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Work-family conflicts and pain interference among midlife adults: a longitudinal serial mediation *via* family strain and loneliness

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ABSTRACT

Objective: Work-family conflict has been shown to adversely affect individuals' health and function, particularly among individuals with chronic pain. The current study's longitudinal serial mediation model examined whether work-to-family conflict predicted greater pain interference through higher levels of family strain and loneliness among midlife adults with chronic pain.

Methods and measures: The study consisted of 303 participants from two waves of the national longitudinal study of Midlife in the United States (MIDUS) at wave II from 2004 to 2006 (M_{age}=57, SD=11) and wave 3 from 2013 to 2014 (M_{age}=66, SD=11). Participants were employed at time 1 and had chronic pain at both time points, and 54.5% of participants identified as female.

Results: Family strain at time 1 (T1) and loneliness at time 2 (T2), respectively, significantly mediated the association of work-to-family conflict (T1) on pain interference at T2. Participants with greater work-to-family conflict perceived more family strain, felt lonelier, and, in turn, reported experiencing higher interference from chronic pain.

Conclusion: Results suggest that unmanaged work-to-family conflict could be a risk factor that exacerbates chronic pain symptoms through worsening family relationships and loneliness among midlife adults with chronic pain.

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KEYWORDS
Work-family conflict; loneliness; family strain; chronic pain; longitudinal mediation

Chronic pain is a public health problem that affects ~40% of midlife and older adults in the United States, and it is deemed the most prevalent health issue encountered by midlife adults (Reid et al., 2015). Although pain is traditionally conceptualized as an internal and physical experience (Sturgeon & Zautra, 2016), a body of research and theoretical frameworks, such as the biopsychosocial theory of chronic pain, indicate the interconnectedness between social, physical, and emotional factors of the pain experience (Kim et al., 2019; Turk & Monarch, 2002). Among multiple social domains in the lives of individuals with chronic pain, work, and family are considered the most prominent domains, as they are the two backbones of human existence (Howard, 1992). Many people with chronic pain still work and take care of their

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families (de Vries et al., 2011). A meta-analysis by Dueñas et al. (2016) indicated that pain deprives individuals of their physical, cognitive, and emotional energy, which in turn interferes with their abilities to fulfill their roles in both work and family domains. Such deprivation may intensify stress, exacerbate conflicts, and increase tensions in both realms. Moreover, conflictual social relationships, particularly with one's family, have been shown to increase the risk of loneliness, a public health hazard that adversely affects midlife adults' health (Holt-Lunstad, 2017). Despite previous studies illustrating the potential associations between work, family, loneliness, and health, little is known about the *conflictual intersections* between work and family (i.e. work-family conflict) among working adults with chronic pain. Based on the gap in the literature, the current study investigated how the conflictual intersection of work and family (e.g. work-to-family conflict) predicted adverse pain-related outcomes *via* family strain and loneliness and among midlife adults with chronic pain.

The direct effect of work-to-family conflict (WTFC) on pain interference

According to Grzywacz and Marks (2000), work and family co-occur; experiences in one domain, either positive or negative, can spill over and influence experiences in the other domain. As previously mentioned, chronic pain can significantly impair individuals' abilities to fulfill their roles and duties at work (e.g. Dueñas et al., 2016) and heighten work-related stress. In turn, this could spill over and negatively affect their family functioning (i.e. WTFC). For instance, a person may bring home their frustration after a stressful day at work or may skip family events because they were exhausted from work. This notion is consistent with the Work-Home resources model (ten Brummelhuis & Bakker, 2012), demonstrating that the development of stressors in one domain, such as work, may lead to depletion of personal resources (e.g. feeling burnout or emotionally drained) and individuals' ability to optimally function in other domains, such as family (ten Brummelhuis & Bakker, 2012).

WTFC can be conceptualized as a specific type of chronic stressor that puts individuals at risk of a host of adverse physical and psychosocial outcomes (Grzywacz & Marks, 2000). Particularly, WTFC has been found to predict unfavorable pain-related outcomes, including worsened pain severity and functioning (Hämmig et al., 2011; Kim et al., 2013; Nützi et al., 2015), as well as other psychosocial risks, such as depression, sleep disturbances, and familial conflicts (Crain et al., 2014; Jawahar et al., 2012). To explain the adverse effects of WTFC on health, the Allostatic Load Model posits that accumulation of stress over the lifetime causes 'wear and tear' on the body, resulting in the dysregulation of physiological stress systems (Juster et al., 2010). If an individual has limited skills and resources to cope with stressors (e.g. receiving a lack of support from family), mounting stress may tax the body's stress response systems, ultimately putting them at greater risk of maladaptive physical outcomes and pain dysfunction (Juster et al., 2010). This line of research is also consistent with studies on how social stressors could worsen physical pain among individuals with chronic pain (Sullivan & Ballantyne, 2021). Taken together, it is plausible to hypothesize that prolonged stress resulting from WTFC may predict worsened pain-related outcomes, particularly exacerbating

the extent to which chronic pain negatively interferes with individuals' lives (i.e. pain interference).

Family strain as the first mediator

The mechanism of how WTFC is associated with unfavorable health-related outcomes is demonstrated in the Stress Process theory (Pearlin, 1989). The theory posits that individuals' struggles do not exist in isolation from one another, and disruption in one area of life would inevitably create disruptions in other areas (Pearlin, 1989). Pearlin (1989) also conceptualized different categories of stressors (i.e. primary and secondary stressors). A primary stressor is defined as an enduring hardship or conflict, from which secondary stressors may develop as a consequence of or a response to a primary stressor. Theoretical and empirical evidence has suggested that secondary stressors largely account for the associations between primary stressors and health-related outcomes (Cohen et al., 2010; Milkie, 2010; Pearlin & Bierman, 2013).

According to Greenhaus and Beutell (1985), WTFC is considered to be a primary stressor of 'Inter-role conflict', which entails 'incompatible demands of multiple roles, especially demands of work and family' (p. 77). Empirical evidence indicates that when individuals' capacities to meet expectations in the family domain decrease due to the WTFC, their abilities to meet demands at home and fulfill familial roles will be diminished, potentially creating strain and stress within a family (i.e. family strain; Milkie, 2010; Minnotte et al., 2015; Shockley & Singla, 2011). Considered a secondary stressor, family strain is defined as 'one's general perception of the critical, irritating, and unreliable nature' of their family (Menaghan, 2010; Walen & Lachman, 2000). In essence, this concept captures a stressful nature as well as the lack of cohesiveness and support of one's family. Studies indicate support for this notion, in which individuals who have higher levels of WTFC experience more familial conflicts, increased strain, and worse family functioning (Brooks et al., 2014; Carroll et al., 2013).

Loneliness as the second mediator

After a primary stressor leads to the secondary role stressor (e.g. WTFC predicts higher family strain), a third 'intrapsychic stressor' or strain may occur as a result (McLeod, 2012; Pearlin, 1989; Seeher et al., 2013). The intrapsychic strain that the current study examined is *loneliness*, which is defined as subjective distress that stems from the perceived lack of connectedness, intimacy, and support in social relationships (Cacioppo et al., 2015). Given that family is the major social domain for many midlife adults (Brooks et al., 2014), perceived lack of cohesiveness and high family strain have been found to predict elevated levels of loneliness (Hawkley & Kocherginsky, 2018). Additionally, in a longitudinal study among 387 adults, the lack of cohesive family dynamics significantly predicted higher levels of loneliness 1 year later (Wakefield et al., 2020).

As WTFC disrupts the family dynamic and intensifies strains between family members (Brooks et al., 2014), a person with chronic pain may feel lonelier due to a perceived lack of connectedness and support from their family (Cacioppo et al., 2015).

According to the Allostatic Load Model, such feelings of loneliness can serve as a source of psychological distress that contributes to one's allostatic load and overall dysregulation of SAM (i.e. sympathetic-adreno-medullar) and HPA (i.e. hypothalamus-pituitary-adrenal) stress systems over time (Cacioppo et al., 2003; Hawkley & Cacioppo, 2010; Juster et al., 2010). Such distress may impede engagement in health behaviors and physically restorative processes necessary for optimal pain management, as well as amplify the functional impact of pain on the individual's daily life (i.e. pain interference; Hawkley & Cacioppo, 2010; Miranda et al., 2008).

There has been substantial evidence on how loneliness is a major predictor of morbidity and mortality among midlife adults (Holt-Lunstad et al., 2015), including chronic pain (Jaremka et al., 2014). Extant literature has found that lonelier individuals are more likely to experience greater pain severity, sensitivity, and fatigue as well as lower pain tolerance (Jaremka et al., 2014; Wolf & Davis, 2014). Research on social pain also indicated that social pain, such as loneliness, can intensify physical pain and predict negative pain-related outcomes (Sturgeon & Zautra, 2016; Sullivan & Ballantyne, 2021). Taken together, loneliness has emerged as a key psychosocial resource that potentially explains the associations between WTFC, family strain, and adverse pain interference.

The longitudinal serial mediation model

The current study utilized the longitudinal serial mediation model to examine the associations between WTFC, family strain, loneliness, and pain interference. The use of longitudinal design is consistent with the Biopsychosocial framework, which highlights the importance of examining chronic pain longitudinally because chronic pain, by definition, extends with time (Turk & Monarch, 2002). Further, the longitudinal model could help address some shortcomings of cross-sectional mediation analyses, such as misspecification of the directions between variables and limitations in estimating longitudinal parameters (Maxwell et al., 2011). Based on theoretical and empirical evidence, the current study utilized a longitudinal model with two-time points at 10-year intervals to examine the proposed serial mediation model to investigate the following questions: Whether WTFC at Time 1 (T1) positively predicted family strain at T1; Whether family strain at T1 positively predicted loneliness 10 years later at time 2 (T2); Whether loneliness at T2 positively predicted pain interference at T2.

Methods

Participants

The study used the two waves of the national longitudinal study of Midlife in the United States (MIDUS), with MIDUS II (Ryff et al., 2004–2006) was us as T1 and MIDUS III (Ryff et al., 2013–2014) as T2. There were ~9–10 years between the two waves. The MIDUS III dataset only includes participants who completed both time points. There were 4,963 participants in MIDUS II, and in MIDUS III, there were 3,294 participants who completed both waves. After adjusting for mortality and ineligibility, the retention rate was 77% (Radler, 2014). Participants were recruited using telephone banks. After

consenting to the study, they completed the study by responding to the phone interview and mail-in survey.

The current study's sample consisted of 303 participants. Participants were included if they reported having chronic pain at both time points and were employed or self-employed at T1. Participants' ages ranged from 34 to 75 at T1 ($M = 52.83$, $SD = 9.13$) and 43 to 84 at T2 ($M = 61.9$, $SD = 9.08$), and 54.5% of participants identified as female. Regarding ethnicity, 281 participants self-identified as White, nine as Black, four as Native American, and nine as Other. Additionally, 217 participants at T1 and 212 participants at T2 were married or cohabited. The median number of children was 2 ($M = 2.5$, $SD = 1.96$), and the mean household size was 2.87 ($SD = .72$) at T1 and 2.23 ($SD = 1.23$) at T2. Further, 17.2% of participants at T1 and 15.5% of participants at T2 reported providing personal care to other family members. Approximately 40% of participants graduated with a Bachelor's or higher degree, followed by attending college but no degree (21.7%), high school diploma (23.7%), and less than high school diploma (5%). Details of demographic information are captured in Table 1.

Measures

Work-to-family conflict (T1)

Participants' WTFC was measured by the 4-item negative work-to-family spillover scale from MIDUS III (Grzywacz, 2000). Items (i.e. Stress at work makes you irritable at home; Your job reduces the effort you can give to activities at home; Your job makes you feel too tired to do the things that need attention at home; Job worries or problems distract you when you are at home) were assessed on a 5-point scale (1 = *all the time* to 5 = *never*). The items were reverse coded and summed into a scale score so that high scores reflected higher levels of WTFC. Previous studies found that WTFC was associated with poorer physical health and more chronic health conditions (Lee et al., 2015). In a study using the MIDUS sample, items yielded a Cronbach's α of .83 (Lee et al., 2015). For this study, the items yielded a Cronbach's α of .83.

Family strain (T1)

Participants' perceived level of family strain was assessed using a 4-item scale from MIDUS III. Items (i.e. How often do members of your family make too many demands on you?; How often do they criticize you?; How often do they let you down when you are counting on them?; How often do they get on your nerves?) were assessed on a 4-point scale (1 = *often* to 4 = *never*). Items were reverse coded, and total scores were the average of the four items. The scale has been validated by other studies using the MIDUS sample (Walen & Lachman, 2000), with findings indicating that family strain was associated with depression and higher levels of pain with a Cronbach's alpha of .80 (Boone & Kim, 2019). The items yielded a Cronbach's α of .80 in the current study.

Loneliness (T2)

Participants' loneliness was measured using a single-item scale from the Center of Epidemiological Studies Depression Scale (CES-D; Radloff & Radloff, 1977). The item

Table 1. Correlation and demographic table.

Correlation tables							
Variable	*M*	*SD*	1	2	3	4	5
1. Work-to-family conflict (T1)	10.77	2.81	–				
2. Family strain (T1)	2.15	.62	.22**	–			
3. Loneliness (T2)	1.74	1.01	.14**	.22**	–		
4. Pain interference (T2)	3.35	2.54	.19**	.14*	.31**	–	
5. Pain interference–covariate (T1)	2.95	2.23	.17**	.26**	.26**	.51**	–

Demographic tables		
Variables	Mean (*SD*), range, or *n* (%)	
	T1 (MIDUS 2)	T2 (MIDUS 3)
Age; mean (*SD*), range	52.83 (9.13), 34–75	61.9 (9.08), 43–84
Age range; *n* (%)		
34–50	117 (38.61%)	33 (10.89%)
51–60	121 (39.93%)	102 (33.66%)
61–70	57 (18.81%)	113 (37.29%)
71–84	8 (2.65%)	55 (18.16%)
Sex; *n* (%)		
Male	138 (45.5%)	
Female	165 (54.5%)	
Race/Ethnicity		
White	281 (92.73%)	
Black	9 (2.97%)	
Native American	4 (1.32%)	
Other	9 (2.97%)	
Marital status; *n* (%)		
Married or cohabitating	217 (71.6%)	201 (66.3%)
Divorced	46 (15.2%)	51 (16.8%)
Separated	9 (3%)	6 (2%)
Widowed	10 (3.3%)	28 (9.2%)
Never married	21 (6.9%)	17 (5.6%)
Numbers of living children; mean (*SD*)	2.5 (1.96)	2.52 (2.08)
Numbers of household members; mean (*SD*)	2.87 (.72)	2.23 (1.23)
Providing personal care; *n* (%)		
Yes	52 (17.2%)	47 (15.5%)
No	251 (82.8%)	256 (84.5%)
Employment; *n* (%)		
Employed (or self-employed)	303 (100%)	182 (60%)
Not employed	–	19 (6.3%)
Retired	–	86 (28.4%)
Not answered	–	16 (5.3%)
Education; *n* (%)		
High school or less than high school	87 (28.7%)	
Attended college, no degree	66 (21.7%)	
Associate degree	29 (9.6%)	
Bachelor's degree and higher	121 (40.0%)	

SD: standard deviation; T1: at time 1 or MIDUS 2; T2: at time 2 or MIDUS 3.
Note. *$p < .05$; **$p < .01$.

consisted of the statement 'During the past week, I felt lonely' and was assessed based on participants' choices based on four ordinal responses: rarely or none of the time, some or a little of the time, occasionally, and most or all of the time. Previous studies using this single-item loneliness scale found that higher scores significantly predicted emotional state declines, less physical activity, and more severe health problems (Nersesian et al., 2018). Research has found that scores from this single-item measure of loneliness were significantly correlated and exhibited a large effect size ($r = .735$, $p < .001$) with scores from the UCLA Loneliness Scale (Russell, 1996), which is one of the most commonly used scales of loneliness (Anderson, 2010). Furthermore, a psychometric analysis comparing the CES-D single item and the UCLA Loneliness Scale indicated that the CES-D's loneliness scale is a sensitive measure of this construct. Based on the psychometric evidence and suggestions, the CES-D's loneliness scale is an adequate measure for the current study.

Pain interference (T2)

A 5-item version of the Brief Pain Inventory's interference subscale (BPI; Cleeland & Ryan, 1994) from MIDUS II was used to measure participants' perceived level of pain interference. Pain interference was assessed by the extent to which chronic pain interferes with five aspects of participants' lives, including daily activity, sleep, mood, social relationships, and enjoyment of life during the past week (e.g. How much did your pain interfere with your relations with other people?; How much did pain interfere with your enjoyment of life?). Participants rated their levels of pain interference using an 11-point numerical scale (0 = *not at all* to 10 = *completely*). The total score was obtained by averaging the responses, in which higher scores helped indicate greater interference from pain. Pain interference was found to be positively related to pain severity, anxiety, and depression (Ryan & McGuire, 2016). In a study using the MIDUS sample, the scale yielded a Cronbach's alpha of .91 (Nguyen et al., 2020). In this study, the items yielded a Cronbach's α of .91.

Covariates

Pain interference at T1, age, marital status, gender, education, number of children, household size, and whether or not participants provided personal care for other family members at both time points were included as covariates in all steps of the serial mediation analyses.

Statistical analyses

The correlation analyses were computed using Pearson R on SPSS. The longitudinal serial mediation was analyzed using Hayes' PROCESS (Hayes, 2017) program, model 6, on SPSS to examine whether pain interference at T1 (X) was associated with pain interference at T2 (Y) *via* family strain as mediator 1 (M1) and loneliness as mediator 2 (M2) while controlling for the aforementioned covariates. The mediating effects were tested using sequences of OLS regressions and the bootstrapping method with 5,000 resamples. The results are deemed significant if the value zero is not included in the 95% confidence intervals. All data, analysis code, and research materials are

available at OSF. This study was not pre-registered (i.e. the study's analysis plan was not publicly shared before it was conducted).

Results

The mean, standard deviation, and bivariate correlation are captured in Table 1. Specifically, WTFC at T1 was positively correlated with family strain at T1 ($r = .22$, $p < .01$), loneliness at T2 ($r = .14$, $p < .05$), and pain interference at T2 ($r = .19$, $p < .01$). Family strain at T1 was also positively correlated with loneliness at T2 ($r = .22$, $p < .01$) and pain interference at T2 ($r = .14$, $p < .01$). Loneliness at T2 was positively related to pain interference at T2 ($r = .31$, $p < .01$). Pain interference at T1 was found to be correlated with pain interference at T2 ($r = .51$, $p < .01$), WTFC at T1 ($r = .17$, $p < .01$), family strain at T1 ($r = .26$, $p < .01$), and loneliness at T2 ($r = .26$, $p < .01$).

The path analysis indicated that WTFC at T1 significantly predicted higher levels of pain interference at T2 ($B = .10$, $SE = .05$, $p < .05$) and family strain at T1 ($B = .04$, $SE = .01$, $p < .001$). Family strain at T1 significantly predicted higher levels of loneliness at T2 ($B = .27$, $SE = .09$, $p < .01$), and higher levels of loneliness were found to predict greater levels of pain interference at T2 ($B = .48$, $SE = .14$, $p < .01$). The serial mediation model indicated significant results (*Effect* = .004, $SE = .003$, 95% *CI* [.002, .010]), indicating that family strain at T1 and loneliness at T2, respectively, were significant mediators that partially explained the adverse association between WTFC at T1 and pain interference at T2 (see Table 2).

A note of caution is due here since the strength of the associations and mediation effects of this study was relatively small, compared to the general guidelines (Ferguson, 2009). One of the potential reasons that could contribute to a small effect size was the control for stability effect by holding pain interference at T1 constant in the model. Furthermore, other demographics and family variables were also included as covariates, potentially removing further variance within the model. Given that pain interference at T1 was strongly correlated with pain interference at T2 ($r = .51$, $p < .01$), as well as all other variables in the models (p's $< .05$), controlling for pain interference at T1 would remove a significant portion of the variance in the statistical model, thus reducing the effect size. Nevertheless, even after controlling for the stability effect and covariates, the mediation analyses still yielded significant results, suggesting that the model is longitudinally meaningful and robust across different types of family history and backgrounds.

Post-hoc analyses

The study explored two alternative models (see Table 2). In the first alternative model with X, M1, and M2 at T1 and Y at T2, the serial mediation model was not significant (*Effect* = .002, $SE = .002$, 95% *CI* [-0.001, .007]), due to the lack of association between Loneliness (M2) at T1 and Pain Interference (Y) at T2 ($B = -0.20$, $SE = .17$, $p > .05$). In the second alternative model with X at T1 and M1, M2, and Y at T2, the serial mediation model was significant (*Effect* = .003, $SE = .002$, 95% *CI* [.001, .008]).

Table 2. Serial mediation analysis of family strain and loneliness between WTFC and pain interference among midlife adults with chronic pain ($n = 303$).

	B	*SE*	*t*	LLCI	ULCI
Path analyses					
WTFC (T1) → Family strain (T1)	.04	.01	3.25**	.016	.065
WTFC (T1) → Family strain (T2)	.04	.01	2.52*	.008	.064
WTFC (T1) → Loneliness (T2)	.03	.02	1.57	−0.007	.069
Family strain (T1) → Loneliness (T2)	.27	.09	2.97**	.091	.449
Family strain (T1) → Pain interference (T2)	−0.19	.21	−0.89	−0.611	.229
Loneliness (T1) → Pain interference (T2)	−0.20	.17	−1.19	−0.538	.131
Loneliness (T2) → Pain interference (T2)	.48	.14	3.53**	.212	.748
WTFC (T1) → Pain interference (T2)	.10	.05	2.22*	.012	.190
Indirect effects					
Main model: WTFC (T1) → Family strain (T1) → Loneliness (T2) → Pain interference (T2)					
WTFC (T1) → Family strain (1) → Pain interference (T2)	−0.009	.008	–	−0.028	.005
WTFC (T1) → Loneliness (T2) → Pain interference (T2)	.013	.011	–	−0.006	.036
WTFC (T1) → Family strain (T1) → Loneliness (T2) → Pain interference (T2)	.004	.003	–	.002	.010
Alternative model 1: WTFC (T1) → Family strain (T1) → Loneliness (T1) → Pain interference (T2)					
WTFC (T1) → Family strain (1) → Pain interference (T2)	−0.007	.001	–	−0.026	.008
WTFC (T1) → Loneliness (T2) → Pain interference (T2)	.006	.006	–	−0.004	.020
WTFC (T1) → Family strain (T1) → Loneliness (T1) → Pain interference (T2)	.002	.002	–	−0.001	.007
Alternative model 2: WTFC (T1) → Family strain (T2) → Loneliness (T2) → Pain interference (T2)					
WTFC (T1) → Family strain (1) → Pain interference (T2)	−0.004	.008	–	−0.020	.012
WTFC (T1) → Loneliness (T2) → Pain interference (T2)	.014	.001	–	−0.003	.036
WTFC (T1) → Family strain (T2) → Loneliness (T2) → Pain interference (T2)	.003	.002	–	.001	.008

WTFC: work-to-family conflict; (T1): at time 1; (T2): at time 2; LLCI: lower level confidence interval 95%; ULCI: upper level confidence interval 95%.

Note. *$p < 0.05$; **$p < .01$; Covariates for the serial mediation model = gender, education level, pain interference (T1), age (T1 and T2), marital status (T1 and T2), numbers of children (T1 and T2), household size (T1 and T2), and whether or not participants provided personal care to family members (T1 and T2).

Discussion

Among multiple social domains that simultaneously exist in the lives of working adults, work and family are deemed to be the foundations of human existence (Howard, 1992), and the interaction between work and family, particularly WTFC, is a significant predictor in unfavorable health, pain, and relationship outcomes (Grzywacz & Marks, 2000; Kim et al., 2013). The current study examined the longitudinal serial mediation model between work-family conflict and pain interference *via* family strain and loneliness.

Firstly, results highlighted the longitudinal and adverse association between WTFC on pain interference, even after controlling for initial levels of pain interference. The study suggested that midlife adults who experienced more WTFC at the initial time point reported higher pain interference a decade later. This finding is consistent with previous literature regarding the adverse associations between WTFC and pain-related

outcomes (e.g. Nützi et al., 2015). It also highlights the theoretical connection between social and physical pain (e.g. Sturgeon & Zautra, 2016), in which prolonged and unmanaged social stress (e.g. WTFC) could exacerbate the extent to which pain interferes with individuals' lives in the long term

Notably, the present study also elucidates potential mediating mechanisms in which greater WTFC predicted worsened pain dysfunction by associating with higher family strain and loneliness. Regarding the positive association between WTFC and family strain, the Work-Home Resources model depicts that stress and challenges that individuals experience at work may affect their abilities to fulfill their roles in the family domain (ten Brummelhuis & Bakker, 2012). This spillover potentially creates ruptures and conflicts within the family domain, predicting higher family strain. Interestingly, the alternative model also demonstrates the longitudinal association between WTFC and family strain, in which WTFC significantly predicted not only family strain at the concurrent time point but also family strain 10 years later (T2). Thus, consistent with previous literature, the findings suggest both the short-term and long-term impacts of work-family conflict on family dynamics (Kayaalp et al., 2021; Vahedi et al., 2018).

Results indicated that the presence of strenuous family relationships stemming from WTFC longitudinally predicted elevated levels of loneliness. This finding supports the notion that loneliness can arise from the lack of a healthy social dynamic or the presence of stressful relationships (Cacioppo et al., 2015). The result also reflects the theorized link between interpersonal (e.g. family strain) and intrapersonal (e.g. loneliness) strains of Pearlin's (1989) Stress Process Theory. In all, this result highlights that midlife adults with chronic pain are at greater risk of experiencing family issues and loneliness (Jaremka et al., 2014).

As individuals reported greater senses of loneliness, the result showed that they were more likely to experience higher pain interference, reflecting worse pain-related functioning. Extant research has supported the intimate associations between social pain (i.e. social rejection, chronic loneliness) and physical pain. As such, elevated social pain can potentially increase the risks of pain interference (Jaremka et al., 2014; Sullivan & Ballantyne, 2021). Further, Cacioppo et al. (2003) also conceptualized loneliness as a source of psychological distress that contributes to one's allostatic load and dysregulation in stress response, which could, in turn, predict poor health and pain-related functioning. The finding is also consistent with previous research by Wilson et al. (2022), demonstrating that adults with elevated levels of psychosocial distress were more likely to experience higher levels of loneliness and pain interference.

It is important to note that there was an increase in loneliness from T1 to T2. Despite the observed increase being statistically significant, the effect size remained small (with a Cohen's *d* of 0.15). This finding suggests that older adults may be more likely to experience higher loneliness. A systemic review conducted by Dahlberg et al. (2022) has identified multiple factors that predict loneliness among older adults, including partner loss, limited social network, low level of social activity, and poor perceived health. It's plausible that these factors, when coupled with family strain, may further intensify the adverse relationship between WTFC and pain interference among older adults.

Interestingly, in the alternative model where WTFC, family strain, and loneliness were measured at T1, and pain interference at T2, the result was not found to be statistically significant. The lack of significance can be primarily attributed to the absence of a longitudinal relation between loneliness at T1 and pain interference at T2. This outcome contradicts findings from other longitudinal studies, which have suggested that loneliness could potentially predict an exacerbation in pain severity or pain-related symptoms over time (e.g. Jaremka et al., 2014; Powell et al., 2022). These discrepancies in results might stem from differences in the design of longitudinal studies between the present study and others. Particularly, the time intervals in other studies are relatively shorter (2–4 years of follow-up), while the MIDUS dataset of the current study employed a 10-year interval. Consequently, the shorter intervals in other studies might render them more sensitive to capturing fluctuations in loneliness and pain symptoms over the years. Conversely, in the MIDUS dataset, there could be a significant variance in loneliness levels and pain interference between the two waves of data collection over 10 years. Furthermore, despite a statistically significant correlation between loneliness at the two-time points, the effect size remains moderate ($r = .34$). This implies that although there is some predictive value of loneliness at one point in time for future loneliness to a certain degree (Mund et al., 2020), individuals have the potential to reduce their loneliness through engagement in different modes of psychological interventions (Cacioppo et al., 2015; Hickin et al., 2021).

Limitations and future research direction

The current study has multiple limitations that should be acknowledged and addressed by future studies. First, the use of an archival dataset like MIDUS limits the researchers' ability to select scales that precisely measure the constructs of interest. Particularly, the MIDUS dataset only offered a single-item scale to measure loneliness. Even though previous studies have suggested that scores from this scale are highly correlated with other psychometrically established scales in loneliness (Anderson, 2010), the use of a single-item scale of loneliness still poses validity and reliability concerns. To address this notable limitation, future studies could use a multidimensional and psychometrically sound scale to measure loneliness.

Additionally, pain interference is the only pain-related assessment that is offered in the MIDUS dataset, and the scale does not discriminate between pain from chronic conditions and acute injuries. Assessment of pain interference provides a holistic view of one's global pain-related functioning and is more consistent with recent guidelines to target quality of life and other psychosocial improvements in pain management, rather than sole reductions in pain severity itself (Cohen et al., 2010). In this study, it is possible that participants with less pain interference at T2 had similar levels of pain *intensity* or *severity* as those with greater pain interference; however, they were more equipped to manage pain and carry out activities of daily life. That being said, the use of only one pain interference scale to assess pain-related outcomes restrained researchers from gathering more comprehensive information, particularly on how WTFC influences other physical indicators of chronic pain (e.g. pain severity or

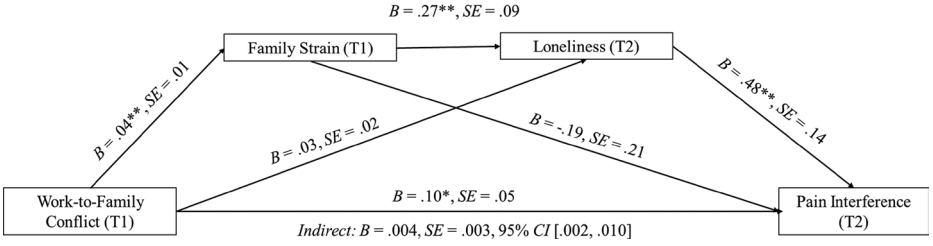

Figure 1. Serial mediation model for the indirect effect (model 6; Hayes, 2017). *$p < .05$, **$p < .01$.

intensity). This limitation highlights the need for future research to incorporate multiple pain scales and assessments to gather more comprehensive results.

The use of an archival dataset also prevented researchers from assessing a more diverse population, as more than 90% of participants in the current study were White, roughly 50% received a college education, and most of the participants reported having some form of health insurance. Additionally, over 80% of the participants reported not providing personal care to other family members and had relatively smaller household sizes. The study's results should be interpreted in the context of this limitation, as it may not be generalizable to individuals from different groups of age, ethnicity, culture, and SES. Particularly, ethnic minority individuals may experience added stressors associated with discrimination or barriers to healthcare (Pillay et al., 2014). As such, they may have fewer resources to facilitate better work-family balance and cope effectively with chronic pain. Moreover, those from other cultures (e.g. East Asian, Latinx) may hold cultural values (e.g. filial piety, familism) that add to the complexity of family dynamics and the experience of pain (Chandra, 2012). Additionally, younger adult parents likely experience higher work-family stress and parenting stress (Allen et al., 2019), which can potentially exacerbate the extent to which WTFC adversely predicts family strain and pain. Future research can explore this model among different groups of age, ethnicity, culture, and SES, to promote the study's generalizability. Scholars can also utilize latent analysis, such as Latent Profile Analysis, to identify different subgroups of participants, based on age or other demographic variables, and examine work-family and pain outcomes for each profile.

Additionally, the 10-year interval between two-time points in the MIDUS dataset limits researchers' ability to gather more continuous information about participants' chronic pain nature and patterns between the two time points. Chronic pain experiences fluctuate over time, and participants might not experience chronic pain consistently between T1 and T2. Thus, future longitudinal studies can implement more frequent follow-up measures during the two-time points to gather more accurate data regarding participants' pain conditions. Future research could also explore whether WTFC at a one-time point could predict the development of chronic pain and pain interference in the future. Lastly, while the study's two-time-point longitudinal serial mediation offers more in-depth insights, scholars have discussed the limitations of a two-time-points mediation model, especially in examining the longitudinal mechanism between the variables (Cain et al., 2018). As such, the results should be approached with caution, and this study could serve as a preliminary step for more complicated longitudinal designs with more time points.

Clinical implications

The insights from our study expand upon the current understanding of holistic and multidimensional approaches in chronic pain care, which have important implications for healthcare practitioners. In chronic pain care, work and family functioning should be integrated into holistic pain assessment and treatment, as clients who have difficulties balancing these roles may be at risk for cascading adverse health outcomes. By acknowledging work-family conflict as an influential health factor, practitioners can raise clients' awareness of its insidious effects on chronic pain and provide resources that help alleviate work stress and family strain. For example, evidence suggests that utilizing work-family benefits at work, developing time management skills, and improving effective communication at home can reduce conflict within the work-family interface (Carroll et al., 2013; Greenhaus & Powell, 2006; Kelly et al., 2014).

Taken together, findings from this study contribute to an understudied area of work-family interface among individuals with chronic pain. In response to the call for more holistic, longitudinal, and multidimensional approaches to chronic pain, the current study highlights how contextual and psychological factors interact with one another to predict outcomes of pain. With these insights, healthcare practitioners are better informed of psychosocial interventions that may potentially complement or replace typical pharmaceutical treatments (i.e. long-term opioid therapies). Targeting psychosocial factors, such as emotional and social well-being, that exacerbate poor pain outcomes is one step toward improved chronic pain care (Figure 1).

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Data availability statement

All data, analysis code, and research materials are available at OSF. This study's design and its analysis were not pre-registered.

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