								
4. Relationship satisfaction	−0.02	−0.03	**– 0.43*****	--							
5. Positive Partner interactions	0.02	−0.16†	**−0.27****	**0.62*****	--						
6. Negative Partner interactions	− 0.08	0.11	**0.47*****	**−0.56*****	**−0.75*****	--					
7. Sexual Intimacy	0.09	−0.15†	−0.07	0.08	0.13	−0.10	--				
8. Whole Blood Telomere Length	−0.10	**−0.19***	−0.02	0.13	0.15	0.01	**0.21***	--			
9. PBMC Telomere Length	−0.07	**−0.23***	−0.05	0.11	0.16†	−0.05	**0.28*****	**0.74*****	--		
10. Granulocyte Telomere Length	−0.13	**−0.18***	−0.00	−0.03	0.06	0.07	0.07	**0.77*****	**0.66*****	--	
11. Telomerase Activity	0.03	0.14	**−0.18***	**0.19***	0.12	**−0.20***	−0.11	−0.05	−0.06	−0.16†	--

$^{\dagger}p < .10$;

$^{*}p < .05$;

$^{**}p < .01$;

$^{***}p < .001$;

Significant associations are bolded. Note: Telomerase activity is log-transformed.

Table 3

Partial correlations between Predictors/Covariates and the Outcome Variables, covarying for age.

	Whole Blood Telomere Length	PBMC Telomere Length	Granulocyte Telomere Length	Telomerase Activity
Health Behavior	−0.11	−0.09	−0.07	−0.03
Illness Symptomology	−0.18†	**−0.21***	−0.13	0.11
Perceived Stress	−0.03	0.01	0.01	−0.17†
Relationship satisfaction	0.15	0.06	0.01	0.18†
Positive Partner interactions	0.11	0.13	0.02	0.11
Negative Partner interactions	0.02	−0.04	0.11	**−0.19***
Sexual Intimacy	**0.21***	**0.30****	0.10	−0.14

† $p < .10$;

* $p < .05$;

** $p < .01$;

*** $p < .001$;

Significant associations are bolded. Note: Telomerase activity is log-transformed.

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Table 4

Multiple Regression Analyses predicting Telomere Length and Telomerase Activity from Relationship Quality and Recent Sexual Intimacy, Unstandardized Coefficients derived from Full Information Maximum Likelihood Estimations.

	Dyadic Adjustment		**Negative Partner**		**Sexual Intimacy**	
	B	**SE**	**B**	**SE**	**B**	**SE**
Whole Blood (Final Model N =112)						
Model 1	--	--	--	--	**0.065** *	0.027
Model 2	--	--	--	--	**0.065** *	0.027
Model 3	0.044	0.027	0.002	0.001	**0.065** *	0.027
PBMC (Final Model N = 122)						
Model 1	--	--	--	--	**0.096** **	0.031
Model 2	--	--	--	--	**0.096** **	0.031
Model 3	0.019	0.030	0.000	0.002	**0.094** **	0.031
Granulocyte (Final Model N = 122)						
Model 1	--	--	--	--	0.022	0.026
Model 2	--	--	--	--	0.022	0.026
Model 3	0.001	0.026	0.001	0.001	0.024	0.026
Telomerase Activity (Final Model N = 122)						
Model 1	--	--	--	--	−0.213	0.142
Model 2	--	--	--	--	−0.207	0.141
Model 3	0.096	0.138	−0.008	0.007	−0.227 †	0.139

† <.10;

* <.05;

** <.01;

Significant associations are bolded.

Model 1: Sexual Intimacy + caregiver status + Age + Body Mass Index + Health Behaviors + Illness Symptomology;

Model 2: Model 1 covariates + Sexual Intimacy + Perceived Stress;

Model 3: Model 2 covariates + Sexual Intimacy + Dyadic Adjustment + Negative Partner interaction.