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ARTICLE

The interplay between relationship effectiveness, life stress, and sleep: A prospective study

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Research has shown that greater stress responses predict worse sleep and that the quality of one's current romantic relationship predicts one's sleep. Despite these established links, research has not examined connections between *ongoing patterns* of interpersonal experiences and competencies (relationship effectiveness) and stress exposure on sleep. Participants in the Minnesota Longitudinal Study of Risk and Adaptation (MLSRA) completed measures assessing relationship effectiveness and stress exposure at ages 23 and 32 years, as well as sleep quality/duration at age 37 years. Analyses demonstrate that relationship effectiveness at age 23 years positively predicts sleep quality—but not sleep duration—at age 37 years via reduced stress exposure at age 32 years. These findings highlight the effects of relationship effectiveness and stress exposure across early to middle adulthood on sleep.

KEYWORDS
close relationships, relationship effectiveness, sleep, stress exposure

1 | INTRODUCTION

Over the past several decades, research has confirmed that people who have higher-quality relationships with their friends, family, and romantic partners tend to have better health outcomes (e.g., Burman & Margolin, 1992; Holt-Lunstad, Smith, & Layton, 2010; Rendall, Weden, Favreault, & Waldron, 2011). Despite these well-established links between relationships and health, less is known about the behavioral mechanisms that account for these associations (Pietromonaco & Collins, 2017). Exactly how do close relationships affect ongoing health behaviors that underlie important long-term health outcomes?

Sleep outcomes, such as sleep duration and quality, are a potential behavioral mechanism linking romantic relationships with health (Troxel, 2010). *Sleep duration* reflects the amount of time a person spends asleep, whereas *sleep quality* reflects the continuity, sleep architecture, daytime behavior (e.g., napping), and subjective perceptions of how well one sleeps (Blunden & Galland, 2014). Given that adults typically share sleeping environments with their romantic partners (National Sleep Foundation, 2013) and given the centrality of romantic relationships in most people's lives, the patterns of behavior and experiences that characterize one's current and past romantic relationships may affect the prevalence of conditions that undermine better sleep.

Stress—which encompasses both exposure to environmental challenges (i.e., *stress exposure*) and one's psychological and physiological reactions to these challenges (i.e., *stress response*; Harkness & Monroe, 2016)—has been shown to be a precipitating factor of poor sleep quality and duration. In order to get sufficient sleep, people need the opportunity to sleep and must reduce vigilance to potential threats in their environment (Dahl, 1996). Stress exposure affects both of these preconditions as it precedes and promotes stress responses and reduces opportunities for sleep. For example, someone who has to work an extra job to stay afloat financially is not only grappling with financial stress but also has fewer hours available to sleep.

Although research has examined whether exposure to stressful events specific to one's relationship (e.g., divorce) predicts sleep outcomes (Cartwright & Wood, 1991), no research was found examining whether features of romantic relationships predict exposure to stressful life events *outside* of these relationships. Furthermore, although people who are involved in higher-quality relationships report better sleep outcomes compared to those in poorer-quality relationships (e.g., Troxel, 2010; Troxel, Robles, Hall, & Buysse, 2007), no research has examined whether relationship-relevant characteristics, perceptions, and behavioral tendencies *over time and across different relationships* predict sleep quality and/or duration.

The current research builds on a model delineating pathways linking relationships and sleep outcomes proposed by Troxel et al. (2007) and examines whether stressful life events operate as a mediating variable in the pathway from relationships to sleep. Specifically, the current model (see Figure 1) posits that people who are high in a global measure of relationship competence,

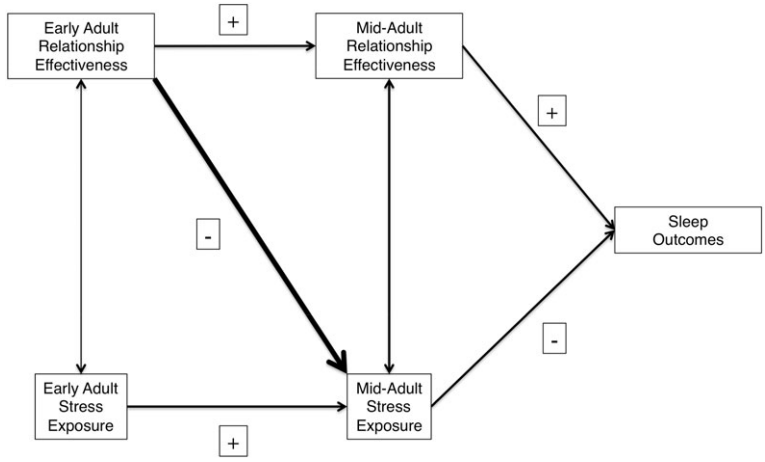

FIGURE 1 Stress exposure reduction model of relationship effectiveness and sleep. Better early adult relationship effectiveness predicts less exposure to severely disruptive stressful events, which predicts better sleep outcomes. The "+" signs are indicative of a positive relationship between the two linked constructs and the "−" signs are indicative of a negative relationship between the two linked constructs

engagement, and positive relationship experiences—relationship effectiveness—are less likely to be exposed to and/or experience severe disruptions in response to stressful events compared to people low in relationship effectiveness, which promotes better sleep quality and/or longer sleep duration over time. To test this model, we leverage a longitudinal sample of people born below the poverty line—a sample that may be especially sensitive to the negative consequences of stress exposure on sleep (Tomfohr, Ancoli-Israel, & Dimsdale, 2010).

1.1 | Stress and sleep

Greater stress exposure has negative implications for sleep outcomes because stress activates physiological (Hermans, Henckens, Joëls, & Fernández, 2014) and psychological (Harvey, Jones, & Schmidt, 2003) arousal, hampering high-quality sleep of sufficient duration. *Stress exposure* involves not only the occurrence of stressful life events but also the severity of disruption caused by these events (Harkness & Monroe, 2016). Exposure to laboratory stressors prior to sleep, such as engaging in a stressful task (Chen, Jarrin, Ivers, & Morin, 2017) or anticipating giving a speech (Germain, Buysse, Ombao, Kupfer, & Hall, 2003), predicts lower sleep efficiency, delayed sleep onset, and more frequent nighttime awakenings. Cross-sectional studies have also confirmed that exposure to more stressful everyday hassles (Benham, 2010) and stressful life events (Drake, Pillai, & Roth, 2014) are associated with sleep impairments (e.g., worse subjective sleep quality, higher risk for insomnia).

1.2 | Romantic relationships and sleep

Whereas stress evokes physiological and psychological arousal that can hinder sleep, cues of social belongingness and emotional security can facilitate a sense of protection that downregulates stress reactivity and promotes better sleep (Dahl & Lewin, 2002). Given that romantic relationships are an especially potent source of social belongingness and emotional security in adulthood (Mikulincer & Shaver, 2016), one's experiences, tendencies, and engagement in his or her romantic relationships should have a particularly strong impact on sleep patterns. In other words, people who have a history of engagement in high-quality relationships that can promote social belongingness and emotional security should get better sleep. Although no research to date has tested whether patterns of experiences and behaviors across relationships predict sleep, a sizable body of research has shown that positive aspects of current romantic relationships—such as greater daily self-disclosure (Kane, Slatcher, Reynolds, Repetti, & Robles, 2014), greater perceptions of partner responsiveness (Selcuk, Stanton, Slatcher, & Ong, 2016), greater marital harmony (Prigerson, Maciejewski, & Rosenheck, 1999), and increases in marital quality over time (Lee, Chopik, & Schiamberg, 2017)—all predict better sleep quality and/or duration. Conversely, greater relationship conflict is associated with poorer sleep quality (Hicks & Diamond, 2011), shorter sleep duration (for women), and difficulties falling asleep (El-Sheikh, Kelly, & Rauer, 2013). Partners' hostile behaviors during conflict interactions also predict worse objective sleep quality (Fillo et al., 2017). Finally, changes in relationship status are also associated with sleep, such that women who remain involved in the same marital relationship for several years report comparatively better subjective sleep quality (Troxel et al., 2010).

This growing literature supports the prediction that, *over time*, people involved in high-quality, more stable relationships should experience better sleep outcomes than those involved in low-quality, less stable relationships. Yet prior research on relationships and sleep has focused on either one-time assessments within a current relationship (e.g., conflict behaviors in a relationship; Fillo et al., 2017) or over-time assessments of a single relationship construct (e.g., changes in relationship status; Troxel

et al., 2010). One possibility, therefore, is that associations between relationships and sleep may partly reflect *ongoing patterns* of relationship experiences and individual competencies rather than solely reflecting the nature and qualities of one's current relationship. Moreover, people who possess characteristics that allow them to form and maintain higher-quality relationships (i.e., relationships characterized by higher levels of trust, harmony, stability, etc.) are likely to feel greater belongingness and emotional security that may facilitate better sleep outcomes. Furthermore, such people may be less inclined to generate or be exposed to stressful life events known to hinder sleep.

1.3 | A stress reduction model of relationship effectiveness and sleep

In their model of the biopsychosocial pathways that explain associations between relationships and sleep, Troxel et al. (2007) suggest that higher-quality relationships promote belongingness and security, both of which reduce stress responses and promote better sleep outcomes. In contrast, lower-quality relationships increase vigilance and hyperarousal, resulting in more negative moods and deleterious health behaviors that adversely affect sleep. In their model, stressful life events are a vulnerability factor that can affect relationship functioning, sleep, and the pathways (e.g., behavioral, psychological) linking them. The current research builds on this model by proposing that stressful events may also be a *mediating* factor accounting for partial associations between relationships and sleep.

Figure 1 illustrates a plausible, yet untested, explanation of the associations between relationships, stress exposure, and sleep. This model is inspired by stress-generation models (e.g., Hammen, 1991; Joiner, 2000), which posit that people both cause stressful events (e.g., conflict with family members) and react to them (e.g., the death of a family member). These models have most often been applied to depression, proposing that people who experience depressive symptoms are more likely to interact with others in ways that elicit social rejection, which sustains or worsens their depressive symptoms. In the context of sleep, our model posits that people who have the interpersonal competencies needed to initiate and maintain good, supportive romantic relationships should be less likely to be exposed to, or experience severe disruptions caused by, stressful life events, resulting in better sleep quality and/or duration across time. For example, a person who is adept at conflict resolution should be more capable of maintaining good, well-functioning romantic relationships and may also be better at maintaining harmonious relationships with other people, potentially lowering the occurrence and severity of disruption of stressful life events compared to a person who is poor at conflict resolution.

A global, across-time evaluation of peoples' interpersonal competencies and experiences in romantic relationships—which we term *relationship effectiveness*—provides an opportunity to test these predictions. *Relationship effectiveness* reflects the degree to which a person appears to have attained competence in romantic relationships. A person's standing on this construct is a function of the tendencies and patterns of behavior and experiences in his or her prior romantic experiences that are the result of both partners' contributions to the relationship. High relationship effectiveness refers to an individual's positive experiences and constructive engagement in relationships. Low relationship effectiveness reflects an individual's negative experiences and destructive engagement in relationships. Whereas people high in relationship effectiveness have a track record of relationships marked by mutual caring, trust; emotional closeness, responsiveness, sharing of experiences, and valuing of faithfulness, loyalty, and honesty (see also Englund, Kuo, Puig, & Collins, 2011; Labella et al., 2018), people low in relationship effectiveness are unable to initiate and maintain such relationships. Thus, relationship effectiveness provides a rich description of not only a person's experiences

and behaviors in an existing relationship but *patterns* of relationship experiences and behaviors over time and across relationships.

Some evidence indicates that relationship effectiveness evolves from earlier relationship experiences (e.g., parent–child relationships, peer relationships) and is linked to important outcomes for adult relationships and experiences. For instance, Englund et al. (2011) found, in part, that teacher rankings of a person's peer competence compared to his or her classmates (averaged across ages 7, 8, and 9 years), attachment security (assessed at 12 and 18 months of age), and friendship security (age 16 years) predict relationship effectiveness at age 23. In addition, Labella et al. (2018) conducted a principal component analysis and found that relationship effectiveness loaded on a single romantic competence factor that also included observations of the quality of interactions with participants' romantic partners and participants' self-reported relationship satisfaction. This suggests that relationship effectiveness is a good marker of adult romantic relationship functioning and is associated with both better interactions and greater satisfaction in romantic relationships. Englund and colleagues also found that relationship effectiveness in early adulthood negatively predicts the occurrence and severity of disruption of stressful events later in life. Thus, this research provides initial evidence for relationship effectiveness as an important, global construct that is built on prior relational experiences and informs future experiences and behavioral tendencies. Building on this earlier work, the current research examines (a) whether relationship effectiveness and stress exposure at age 23 predicts later relationship effectiveness and stress exposure at age 32 and (b) whether both stress exposure and relationship effectiveness predict sleep at age 37.

How might relationship effectiveness impact stress exposure? First, to the extent that people who are high in relationship effectiveness display better interpersonal competencies within their romantic relationships (e.g., better conflict resolution skills, the ability to initiate and maintain higher-quality relationships), they should also have interpersonal competencies that extend to and positively affect other types of relationships. If so, such people should also be less likely to encounter stressful events stemming from tension or conflict in their other relationships (e.g., with coworkers, friends, family members), whereas people who lack these interpersonal skills may be more prone to encountering these stressful events on a more regular basis. Second, because people high in relationship effectiveness have a history of involvement in higher-quality relationships that have provided good social support and larger or stronger social networks, they should also be more resilient when confronted with stressful life events. Third, people high in relationship effectiveness have been involved in high-quality, well-functioning romantic relationships in the past, which should enable them to build and maintain the social and emotional skills and resources needed to decrease stress exposure and reduce the severity of stress when it is encountered, both of which ought to promote better sleep quality and/or duration.

1.4 | The current research

The current study examines the effects of relationship effectiveness and stress exposure on sleep quality and duration using data from the Minnesota Longitudinal Study of Risk and Adaptation (MLSRA; Egeland & Brunnquell, 1979; Sroufe, Egeland, Carlson, & Collins, 2005). The MLSRA recruited first-time mothers living below the poverty line in 1975–1976 and then tracked their child, assessing his or her health, social relationships, and socioemotional functioning from birth to middle adulthood. Given that childhood socioeconomic status (SES) predicts lower subjective sleep quality in adulthood (Blunden & Galland, 2014), this sample may be especially prone to experiencing sleep problems. This study uses data from three waves of assessment of the MLSRA: ages 23, 32, and 37 years (see Table 1 for measurements).

TABLE 1 Means and bivariate correlations between key model constructs and covariates

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. Stress (age 23)	1																
2. Stress (age 32)	0.39**	1															
3. Rel. effect (age 23)	−0.34**	−0.32**	1														
4. Rel. effect (age 32)	−0.22*	−0.26**	0.46**	1													
5. Sleep duration (age 37)	−0.11	−0.23*	0.08	0.22*	1												
6. Sleep quality (age 37)	−0.17	−0.42**	0.21*	0.20*	0.36**	1											
7. Depressive symp. (age 23)	0.40**	0.32**	−0.27**	−0.13	−0.00	−0.22*	1										
8. Depressive symp. (age 37)	0.17	0.30**	−0.08	−0.18	−0.07	−0.40**	0.39**	1									
9. Income (age 32)	−0.20*	−0.07	0.08	0.11	−0.01	−0.04	−0.15	−0.16	1								
10. Income (age 37)	−0.17	−0.18	0.14	0.30**	0.20*	0.02	−0.18	−0.21*	0.42**	1							
11. Edu. (age 23)	−0.07	0.29**	−0.00	−0.16	0.02	0.09	−0.01	−0.07	−0.07	−0.12	1						
12. Edu. (age 32)	−0.02	−0.08	0.17	0.25**	0.18	0.00	−0.05	−0.14	0.20*	0.39**	−0.05	1					
13. Edu. (age 37)	0.00	0.03	0.12	0.21*	0.14	−0.01	0.02	−0.12	0.16	0.34**	0.03	0.81**	1				
14. Sex	0.17	0.16	−0.03	0.02	0.09	−0.10	0.26**	0.03	−0.01	0.13	0.04	0.25**	0.32**	1			
15. Ethnicity	0.11	−0.02	−0.09	−0.08	0.02	−0.09	0.03	0.15	−0.08	−0.16	−0.03	−0.10	0.03	0.15	1		
16. Maternal education	0.01	−0.12	−0.00	0.01	−0.16	0.05	−0.13	−0.11	−0.04	0.02	−0.03	−0.10	−0.03	0.04	−0.03	1	
17. Stress (age 37)	0.29**	0.38**	−0.38**	−0.32**	−0.21*	−0.33**	0.23*	0.31**	−0.07	−0.30**	0.00	−0.15	−0.08	0.06	0.06	0.12	1
M (*SD*)	7.46 (4.96)	6.54 (4.81)	2.68 (1.22)	3.59 (1.27)	6.53 (1.23)	3.85 (1.20)	5.95 (6.64)	10.70 (8.97)	—	—	—	—	—	—	—	—	6.64 (5.03)

Note. See Participants section and Table 2 for descriptive statistics regarding income, education, sex, ethnicity, and maternal education.
*$p < 0.05$; **$p < 0.01$.

As shown in Figure 2, one of three models is predicted to emerge. Model 1 examines whether relationship effectiveness at age 23 is related to sleep quality and/or sleep duration at age 37 through stress exposure at age 32, with better relationship effectiveness at age 23 predicting exposure to fewer stressful life events at age 32 and better sleep quality/duration at age 37 (Hypothesis 1). Finding support for Hypothesis 1 would indicate that stress exposure is one mechanism through which relationship effectiveness impacts sleep and would support a stress reduction model of relationship effectiveness and sleep.

Model 2 considers whether both relationship effectiveness and stress exposure predict sleep outcomes but have independent effects on sleep. Given research showing that stress exposure negatively predicts sleep (e.g., Benham, 2010) and that relationship functioning positively predicts sleep (e.g., Troxel, 2010), it could be the case that relationship effectiveness and stress exposure both predict sleep but that relationship effectiveness and stress exposure do not affect each other. Hypothesis 2 predicts that relationship effectiveness at age 23 positively predicts sleep quality/duration at age 37 through relationship effectiveness at age 32 above and beyond the effects of stress exposure on sleep. Finding support for this hypothesis would demonstrate that earlier relationship effectiveness has an independent effect on sleep that is not explained by its association with stress or associations between stress exposure and sleep. Likewise, Hypothesis 3 predicts that stress exposure at age 23 negatively predicts later sleep quality/duration through later stress exposure (age 32) above and beyond

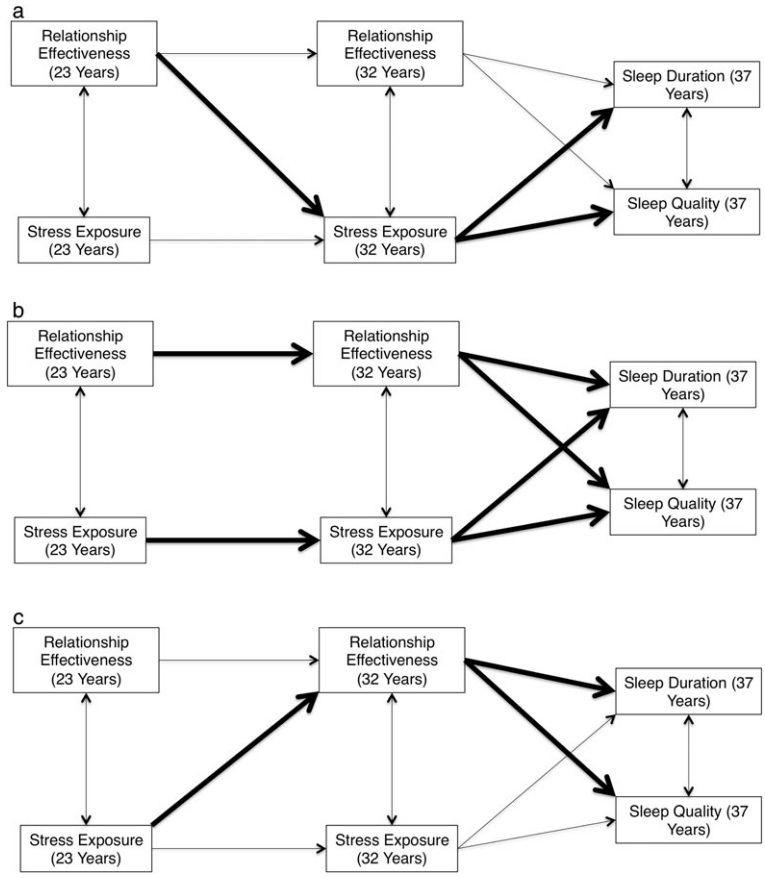

FIGURE 2 Differences between Models 1, 2, and 3. (a) Model 1. Hypothesis 1 is tested by the bold path. (b) Model 2. Hypotheses 2 and 3 are tested by the bold paths. (c) Model 3. Hypothesis 4 is tested by the bold path

the effects of relationship effectiveness on sleep. Finding support for Hypothesis 3 would indicate that stress exposure has an independent effect on sleep that is not explained solely by its associations with relationship effectiveness or associations between relationship effectiveness and sleep.

Model 3 tests whether stress exposure at age 23 has indirect effects on sleep quality/duration at age 37 through its effects on relationship effectiveness at age 32 (Hypothesis 4). Finding support for Hypothesis 4 would demonstrate that stress exposure at age 23 predicts relationship effectiveness, which then affects sleep quality/duration. Given research showing that exposure to stressful events is associated with poorer relationship quality (Karney & Bradbury, 1995), it is possible that stress exposure at age 23 could impact relationship effectiveness; however, given that relationship effectiveness is operationalized as one's relationship-relevant tendencies and competencies that are carried across relationships over time, this construct should, theoretically, be less likely to be affected by stress exposure at a given time.

2 | METHOD

2.1 | Participants

In 1975–1976, 267 mothers were recruited to the MLSRA when they were in the third trimester of pregnancy with their first-born child (i.e., the study participants). All were living below the poverty line and receiving free prenatal services in Minneapolis, Minnesota. All mothers provided consent for their children to participate in the study until the children were 18 years old, and children gave assent from 13 years until 17.5 years, at which time they gave consent as adults. From initial recruitment in 1975–1976 to age 23, attrition resulted in a loss of 37% of the original sample. From ages 23 to 37 (the period examined in the current research), there was attrition of an additional 21% of the sample. Complete data on the variables relevant to our hypotheses were collected on 112 participants; all of the participants who provided data at the age 37 assessment also had data at ages 23 and 32.

Compared to participants in the original sample, participants in the current sample did not significantly differ with respect to maternal age ($M = 20.84$ years, $SD = 3.55$ years), maternal race (83% White), marital status (55.4% single), or maternal education ($M = 11.85$ years, $SD = 1.6$ years) at the time of the child's birth. Participants in the current sample did differ from the original sample in terms of race, $t(265) = 2.52$, $p = 0.012$, with more African American and mixed race participants in the original sample, and in terms of sex, $t(265) = -2.83$, $p = 0.005$, with more males than females in the original sample. See Table 1 for income, education, and relationship characteristics (e.g., number of partners) across time points in the current sample.

2.2 | Measures and procedure

2.2.1 | Relationship effectiveness (ages 23 and 32 years)

Participants were interviewed (audio-recorded) about their current and recent romantic relationships at both ages 23 and 32 years. In the interviews, participants described past conflict experiences (e.g., reasons for conflicts, how conflicts were resolved, or why they were ongoing), how their partner(s) treated them in the past and how they treated their partner(s), aspects of their relationship they did and did not like, perceptions of their partners' values and feelings related to the relationship, and additional details regarding their general experiences in romantic relationships.

At each time point (age 23 and 32), trained coders rated the degree to which participants were competently engaged in romantic relationships on a 5-point Likert-type scale (1 = *low effectiveness*, 5 = *high effectiveness*). High scores indicate that a person has a history of relationships in which there is mutual caring, trust, and emotional closeness; concern for, and sensitivity to, the other's needs and wishes; sharing of experiences and enjoyment of each other; and faithfulness, loyalty, and honesty. Conflicts, when they exist, are resolved to the mutual satisfaction of both parties. People scoring at the low end of the scale are either consistently involved in relationships devoid of the qualities described above or they have been unable to maintain romantic relationships for more than a short period of time. In addition, their relationships are emotionally distant and lack trust and mutual caring, and participants and/or their partners are insensitive to each other's needs and wishes (e.g., there may be unfaithfulness). Negative features, such as victimization, chronic or intense conflict, active rejection, controlling behaviors, disrespect, and/or mistrust, may also characterize these relationships. Participants receiving moderate relationship effectiveness scores tend to report various combinations of insufficient positive qualities or moderately negative qualities. (See the Supporting Information for the complete scoring rubric.)

Ratings had high interrater reliability (intraclass correlations [ICCs] = 0.93 and 0.94). The distributions of relationship effectiveness scores at the 23-year assessment and 32-year assessment were normal (skewness = 0.276 and −0.392, respectively). See Table 1 for means, standard deviations, and bivariate correlations associated with relationship effectiveness. When relationship effectiveness was assessed at age 23, most participants (53.5%) reported on romantic relationships with more than one partner, most (70.5%) were currently involved in a relationship, and most (70%) had lived with at least one of their romantic partners. When relationship effectiveness was assessed at age 32, 48.2% of participants reported on romantic relationships with more than one partner, most (77.7%) were currently involved in a relationship, and all participants had lived with at least one of their romantic partners. At the 32-year assessment, 28.8% of participants indicated that they were in a relationship with the same individual that they had been in a relationship with at the 23-year assessment.

2.2.2 | Life stress exposure (ages 23, 32, and 37 years)

At multiple time points during the MLSRA, participants completed semistructured, audio-recorded interviews about stressful life events that had occurred during the preceding year. Given that relationship effectiveness was assessed only at ages 23 and 32 and sleep quality and duration were assessed only at age 37, we focused our analyses on Life Events Schedule (LES; Egeland, Breitenbucher, & Rosenberg, 1980) data at these ages. Life stress exposure at age 37 was treated as a covariate in the statistical models.

The LES was designed for a low-socioeconomic-status (SES) population. It contains approximately 41 questions that ask about the presence and severity of various stressful life events within the past 12 months (e.g., occupational changes, health and legal problems, interpersonal events). Ratings for each potential stressor were measured on a scale from 0 to 3 (0 = *stressor did not occur/no disruption due to a changing life event*, 3 = *severe disruption*). (See the Supporting Information for examples from the scoring rubric.) Scoring criteria were originally developed to capture the severity of the disruption stemming from each potentially stressful life event. For example, participants were asked if they had moved during the past 12 months. If they had, the interviewer then asked the participant to discuss and explain the circumstances, including the number of times moved, where they moved from and to, and with whom they moved. If a participant indicated that he or she had never moved, the item was scored 0. If a participant said that stressful circumstances precipitated one move (e.g., eviction, fights with neighbors), the item was scored 2. If the participant had to move due to

fire, property destruction, or a life-threatening situation, the item was scored 3. Trained coders rated responses to each of the LES questions using these criteria.

Trained coders (four coders at the 23-year assessment, five coders at the 32-year assessment, and three coders at the 37-year assessment) rated responses to each LES item using weighted scores based on the coding criteria that established scores based on the intensity of disruption associated with each endorsed stressful event. A total score was obtained by summing the item scores for each participant. Interrater reliability was calculated on the total LES score and was based on 29% of participants coded at 23 years, 26% of participants coded at 32 years, and 31% of the participants coded at 37 years. The total LES score for each time point had high interrater reliability (ICCs = 0.94, 0.99, and 0.98, respectively).

Importantly, 15 stressful events directly related to romantic partners (e.g., arguments with partners) were *not* included in the stress exposure measure. Without setting aside partner-related stressors, one cannot determine whether relationship effectiveness prospectively predicts sleep quality and/or duration via stress exposure because people with a history of better relationship effectiveness are likely to experience less stress tied to their partners/relationships, independent of the degree to which they experience other stressful events (e.g., work problems). Accordingly, the remaining 26 LES events were summed, with higher scores indicating more stress exposure.

2.2.3 | Sleep quality and sleep duration (age 37 years)

Participants provided subjective reports of their sleep quality and sleep duration, both of which provide unique information about peoples' perceptions of their sleep behavior (Burg, King, Stoney, & Troxel, 2016) and predict health and well-being (Buysse, 2014). At age 37, participants completed the Adult Health Survey (AHS), a modified version of the Adolescent Health Survey (Blum, Resnick, & Bergeisen, 1989). The AHS has two items that assess sleep quality: (a) "How well do you sleep most nights (1 = *very poorly*, 7 = *very well*)?" and (b) "How rested or refreshed do you feel when you wake up most mornings (1 = *not at all rested*, 5 = *very rested*)?" These items were highly correlated ($r = 0.63$), so they were averaged to create a composite sleep quality measure. The AHS has one item that assesses sleep duration: (c) "How much sleep do you usually get at night on weekdays or workdays (number of hours)?" This sleep quantity item was moderately correlated with the two sleep quality items ($r = 0.33$ and $r = 0.32$, respectively).

2.2.4 | Covariates

Six potential confounds routinely included in prior research on relationships, stress, and sleep (Bixler, Vgontzas, Lin, Vela-Bueno, & Kales, 2002; Fincham, Beach, Harold, & Osborne, 1997; Selcuk et al., 2016; Tennant, 2002) were treated as covariates in the final model[1] to provide evidence of the model's robustness: participants' sex, ethnicity (White/non-Hispanic vs. Other), income (assessed at ages 32 and 37), education (assessed at ages 23, 32, and 37), depressive symptoms (assessed at ages 23 and 37), and prenatal maternal education.

The income variable was highly skewed (skewness = 3.88 and 2.85, respectively) at both the time points it was assessed (ages 32 and 37 years), so it was log-transformed [income = log10 (income +1)]. Although depressive symptoms were assessed at two time points (ages 23 and 37 years), two different measures were used. At age 23, depressive symptoms were assessed using the Symptom Checklist–90–R (SCL–90–R; Derogatis, 1993). The SCL–90–R asks participants to indicate how much a given symptom (e.g., crying easily) has distressed or bothered them during the past week (0 = *not at all*, 4 = *extremely*). Depressive symptoms at age 37 were assessed using the

[1]There was not sufficient power to test for moderation effects for any of the covariates.

Center for Epidemiological Studies Depression Scale (CES–D; Radloff, 1977; $\alpha = 0.90$). The CES–D asks how participants felt or behaved during the past week, answered by indicating 0 (less than 1 day), 1 (1–2 days), 2 (3–4 days), or 3 (5–7 days). For both measures, higher scores indicate more depressive symptoms. One item, "My sleep is restless," was not included in the summed CES–D variable because it overlapped in content with the sleep variables, nor was an equivalent item, "Sleep that is restless or disturbed," included in the SCL–90–R. The correlation between the two depressive symptom measures was $r = 0.39$. In addition, stress exposure at age 37 was included as a covariate in order to assess whether the associations between relationship effectiveness, stress, and sleep held when controlling for concurrent stress exposure (see Table 2 for descriptive statistics for stress).

2.3 | Data analysis

Three path analysis models using maximum likelihood estimation were tested using Mplus 7.3 (Muthen & Muthen, 2014; see Figure 2 for depiction of models). Hypothesis 1 was tested in Model 1. Hypotheses 2 and 3 were tested in Model 2 by specifying paths from relationship effectiveness (23 years) to relationship effectiveness (32 years) to sleep quality and sleep duration (Hypothesis 2) and paths from stress exposure (23 years) to stress exposure (32 years) to sleep quality and sleep duration (Hypothesis 3). Hypothesis 4 was tested in Model 3. Comparing Model 1 with Model 2 tests whether the model examining stress exposure (32 years) as a mediator between relationship effectiveness (23 years) and sleep (37 years) provides a better fit than the model that does not include this meditation path. Comparing Model 1 with Model 3 determines whether the model examining relationship effectiveness (32 years) as a mediator between stress exposure (23 years) and sleep (37 years) (Model 3) provides a better fit than the model that does not include this meditational path (Model 1). Models 1 and 3 were not nested and could be compared only using fit indices (rather than chi-square difference testing).[2]

All models included within-time, between-construct correlations at 23 and 32 years (e.g., relationship effectiveness and stress at 23 years were allowed to correlate) and at 37 years (e.g., sleep quality and sleep duration were allowed to correlate) to control for (a) the concurrent effects of stress exposure on relationship functioning and vice versa, and (b) the associations between sleep quality and sleep duration.

The comparative fit index (CFI), the root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMSR) were used to assess the degree to which each model provided an acceptable fit. A good fit is indicated by a CFI at or above 0.95 and an RMSEA/SRMSR of 0.05 or less, and an acceptable fit is indicated by a CFI of 0.90–0.94 and an RMSEA/SRMSR of 0.06–0.08 (Hoyle, 1995; Hoyle & Panter, 1995; McDonald & Ho, 2002). Chi-square difference testing was used for model comparisons by comparing the fit of the nested models.

3 | RESULTS

3.1 | Correlations

Bivariate correlations between all variables in the models are shown in Table 2. Relationship effectiveness was positively correlated across time, with earlier adult relationship effectiveness (23 years)

[2]Models 2 and 3 were also compared using chi-square difference testing. Model 3 was not a significant improvement over Model 2, which indicated that a model in which a cross-lagged path was added between stress exposure (age 23) and relationship effectiveness (age 32) did not fit the data better than a model that does not include any cross-lagged paths.

TABLE 2 Demographic characteristics at each time point

Prenatal			
Prenatal maternal education			
Has not graduated from high school			35%
GED or high school diploma			42%
Some post–high school education			20%
Birth			
Sex		55% women	
Ethnicity		66% White/non-Hispanic	
		20% multiracial	
		11% African American	
		3% native American, Hispanic, or Asian American	
	Age 23 years	**Age 32 years**	**Age 37 years**
Income	Not assessed	*M* = $120,600.93	*M* = $73,051.72
		Mdn = $96,575.20	*Mdn* = $65,268
		SD = $89,560.16	*SD* = $61,986.91
Highest level of education			
Has not graduated from high school	8.9%	4.5%	5%
GED or high school diploma	63.4%	28.6%	18%
Some post–high school education	16.1%	49.1%	57%
Baccalaureate degree or higher	8.9%%	17.9%	21%
Relationship status			
Not in a relationship	29.5%	22.3%	24.1%
Dating	47.3%	19.6%	6.3%
Engaged or living together	9.8%	10.7%	25%
Married	12.5%	38.4%	43.8%
Cohabitation	Since age 21	Since age 26	*Not assessed*
Has not lived with any partners	30%		
Has lived with one partner	52%	69.6%	
Has lived with two partners	16.1%	15.2%	
Has lived with three partners	0%	3.6%	
Has lived with four or more partners	2%	0%	
Number of partners	Since age 21	Since age 26	*Not assessed*
No partners	2.7%	0%	
One partner	43.8%	51.8%	
Two partners	21.4%	21.4%	
Three partners	13.4%	17%	
Four partners	7.1%	4.5%	
Five or more partners	10.8%	<1%	

Note. At the age 23 assessment, 0.9% of the relationship status data were missing, 0.8% of the data for number of people participants identified as being in a relationship with were missing, and 2.7% of the education data were missing. At the prenatal assessment, 3% of mothers had missing education data.

correlated with later relationship effectiveness (32 years). Stress exposure was also positively correlated across time. At each time point, relationship effectiveness was negatively correlated with stress exposure, demonstrating that better relationship effectiveness is associated with lower stress

exposure. Sleep quality (37 years) was significantly correlated with stress exposure at 23 years, relationship effectiveness (23 and 32 years), and sleep quantity (37 years) in the expected directions. There were nonsignificant correlations between sleep quality and stress exposure at 23 years. Sleep duration was significantly correlated with stress exposure (32 years) and relationship effectiveness (32 years).

3.2 | Model comparisons

Chi-square difference tests were used to determine whether each model was a significant improvement over the null model (which contained all possible paths among the variables) and which model fit the data better (see Table 3 for goodness-of-fit indices). The hypothesis-driven model (Model 1) fit the data significantly better than the null model. Model 1 also fit the data significantly better than Model 2, demonstrating that a model that includes a cross-lagged path between relationship effectiveness (23 years) and stress exposure (32 years) improved model fit over a model that does not include this path.

Model 1 also fit the data significantly better than Model 3, which indicates that adding the cross-lagged path between stress exposure (23 years) and relationship effectiveness (32 years) did not improve model fit. Given that Model 3 did not improve model fit and given that the path from stress exposure (23 years) to relationship effectiveness (32 years) was not significant ($\beta = -0.08$, 95% CI [−0.262, 0.111], $p = 0.431$), Hypothesis 4 was not supported. Model 1 was selected as the best fitting model, accounting for 18.7% of the variance in sleep quality and 7.9% of the variance in sleep duration at 37 years (see Figure 3).[3]

3.3 | Sleep quality

Next, we tested each of our first three hypotheses, focusing on sleep quality as the outcome measure.

> **Hypothesis 1** Relationship effectiveness (23 years) predicts sleep quality through later stress exposure (32 years). Indirect effects were tested using bootstrapped standardized errors (Shrout & Bolger, 2002). Hypothesis 1 was supported (see Figure 2). There was a significant indirect effect of relationship effectiveness (23 years) through stress exposure (32 years) on sleep quality (37 years) ($\beta = 0.09$, 95% CI [0.013, 0.163], $p = 0.022$). In other words, this comparison showed that, although relationship effectiveness at 23 years may impact sleep through relationship effectiveness at 32 years, a

TABLE 3 Goodness-of-fit indices for alternative models

Model	*Df*	χ^2	χ^2/df	$\Delta\chi^2/(\Delta df)$	CFI	RMSEA	SRMSR
Null model	14	96.73	6.91	93.16 (9)***	—	—	—
Model 1 (final model)	5	2.15	0.43	—	1.00	0.000	0.020
Model 2	6	7.73	1.29	5.58 (1)*	0.979	0.051	0.052
Model 3	5	6.84	1.37	0.89 (1)	0.978	0.057	0.047
Model 1 with covariates	37	77.23	2.09	75.08 (32)***	0.764	0.104	0.092

Note. Model 1 with covariates was compared against Model 1 (without covariates). The asterisks denote chi-square difference test comparisons between each nested model and Model 1, except in the case of Model 3, which was compared against Model 2. CFI: comparative fit index; RMSEA: root mean square error of approximation; SRMSR: standardized root mean square residual.
*$p < 0.05$; ***$p < 0.001$.

[3]Model comparisons were also conducted with covariates included in each model (null model, Model 1, Model 2, and Model 3). Model 1 remained the best fitting model.

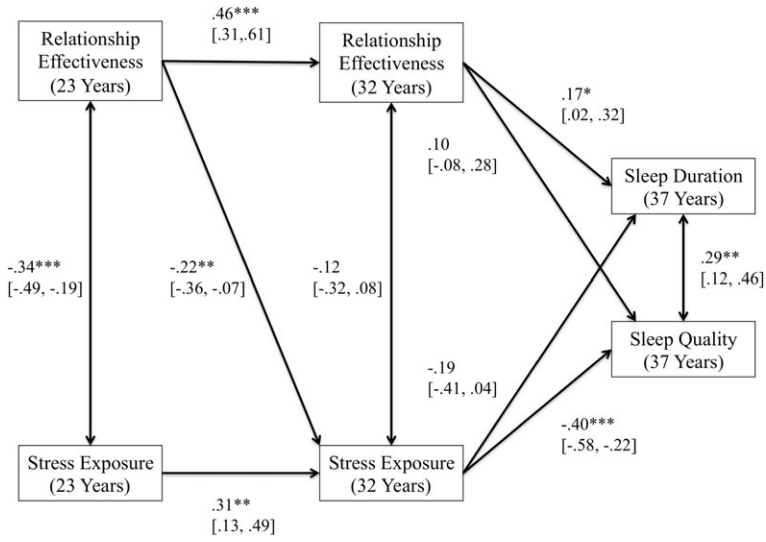

FIGURE 3 Model 1. Life stress exposure and relationship effectiveness at ages 23 and 32 predicting sleep quality and duration at age 37. Path values are standardized estimates (*Betas*) with 95% confidence intervals shown in brackets. R^2 effect sizes: stress exposure at 32 years ($R^2 = 0.19$), relationship effectiveness at 32 years ($R^2 = 0.21$), sleep duration at 37 years ($R^2 = 0.08$), and sleep quality at 37 years ($R^2 = 0.19$). Fit indices: $\chi^2/df = 0.43$ ($p = 0.829$); root mean square error of approximation = 0.000; comparative fit index = 1.00; standardized root mean square residual = 0.020.
$^{\dagger}p < 0.10$; $*p < 0.05$; $**p < 0.01$: $***p < 0.001$

model in which relationship effectiveness at 23 years predicts sleep through stress exposure at 32 years fits the data better than Model 2, which does not include this mediation path.

Hypothesis 2 Relationship effectiveness (23 years) predicts sleep quality through later relationship effectiveness (32 years). The indirect effect of relationship effectiveness (23 years) on sleep quality (37 years) through relationship effectiveness (32 years) was nonsignificant ($\beta = 0.04$, 95% CI [−0.041, 0.130], $p = 0.310$). Thus, Hypothesis 2 was not supported.

Hypothesis 3 Stress exposure (23 years) predicts sleep quality through later stress exposure (32 years). There were indirect effects of stress (23 years) on sleep quality (37 years) through stress (32 years; $\beta = -0.12$, 95% CI [−0.22, −0.03], $p = 0.008$). Hypothesis 3 was supported.

3.4 | Sleep duration

We then tested each of our first three hypotheses, focusing on sleep duration as the outcome measure.

Hypothesis 1 Relationship effectiveness (23 years) predicts sleep duration through later stress exposure (32 years). The indirect effects of relationship effectiveness (23 years)

through stress exposure (32 years) on sleep duration (37 years) were not significant ($\beta = 0.04$, 95% CI [−0.02, 0.10], $p = 0.175$). Thus, Hypothesis 1 was not supported.

Hypothesis 2 Relationship effectiveness (23 years) predicts sleep duration through later relationship effectiveness (32 years). There was a significant indirect effect of relationship effectiveness (23 years) on sleep duration (37 years) through relationship effectiveness (32 years) ($\beta = 0.08$, 95% CI [0.01, 0.15], $p = 0.037$). Hypothesis 2 was supported.

Hypothesis 3 Stress exposure (23 years) predicts sleep duration through later stress exposure (32 years). There were nonsignificant indirect effects of stress (23 years) on sleep duration (37 years) through stress (32 years) ($\beta = -0.06$, 95% CI [−0.14, 0.02], $p = 0.163$). Accordingly, Hypothesis 3 was not supported.

3.5 | Model robustness

To assess the robustness of the final model, the covariates (depressive symptoms at ages 23 and 37 years, participant sex, ethnicity, income at ages 32 and 37 years, education, prenatal maternal education, and stress exposure at age 37) were all statistically controlled at each time point (see Supporting Information Figure S1). Model fit worsened (CFI from 1.00 to 0.760; RMSEA from 0.000 to 0.110; SRMSR from 0.020 to 0.093), and chi-square difference testing indicated that Model 1 without the covariates fit the data significantly better than the model with the covariates (see Table 3 for goodness-of-fit indices).[4]

Adding the covariates to Model 1 did not significantly affect the direct-effect estimates of stress exposure (32 years) on sleep quality (37 years). Including the covariates also did not significantly affect the indirect effects of relationship effectiveness (23 years) on sleep quality (37 years) through stress exposure (32 years) or the indirect effects of stress exposure (23 years) on sleep quality (37 years) through stress exposure (32 years). However, adding the covariates resulted in a nonsignificant direct effect of relationship effectiveness (32 years) on sleep duration (37 years; $\beta = 0.14$, 95% CI [−0.03, 0.32], $p = 0.131$). In addition, adding the covariates resulted in a nonsignificant indirect effect of relationship effectiveness (23 years) on sleep duration (37 years) through relationship effectiveness (32 years; $\beta = 0.07$, 95% CI [−0.02, 0.15], $p = 0.109$).

Overall, Hypothesis 1, whereby relationship effectiveness at age 23 predicts sleep quality via stress exposure at age 32, was robust to the addition of the six covariates and concurrent stress exposure at age 37. In addition, Hypothesis 3, in which stress exposure at age 23 predicts sleep quality through stress exposure at age 32, was also robust to the inclusion of all the covariates. However, Hypothesis 2 was not robust to the inclusion of the covariates.

4 | DISCUSSION

To date, research examining the effects of relationship quality or stress exposure on sleep outcomes has relied on either cross-sectional data (e.g., Benham, 2010; Drake et al., 2014) or data regarding

[4]Model comparisons were also conducted with covariates included in each model (null model, Model 1, Model 2, and Model 3). Model 1 remained the best fitting model.

daily variations in relationship quality or stress on sleep over brief periods of time (e.g., Kane et al., 2014; Selcuk et al., 2016). Although this important work has demonstrated the significance of concurrent interpersonal processes and stressors for sleep quality and duration, the extent to which relationship functioning and stress exposure exert cumulative impacts on sleep over time remains unclear. This is the first longitudinal study to document how a person's romantic relationship effectiveness and life stress exposure at two key points in early adulthood (at age 23 and 32) are prospectively related to sleep quality and quantity in middle adulthood (at age 37). The current study uses a novel, global assessment—relationship effectiveness—that reflects a person's interpersonal competencies and experiences in romantic relationships across specific time points. We find that people who are high in relationship effectiveness in early adulthood experience fewer, less disruptive stressful life events at age 32, which in turn predict better sleep quality at age 37. This finding holds controlling for participants' depressive symptoms (age 23 and 32), sex, ethnicity, income (age 32 and 37), education, maternal education, and stress exposure at age 37. The current study also connects two lines of research—stress exposure and sleep and relationships and sleep—and illustrates an important link between them. Prior studies documenting ties between the quality of a person's current romantic relationship and sleep outcomes are not artifacts of a confounding association between stress exposure and sleep. Rather, the current research suggests that stress exposure is an important mechanism that links relationships to sleep quality.

This study also demonstrates that people who are higher in relationship effectiveness experience lower severity of disruption to stressful life events in general. How might this occur? One explanation is that people who possess the interpersonal competencies necessary to maintain relationships marked by mutual caring, trust, conflict resolution, and other positive characteristics are also more likely to have other traits that may mitigate their exposure to and reduce the severity of those stressors when they occur. For instance, people who score high in romantic relationship effectiveness may be more likely to demonstrate caring and responsiveness in other types of relationships (e.g., with family or coworkers), which might reduce exposure to conflict. Moreover, when stressful events due to uncontrollable sources are encountered (e.g., unemployment, death of a family member), people high in relationship effectiveness may also be more likely to possess intrapersonal and interpersonal resources, allowing them to cope better with the stressful life event and reduce its severity.

In addition, the current research shows that people who are exposed to fewer stressful life events report better sleep quality. One obvious intermediary mechanism linking stress exposure and sleep quality is a person's stress responses. S*tress responses* include a broad set of psychological and/or biological reactions to stress exposure (Harkness & Monroe, 2016), such as feelings of stress (Loft & Cameron, 2014) or appraisals of events as being stressful (Cohen, Kamarck, & Mermelstein, 1983). Research has shown that stress responses are associated with worse sleep outcomes (e.g., Benham, 2010; Vgontzas et al., 2008). Although the severity of the disruption of the stressful event is incorporated into the stress exposure assessment, it is important to have an assessment of individuals' perceptions of how stressful the events were (e.g., directly asking participants: “How stressful was this event?”). Therefore, one important direction for future research is to test whether improving relationship effectiveness reduces stress exposure and subsequent stress responses, which then impact sleep quality. Relationship scientists are beginning to develop interventions that enhance important relationship perceptions, such as satisfaction (McNulty, Olson, Jones, & Acosta, 2017) and marital quality (Finkel, Slotter, Luchies, Walton, & Gross, 2013). Future research should examine (a) whether relationship effectiveness can be improved through interventions and (b) whether improving relationship effectiveness leads to changes in stress exposure and subsequent sleep quality over time.

This study is also the first to investigate whether relationship effectiveness and stress exposure have independent effects on sleep quality and duration when modeled together. Interestingly, after the inclusion of the covariates in the model, there were no direct or indirect effects of relationship effectiveness on sleep duration. There were, however, direct and indirect effects of stress exposure, and indirect effects of relationship effectiveness through stress exposure, on sleep quality. Thus, the current research also contributes to the developing body of research documenting distinctions between sleep duration and sleep quality (e.g., Buysse, 2014). Another goal of future research should be to replicate this pattern of results and examine when and why sleep duration versus sleep quality are affected by stress exposure and romantic relationship experiences and characteristics. One possible explanation for these discrepant findings is that stress exposure and relationship effectiveness might influence sleep through different processes. It is possible that people who are exposed to more stressful life events experience more *feelings* of stress, which then bias their perceptions of sleep quality, whereas sleep duration may be less subject to subjective biases.

4.1 | Limitations

Although the MLSRA has excellent measures of relationship effectiveness and stress exposure at ages 23 and 32, the most substantial limitation of this study is the absence of sleep measures at these same ages. The MLSRA was not designed to assess reciprocal associations between sleep outcomes, stress exposure, and relationship effectiveness. Stress exposure, however, may be less affected by sleep quality and sleep duration than other stress-related constructs, such as stress responses, because a person's amount or quality of sleep may have a limited impact on whether stressful events, such as financial problems, homelessness, or the death of a family member, occur. Similarly, to the extent that relationship effectiveness taps relatively stable characteristics and tendencies, relationship effectiveness may be less sensitive to the effects of sleep quality or duration than daily assessments of current romantic relationship functioning might be. Nevertheless, future research should examine possible reciprocal associations between relationships, stress, and sleep over time.

A related limitation is that although stress exposure was assessed at age 37, we did not assess relationship effectiveness at this age. Therefore, the current research could not test the continuity of relationship effectiveness across the time points and determine whether concurrent relationship effectiveness also affected sleep outcomes. Similarly, several covariates were assessed using different measures or were missing at some of the assessments (e.g., depressive symptoms, income). However, given the moderate to high correlations between depressive symptoms at ages 23 and 37 and the high correlations between income at ages 32 and 37, it is likely that we would have obtained the same results if the covariates had been consistently measured across all time points.

A third limitation is the reliance on self-report methods to assess sleep outcomes. Subjective sleep measures can be vulnerable to biases stemming from negative affect on the day of assessment or lack of knowledge. However, subjective sleep measures do predict important health and well-being outcomes and have good face validity (Buysse, 2014). Future research should assess multiple components of sleep using more varied methodologies.

A fourth limitation is the utilization of a sample born below the poverty line who may have been more vulnerable to the negative effects of chronic stress exposure than a sample who had grown up in a middle- or high-income environment. Chronic stressors are distinct from acute stressors in that chronic stressors are ongoing and enduring (Harkness & Monroe, 2016) and can have different implications for individuals' well-being (e.g., Hammen, Kim, Eberhart, & Brennan, 2009). The stress exposure measure used in the current study assesses both acute and chronic stressors, but this measure is not designed to capture distinct indicators of acute and chronic stress. A priority for future

research is to examine whether associations between relationship effectiveness, stress, exposure, and sleep outcomes differ as a function of the type of stressor (chronic vs. acute). For instance, although we did not find significant associations between earlier stress exposure (age 23) and later relationship effectiveness (age 32), it could be the case that there would be an association between exposure to chronic stressors and later relationship effectiveness because chronic stressors could have enduring impacts on a person's interpersonal competencies and positive relationship experiences. A priority for future research is to tease apart the associations between relationships, exposure to acute versus chronic stressors, and sleep outcomes, and to assess these associations in different samples that may vary in their exposure to acute versus chronic stressors.

A fifth limitation is that the relationship effectiveness construct was conceptualized and scored as a global measure, rather than a sum of individually assessed relationship facets. A priority for future research is to examine the extent to which our effects are due to the positive relationship experiences that people have had and/or their interpersonal competencies. If positive relationship experiences contribute more strongly to reducing stress exposure than interpersonal competencies, this might suggest that specific events that happen within a relationship have greater impacts on stress exposure than interpersonal competencies that can be carried across relationships.

A final limitation is that sample attrition (21% attrition from ages 23 to 37) placed limits on the statistical power needed to test for a buffering effect of relationship effectiveness on stress exposure. For instance, it could be the case that people who are high in relationship effectiveness and are exposed to more stressful events report better sleep quality than those who are low in relationship effectiveness and are exposed to more stressful events. The sample size was also too small to test for the moderating effects of any of the covariates. For example, the pattern of results may vary by gender (e.g., Troxel, Buysse, Hall, & Matthews, 2009), such that women may show stronger associations between relationship effectiveness and sleep through stress exposure. Future research should examine these questions with prospective data on larger samples.

4.2 | Conclusion

Despite these identified limitations, the current study is the first to demonstrate stress exposure as a mechanism linking relationship effectiveness to an important health outcome—sleep quality—over time. A large body of research has consistently found that romantic relationships are important predictors of long-term health and well-being. Although the behavioral processes linking relationships and health outcomes are not fully understood, sleep is a shared behavior in many romantic relationships, and it is a strong contender for how relationships "get under the skin" to affect long-term health outcomes. The current research found support for a stress exposure reduction model of relationship effectiveness and sleep and added to a growing body of literature showing that one of the important ways in which relationships impact individuals is by reducing the occurrence and severity of life stress.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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