




Childhood maltreatment exposure and physical functional limitations in late adulthood: examining subjective sleep quality in midlife as a mediator

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ABSTRACT

Objective: The present study had three major aims: 1) To identify sub-groups of adults with differing combinations of childhood maltreatment exposures, 2) to understand the association of childhood maltreatment sub-group membership with subjective sleep quality in midlife, and 3) to assess poor sleep quality in midlife as a mechanism between childhood maltreatment sub-group membership and physical functional limitations in late adulthood. **Design:** Data come from the Biomarker project of the Midlife Development in the United States study ($n = 1251$). **Outcome measures:** The Pittsburgh Sleep Quality Index (Buysse et al., 1989) was used to assess sleep quality in midlife. Functional limitations in late adulthood were measured using a version of the SF-36 (Brazier et al., 1992). **Results:** Two vulnerable childhood maltreatment sub-groups emerged (Physical and Emotional Maltreatment Sub-group, $n = 49$, and Sexual Abuse Sub-group, $n = 105$) and a normative sub-group ($n = 1087$; low exposure to childhood maltreatment). Poor sleep quality in midlife mediated the association between both maltreatment sub-groups and functional limitations in late adulthood. **Conclusion:** Results highlight the role of sleep in linking childhood maltreatment with functional impairments in adulthood and offer a potential target for interventions to improve quality of life in older adults.

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Childhood maltreatment has been associated with physical functional limitations and poor sleep quality in adulthood, particularly in middle adulthood (Archer, Pereira, & Power, 2017; Greenfield, Lee, Friedman, & Springer, 2011; Koskenvuo, Hublin, Partinen, Paunio, & Koskenvuo, 2010). Moreover, midlife is emerging as a critical developmental period for both overall declines in sleep quality and for understanding age-related declines in physical functioning (Lachman, Teshale, & Agrigoroaei, 2015; Millán-Calenti et al., 2010). However, previous research has not evaluated many potential

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mechanisms of the association between childhood maltreatment exposure and physical functional declines in late adulthood. To address gaps in current knowledge, the present research evaluates subjective sleep quality in midlife as a mechanism of the association between childhood maltreatment exposure and physical functional limitation in late adulthood. Such an evaluation can highlight the role of subjective sleep as a potential psychological mechanism linking childhood maltreatment exposure with functional impairments in adulthood and offer a potential target for prevention efforts aimed at improving quality of life in older adults. Moreover, due to the high co-occurrence of exposure to multiple maltreatment types (Debowska, Willmott, Boduszek, & Jones, 2017; Finkelhor, Turner, Shattuck, & Hamby, 2013; Higgins & McCabe, 2001) and the association of more chronic maltreatment exposures with worse adult outcomes (e.g., more substance use, depression, physical health problems; Arnow, 2004; Debowska & Boduszek, 2017; Rehan, Antfolk, Johansson, Jern, & Santtila, 2017), we utilized a person-centered approach to evaluate combinations of maltreatment exposures based on both type and chronicity of exposure. It is likely that chronicity, along with various combinations of maltreatment types, may differentially influence sleep quality in midlife and physical functional limitations in late adulthood.

Childhood maltreatment exposure and adult physical functional limitations

Although some early-life risk factors such as lower birth-weight (Kuh et al., 2006) and low socio-economic status (Birnie et al., 2011; Haas, 2008) have been linked with greater physical functional limitations among aging adults, few studies have evaluated the impact of childhood maltreatment as a potential early-life influence on later-life physical functionality. Physical functional limitations are defined as the inability to carry out basic activities required for day-to-day functioning (e.g., bathing or carrying groceries). Such limitations are a prominent health concern and a leading indicator of mortality risk among older adults (Millán-Calenti et al., 2010).

Limited research on the association between childhood maltreatment and adult physical functional limitations demonstrates that exposure to any type of childhood maltreatment (Leserman, Li, Hu, & Drossman, 1998; Walker et al., 1999), and childhood sexual abuse in particular (Dickinson, deGruy III, Dickinson, & Candib, 1999), are associated with lower physical functional limitations among adult female survivors (Leserman et al., 1998; Walker et al., 1999). Childhood sexual abuse has also been linked with more chronic illnesses and poorer physical functioning in adults over age 50 (Talbot et al., 2009). More recently, Archer and colleagues (2017) used a longitudinal design to assess the differential effects of childhood maltreatment types on adult physical functional limitations. Findings demonstrate that exposure to multiple types of childhood maltreatment increases the likelihood of physical function declines. Physical neglect, psychological abuse, and sexual abuse were each significantly and independently associated with decreased physical functioning in midlife (Archer et al., 2017).

Together, these studies suggest that maltreatment experiences during childhood may have a deteriorating effect on overall functionality in adulthood. Studies

evaluating the mechanisms linking maltreatment exposure in childhood to physical functional limitations in late adulthood, however, are limited. The evaluation of mechanisms can provide clinicians with tangible prevention points in midlife for victims of childhood maltreatment in order to forestall later-life physical functional declines (Kajepeta, Gelaye, Jackson, & Williams, 2015). One likely mechanism that has been associated with both childhood maltreatment exposure and physical functional limitation is sleep quality.

The role of sleep as a potential mediator

Sleep quality often declines in midlife and subjective reports of poor sleep quality during this period are linked to diverse health problems (Friedman, 2016; Ohayon, Carskadon, Guilleminault, & Vitiello, 2004). For example, shorter sleep duration, lower subjective sleep quality, and disturbed sleep are all associated with greater risks for obesity (Beccuti & Pannain, 2011), chronic hypertension (Bansil, Kuklina, Merritt, & Yoon, 2011), Type 2 diabetes (Yaggi, Araujo, & McKinlay, 2006), metabolic syndrome (Hall et al., 2008), and lower overall self-rated health (Shankar, Charumathi, & Kalidindi, 2011). Particularly germane to the current study is research showing that sleep loss and poor sleep quality in midlife predict functional declines and physical limitations in older adults (Friedman, 2016; Goel et al., 2013).

The possibility that poor subjective sleep quality might mediate the association between childhood adversity and later-life functional limitations is supported by research showing that maltreatment in childhood can contribute to poor sleep quality into adulthood (Guastella & Moulds, 2007; Greenfield et al., 2011; Kendall-Tackett, 2009; Koskenvuo et al., 2010). For instance, adults with exposure to childhood maltreatment exhibit increased wake bouts during sleep, more night terrors, and lower sleep efficiency or time spent asleep during a typical night compared to adults who report no exposure to childhood maltreatment (Greenfield et al., 2011; Koskenvuo et al., 2010). One study of adult participants from the Midlife in the United States (MIDUS) study found that individuals who reported any exposure to sexual abuse, physical abuse, or emotional abuse in childhood had more self-reported sleep problems, as did those who reported more frequent physical or emotional abuse exposures (Greenfield et al., 2011). Another study utilizing the same MIDUS sample demonstrated that parental emotional neglect was not significantly associated with sleep problems in midlife (Poon & Knight, 2011). Taken together, these findings indicate nuanced associations between specific maltreatment exposures (i.e., types) and both sleep quality in midlife and subsequent physical functional limitations.

According to the life-course perspective (Kuh, Ben-Shlomo, Lynch, Hallqvist, & Power, 2003), health in later life reflects the aggregate influence of diverse exposures across the duration of the lifespan. Moreover, the timing of these influences (e.g., maltreatment in childhood or sleep problems in midlife) is important. For example, sleep quality in midlife is a critical factor influencing physical functional declines in late adulthood, and maltreatment in childhood can be a key contributor for poor sleep quality in midlife (Guastella & Moulds, 2007; Greenfield et al., 2011; Kendall-Tackett, 2009; Koskenvuo et al., 2010). Impaired mental health may be a mechanism by which

childhood adversity affects sleep in midlife as well as later functional capacity. Based on convergent evidence from the stress process model, stress associated with childhood maltreatment exposure can produce trauma symptoms such as hypervigilance or arousal—states that have been linked to sleep problems and poor overall sleep quality (Buckley & Schatzberg, 2005; Koskenvuo et al., 2010). Behavioral patterns in children, such as frequent night awakenings to avoid continued victimization, can lead to disturbed sleep patterns throughout childhood and into adulthood (Spilsbury, 2009). Moreover, both the life-course perspective and stress process model have emphasized that chronic early-life adversity tends to generate later-life mental health and behavioral problems, including sleep problems, due to the alteration of the neuro-endocrine systems and the increased states of hypervigilance—ultimately increasing the risk for physical functional declines (Fried, Darer, & Walston, 2003; Germain, Buysse, & Nofzinger, 2008; Jaffee & Christian, 2014; Kajeepeeta et al., 2015; Koskenvuo et al., 2010; Shonkoff et al., 2012; Turner & Schieman, 2008).

Present study

The aforementioned lines of research converge on the overarching hypothesis that childhood maltreatment may lead to changes in sleep patterns in midlife that then increase risk of physical functional limitations in late adulthood. In this study, we used two waves of data, measured 10 years apart, from the longitudinal, national MIDUS study to examine the following aims: 1) whether there are sub-groups with specific combinations of childhood maltreatment exposures (i.e., based on both type and chronicity) in this sample of aging adults, 2) whether membership in specific childhood maltreatment sub-groups is associated with more subjective sleep problems or poorer sleep quality in midlife (i.e., around age 57 for this sample) and greater physical functional limitations in late adulthood (i.e., mean sample age = 68), and 3) whether subjective sleep problems in midlife (i.e., at mean age = 57) help explain the association between childhood maltreatment sub-group membership and subsequent physical functional limitations assessed 10 years later in late adulthood when the participants were around 68 years old, on average. The use of this population-based, non-clinical sample helps to illuminate the associations between maltreatment exposures, sleep quality, and functional declines for individuals who may not be actively seeking treatment for sleep-related problems in particular (Ford & Cooper-Patrick, 2001; Greenfield et al., 2011). Further, a population-based approach accounts for other demographic factors that may influence the proposed associations, providing estimates of key associations that have greater precision than is typically possible with clinical samples (Ford & Cooper-Patrick, 2001; Greenfield et al., 2011).

Methods

Data

The sample for this study comes from the second and third waves of MIDUS (Brim, Ryff, & Kessler, 2004)—a longitudinal panel study designed to understand factors associated with physical and mental health among middle-aged and older adults in the

United States. All participants ($n = 5394$) were assessed longitudinally at three waves approximately 10 years apart: wave 1 (MIDUS 1) were collected between 1994 and 1995, wave 2 (MIDUS 2) between 2004 and 2005, and wave 3 (MIDUS 3) in 2013. Mortality-adjusted retention rates were 75% between MIDUS 1 and MIDUS 2, and 77% between MIDUS 2 and MIDUS 3. An additional sample of African-Americans ($n = 592$) was recruited at MIDUS 2 and subsequently followed.

MIDUS assessments included a telephone interview and a self-administered questionnaire (SAQ) at each wave. At MIDUS 2, a sub-sample of participants ($n = 1255$) also participated in what was referred to as the Biomarker project—a clinic-based study to assess physiological functioning and health-related biomarkers. The Biomarker project was open to all MIDUS participants who completed both the phone interview and SAQ at MIDUS 2 and were willing to travel to the clinic for an overnight stay. Retrospective childhood maltreatment and subjective sleep quality measures were administered to Biomarker project participants. Thus, the sample included adults ($n = 1251$) who participated in the Biomarker project and had complete data on the childhood maltreatment measure.

Measures

Childhood maltreatment

The Childhood Trauma Questionnaire (CTQ; Bernstein & Fink, 1998), was administered to assess exposure to physical and emotional abuse and neglect as well as sexual abuse. Example items for each type include: 'People in my family said hurtful or insulting things to me' (emotional abuse; $\alpha = .88$), 'I got hit so hard by someone in my family that I had to see a doctor or go to the hospital' (physical abuse; $\alpha = .79$), 'Someone tried to make me do sexual things or watch sexual things' (sexual abuse; $\alpha = .94$), 'There was someone in my family who helped me feel that I was important or special' (emotional neglect, reverse-coded; $\alpha = .89$), and 'I didn't have enough to eat' (physical neglect; $\alpha = .70$). Each childhood maltreatment type consisted of five items and all items were scored using Likert-type items ranging from 1 ('Never true') to 5 ('Very often true'), with positive items reverse-coded so that higher scores were indicative of more chronic childhood maltreatment exposure. The CTQ is a commonly used, reliable and valid measure of retrospective childhood maltreatment exposure (Baker & Maiorino, 2010; Bernstein & Fink, 1998). The five childhood maltreatment types were scored by summing all items for each maltreatment type. Higher scores for each type indicated greater chronicity of that particular type of childhood maltreatment exposure, and scores for each type ranged from 1–25.

Subjective sleep quality

The Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989; $\alpha = .70$) was used to assess subjective sleep quality in the prior month. The PSQI assesses seven domains of sleep quality—subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, daytime dysfunction, and use of sleep medication. Responses within each domain were scored from 0–3 such that higher scores indicated more sleep problems. Domain scores were then aggregated into a global sleep

score ranging from 0–21, with scores over five indicating problematic sleep (Buysse et al., 1989).

Physical functional limitations

Functional limitations were measured at MIDUS 3 with a modified version of the SF-36 (Brazier et al., 1992; $\alpha = .85$). In the MIDUS version, respondents had four possible options (1: 'A Lot', 2: 'Some', 3: 'A Little', and 4: 'Not At All') to indicate how much their physical health limited their ability to perform various daily activities, including 'bathing or dressing', 'walking a block', 'climbing single flight of stairs', 'walking several blocks', 'walking more than a mile', 'bending, kneeling or stopping', 'lifting or carrying groceries', 'performing vigorous activities', and 'performing moderate activities'. Items were reverse-coded so that higher scores indicated more functional limitations, with scores ranging from 1–4. An average score was computed for overall physical functional limitations.

Covariates

Several demographic variables previously associated with physical functional limitations were included in all analyses to avoid confounding. Participant racial identity and gender were coded dichotomously such that a response of 1 corresponded to 'White' (Non-white: reference category) and 'Male', (Female: reference category), respectively. Age (in years) was included as a continuous variable. Educational attainment was evaluated using dummy variables for 'some college or bachelor's degree', 'more than a bachelor's degree', or 'no college education' (reference category). Similarly, marital status was coded into two dummy variables, responses of 1 indicated 'married' and 'divorced/separated/widowed' for each dichotomous variable, with 'never married' as the reference category. Other covariates included a count variable of other childhood adversities experienced before age 18 (i.e., parental disability, parental alcohol or drug use, parental death before age 16, parental mental health problems, and parental divorce) that may co-exist with childhood maltreatment exposure (Dong et al., 2004), and may confound the association between childhood maltreatment exposure and functional limitations (Edwards et al., 2004). Respondents' current prescription and over-the-counter medication use, current smoking status, recent binge drinking episodes (in the last 12 months) were also included as covariates due to their potential role in confounding associations with sleep quality (Irish, Kline, Gunn, Buysse, & Hall, 2015; Smagula et al., 2016).

Analytic strategy

Latent profile analysis was conducted to identify sub-groups with co-occurring childhood maltreatment types (i.e., physical abuse and neglect, emotional abuse and neglect, and sexual abuse; aim 1). Using this approach, individuals with similar chronicity of co-occurring childhood maltreatment exposure types were grouped together. Sub-group membership was assigned for each individual using their posterior probability of group membership (threshold = .98) and sub-groups were given descriptive labels based on the pattern of maltreatment exposures for that sub-group. To obtain optimal

sub-group solution, five statistical indicators: AIC, BIC, adjusted-BIC, entropy, and replication of results with increased random starts were used to compare a 2, 3, and 4-class model (Gibson, 1959).

After an optimal sub-group solution was obtained, mediation models were estimated to test aims 2 and 3. In this model, the direct associations between childhood maltreatment sub-groups and physical functional limitations were estimated, along with the indirect associations of childhood maltreatment sub-groups with physical functional limitations via subjective sleep quality. A product of coefficients method (MacKinnon, Fairchild, & Fritz, 2007) was used to estimate indirect effects. Full information maximum likelihood (FIML; Arbuckle, 1996) was used to account for missing data and all models were analyzed using Mplus 7.4 statistical software (Muthén & Muthén, 2015).

Results

For the latent profile analysis used to complete aim 1, we compared model fit statistics of 2-sub-group, 3-sub-group, and 4-sub-group solutions to determine final solution. A 3-sub-group solution was found optimal with the following fit indices: AIC: 29668.05, BIC: 29832.27, adjusted-BIC: 29730.62, entropy: .98, which were better than those of the 2-sub-group solution (AIC: 30004.97, BIC: 30138.39, adjusted-BIC: 30055.81, entropy: .99). The 4-sub-group solution was a local solution, as the results for this solution did not replicate when random starts were increased. Descriptive sub-group labels were applied for the 3 sub-groups based on the patterns of maltreatment exposures for each group: 1. normative sub-group: low chronicity of all childhood maltreatment types; 2. physical and emotional maltreatment sub-group: high chronicity of emotional and physical maltreatment and low chronicity of sexual abuse; and 3. sexual abuse sub-group: high chronicity of sexual abuse and higher than average frequencies for all other childhood maltreatment.

Posterior probability of sub-group membership was used to create dummy variables for each childhood maltreatment sub-group (i.e., physical and emotional maltreatment sub-group and sexual abuse sub-group) with the normative sub-group (i.e., sub-group 1) as the reference group. [Figure 1](#) describes childhood maltreatment prevalence for each sub-group. [Table 1](#) summarises the descriptive statistics for the childhood maltreatment sub-groups.

[Table 2](#) includes results from pairwise comparisons used to assess differences between the maltreatment sub-groups in mean levels of childhood maltreatment type exposures and covariates. Results indicate that both the physical and emotional childhood maltreatment sub-group and the sexual abuse sub-group were higher than the normative sub-group on their mean levels for all childhood maltreatment types and other childhood adversities. Comparison between the physical and emotional childhood maltreatment sub-group and the sexual abuse sub-group showed that the physical and emotional childhood maltreatment sub-group were higher than the sexual abuse sub-group on all maltreatment types except sexual abuse. The sexual abuse sub-group had significantly higher levels of sexual abuse in comparison to the physical and emotional childhood maltreatment sub-group. Members of the sexual abuse sub-

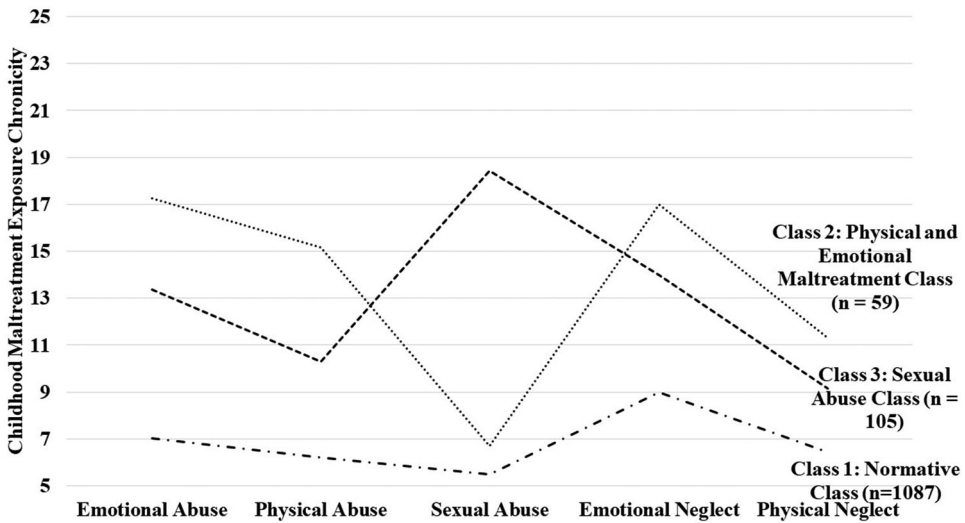


Figure 1. Childhood maltreatment exposure based on type and chronicity (y-axis denotes chronicity of each childhood maltreatment exposure ranging from 5–25; items for each type range from 1 ‘Never True’ and 5 = ‘Very Often True’) for the 3-class solution.

Table 1. Descriptive statistics for childhood maltreatment sub-groups.

	Sub-group 1: Normative sub-group (n = 1087)			Sub-group 2: Physical and emotional maltreatment sub-group (n = 59)			Sub-group 3: Sexual abuse sub-group (n = 105)		
	N	Mean	Std. Dev.	N	Mean	Std. Dev.	N	Mean	Std. Dev.
Key variables									
Physical functional limitations wave 3	756	1.56	0.68	41	1.86	0.92	68	2.04	0.85
Subjective sleep quality	1015	5.92	3.46	56	7.61	3.72	97	8.47	4.64
Emotional abuse	1087	7.03	2.82	59	17.39	4.41	104	13.38	5.61
Physical abuse	1087	6.22	1.56	59	15.25	3.54	105	10.32	4.92
Sexual abuse	1084	5.48	1.32	59	6.74	2.84	103	18.40	4.05
Emotional neglect	1087	8.97	3.94	59	16.97	3.65	104	14.02	5.18
Physical neglect	1087	6.45	2.25	59	11.46	3.46	105	9.10	3.68
Covariates continuous/count									
Drinking	274	2.32	0.80	16	2.56	0.51	30	2.37	0.76
Other childhood adversities	922	4.69	1.54	52	5.65	1.60	79	5.33	1.83
Age	922	55.79	11.86	52	49.04	8.69	79	53.27	11.41
Covariates proportions									
Smoking: yes	384	23%	0.42	33	48%	0.51	36	19%	0.40
Prescription medication: yes	1024	73%	0.44	58	67%	0.47	99	76%	0.43
Over the counter medication: yes	1024	77%	0.42	58	78%	0.42	99	83%	0.38
Race: White	892	94%	0.24	50	96%	0.20	74	95%	0.23
Gender: male	922	48%	0.50	52	40%	0.50	79	15%	0.36
Marital status: married	920	73%	0.44	52	75%	0.44	79	58%	0.50
Marital status: widowed/separated/divorced	920	19%	0.39	52	21%	0.41	79	30%	0.46
Education: some college/ bachelor's degree	922	52%	0.50	52	54%	0.50	79	52%	0.50
Education: graduate degree	922	24%	0.43	52	13%	0.34	79	22%	0.41

group were less likely to be married, and were more likely to be women compared to the other sub-groups. Members of the sexual abuse sub-group were also more likely to be divorced, widowed, or separated compared with the normative sub-group.

Table 2. Comparison of chronicity of childhood maltreatment type and covariate means by sub-groups.

Variable	Physical and emotional maltreatment sub-group vs. normative sub-group			Sexual abuse sub-group vs. normative sub-group			Physical and emotional maltreatment sub-group vs. sexual abuse sub-group				
	Mean difference	t	df	p	Mean difference	t	df	Mean difference	t	df	p
Emotional abuse	10.36	26.54	1144	<.001	6.34	19.56	1189	4.01	4.73	161	<.001
Physical abuse	9.04	39.43	1144	<.001	4.10	19.29	1190	4.94	6.78	162	<.001
Sexual abuse	1.26	6.58	1141	.001	12.92	72.29	1185	-11.66	-19.53	160	<.001
Emotional neglect	7.99	15.21	1144	<.001	5.05	12.09	1189	2.95	3.85	161	<.001
Physical neglect	5.01	16.08	1144	<.001	2.65	10.75	1190	2.36	4.02	162	<.001
Race: White	0.02	0.62	940	.532	0.01	0.26	964	0.01	-0.36	122	.732
Gender: Male	0.08	1.09	972	.276	-0.33	-5.73	999	0.25	3.36	129	.001
Marital status: married	0.02	0.26	970	.796	-0.15	-2.89	997	0.17	1.98	129	.049
Marital status: widowed/separated/divorced	0.03	0.46	919	.645	0.12	2.20	920	-0.09	-1.16	129	.246
Education: some college/bachelor's degree	0.02	0.27	970	.791	0.00	0.01	999	0.02	0.22	129	.829
Education: graduate degree	0.11	1.80	972	.072	-0.03	0.57	922	0.08	1.16	129	.246
Prescription medication: yes	0.06	0.93	1080	.352	0.03	0.62	1121	-0.08	-1.16	155	.251
Over the counter medication: yes	0.00	0.04	1080	.966	0.50	-1.25	1121	-0.05	-0.80	155	.423
Other childhood adversities	-0.96	-4.38	972	<.001	-0.636	-3.48	999	0.32	1.04	129	.298
Age	-6.75	4.05	972	<.001	-2.52	1.92	999	-4.23	2.27	129	.024

Note: Means for pairwise comparison are from Table 1.

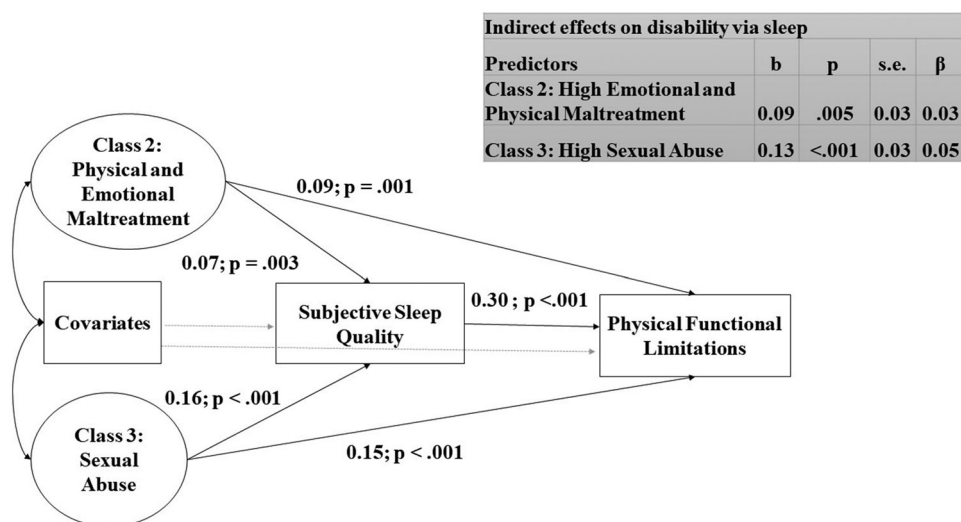


Figure 2. Mediation model with standardized effects controlling on all covariates. Note: Comparison group is the normative class.

In the mediation model (Figure 2), we tested whether maltreatment sub-group membership was directly associated with functional limitations at MIDUS 3 and with sleep problems at MIDUS 2. We also tested whether the associations between childhood maltreatment sub-group membership and functional limitations in late adulthood at MIDUS 3 were mediated or explained, in part, by sleep problems at MIDUS 2. Table 3 summarises the results for the direct associations between: 1) childhood maltreatment sub-groups and physical functional limitations, and 2) the childhood maltreatment sub-groups and subjective sleep problems. Relative to membership in the normative sub-group, membership in the sexual abuse sub-group was directly associated with both higher levels of functional limitations ($\beta = .15$) and poorer sleep quality ($\beta = .16$); and, membership in physical and emotional childhood maltreatment sub-group was directly associated with higher levels of functional limitations ($\beta = .08$) and subjective sleep problems ($\beta = .09$). In summary, individuals in both maltreatment sub-groups reported poorer sleep quality in midlife and more functional limitations in late adulthood after controlling for covariates compared to the normative sub-group.

Indirect associations between childhood maltreatment sub-groups and functional limitations are summarised in Figure 2. Relative to individuals in the normative sub-group, membership in both the sexual abuse sub-group and the physical and emotional childhood maltreatment sub-group was indirectly associated with physical functional limitations in late adulthood (i.e., at MIDUS 3) via subjective sleep quality in midlife (i.e., at MIDUS 2). To illustrate, exposure to maltreatment, such as that experienced by members of both the sexual abuse sub-group and the physical and emotional childhood maltreatment sub-group - relative to the normative group, was associated with poorer sleep quality in midlife, which then subsequently resulted in higher levels of physical functional limitation in late adulthood. Overall, the model explained 13.9% of the variance in subjective sleep quality at MIDUS 2 and 27.9% of the variance in functional limitation at MIDUS 3.

Table 3. Estimating direct effects on physical functional limitations and sleep problems.

Predictors	Direct effects on physical functional limitations				Direct effects on subjective sleep quality			
	<i>b</i>	<i>p</i>	SE	β	<i>b</i>	<i>p</i>	SE	β
Sub-group 2: physical and emotional maltreatment sub-group	0.33	.014	0.13	0.09	1.46	.003	0.49	0.08
Sub-group 3: sexual abuse sub-group	0.41	.000	0.10	0.15	2.06	<.001	0.39	0.16
Subjective sleep quality	0.06	.000	0.01	0.30	-0.11	.834	0.51	-0.01
Race: White	0.13	.145	0.09	0.04	-0.02	.170	0.01	-0.05
Age	0.02	<.001	0.00	0.30	-0.64	.009	0.25	-0.09
Gender: male	-0.12	.006	0.04	-0.08	-0.90	.040	0.44	-0.11
Marital status: married	0.07	.319	0.07	0.05	-0.02	.973	0.50	0.00
Marital status: widowed/separated/divorced	0.03	.721	0.09	0.02	-0.28	.335	0.29	-0.04
Education: some college/bachelor's degree	-0.11	.055	0.06	-0.07	-0.37	.273	0.34	-0.04
Education: graduate degree	-0.25	<.001	0.06	-0.15	1.03	<.001	0.26	0.13
Prescription medication: yes	0.10	.030	0.05	0.06	-0.69	.010	0.27	-0.08
Over the counter medication: yes	-0.02	.769	0.06	-0.01	0.12	.104	0.07	0.05
Other childhood adversities	-0.02	.117	0.01	-0.05				

Note: Comparison group is the normative sub-group.

Discussion

Maltreatment sub-groups

The current study had three aims. The first was to identify sub-groups with specific combinations of childhood maltreatment exposures (i.e., based on both type and chronicity) in a nationally-representative sample of aging adults in the United States. We identified three sub-groups with differing co-occurring childhood maltreatment exposures, based on type and chronicity. The first and largest sub-group was the 'normative sub-group' comprised of individuals who reported no or low chronicity of exposure to all maltreatment types. The second sub-group, the 'physical and emotional childhood maltreatment sub-group', showed higher than average chronicity of emotional abuse and physical abuse, as well as high chronicity of emotional and physical neglect but no or low exposure to sexual abuse. The final sub-group that emerged was the 'sexual abuse sub-group', for whom the most prevalent and chronic form of childhood maltreatment experienced was sexual abuse. The sexual abuse sub-group also experienced higher frequencies of all other types of childhood maltreatment (i.e., emotional and physical abuse and neglect) compared to the normative sub-group and was therefore the sub-group with the most widespread childhood maltreatment exposure overall (i.e., to both: multiple types of maltreatment and to greater chronicity of maltreatment). These findings corroborate previous research on co-occurring types of childhood maltreatment that typically find three similar sub-groups with similar combinations of childhood maltreatment exposures (Aebi et al., 2015; Mishra & Marceau, 2019; Debowska & Boduszek, 2017; Petrenko, Friend, Garrido, Taussig, & Culhane, 2012).

Direct association with sleep quality and physical functional limitations

The second aim was to examine the associations of the sub-groups with differing childhood maltreatment exposures identified in aim 1 with sleep quality in midlife and physical functional limitations in late adulthood. Results showed that both sub-groups who experienced childhood maltreatment had poorer sleep quality in midlife (around age 57) and more functional limitations in late adulthood (around age 68) compared to the normative sub-group. The sexual abuse sub-group reported poorer sleep quality in midlife and more physical functional limitations in late adulthood compared to both of the other sub-groups, with effect sizes approximately two times that of the physical and emotional maltreatment sub-group for both sleep quality and functional limitations.

Results from this aim are generally in line with prior research. One study examining the association between childhood maltreatment exposure types and subsequent functional limitations in adulthood demonstrated that although sexual abuse, emotional abuse, and neglect were all associated with increased risk for physical functional limitations, sexual abuse was linked with the highest likelihood of developing physical functional limitations (Archer et al., 2017). Similarly, even though all abuse types are linked to poor sleep quality, the presence of sexual abuse with other forms of childhood maltreatment exposure has been linked with worse sleep quality in midlife

compared to other forms of abuse (Greenfield et al., 2011). Specifically, the biosocial consequences of early life adversity or stress can increase susceptibility to mental health problems, such as depression and hypervigilance, that can manifest as poorer sleep quality and functional limitations in adulthood (Buckley & Schatzberg, 2005; Fried, Darer, & Walston, 2003; Germain, Buysse, & Nofzinger, 2008; Jaffee & Christian, 2014; Kajeepeta et al., 2015; Koskenvuo et al., 2010; Shonkoff et al., 2012; Turner & Schieman, 2008). Future research should determine specific mental health declines across the lifespan, as well as how these influence sleep quality in midlife and physical functioning in adulthood for survivors of chronic and co-occurring childhood maltreatment exposure.

Moreover, treatment for adults with histories of childhood maltreatment exposure could be an effective downstream approach for preventing maltreatment-associated poor sleep quality and health problems later in adulthood (Kajeepeta et al., 2015). For instance, cognitive-behavioral therapy (CBT) interventions have been shown to improve sleep and mental health in trauma survivors (Davis & Wright, 2007). Among survivors of sexual assault in particular, imagery rehearsal therapy and cognitive processing therapy have been used to lessen sleep disturbances (Gutner, Casement, Stavitsky Gilbert, & Resick, 2013; Krakow et al., 2001) and may be beneficial for improving sleep quality among members of the sexual abuse sub-group in particular. Such therapeutic approaches, however, should be thoroughly evaluated to determine the effectiveness for improving overall sleep quality among individuals with specific constellations of co-occurring maltreatment exposures.

Mediating role of sleep quality

The final aim of our study was to assess the indirect association between childhood maltreatment sub-group membership and physical functional limitations in late adulthood via subjective sleep quality in midlife (i.e., mediation). Results revealed that subjective sleep quality in midlife partially mediated the association between sub-group membership and functional limitations in late adulthood. Specifically, membership in either sub-group was associated with poorer sleep quality in midlife and with more subsequent functional limitations in late adulthood—approximately 50 years after childhood maltreatment exposure. We found that the indirect effect of membership in the sexual abuse sub-group on physical functional limitations via sleep quality was also larger than that found for the physical and emotional maltreatment sub-group—indicating that members of the sexual abuse sub-group experienced even poorer sleep quality compared to the physical and emotional maltreatment sub-group, which, in turn, resulted in greater functional limitations.

Although better sleep quality has generally been associated with better health outcomes, including physical functionality, in aging adults (Friedman, 2016; Goel et al., 2013), exposure to childhood maltreatment can reduce the protective effects of sleep quality on positive health outcomes—even after accounting for other health and social factors (Greenfield et al., 2011; Koskenvuo et al., 2010). Sleep quality in particular is important for proper psychological functioning and promotes resilience against biological dysregulations (e.g., neuroendocrine) and states of hyper-arousal induced by

exposure to childhood maltreatment (Fried, Darer, & Walston, 2003; Jaffee & Christian, 2014; Germain, Buysse, & Nofzinger, 2008; Kajeepta et al., 2015; Koskenvuo et al., 2010; Shonkoff et al., 2012; Turner & Schieman, 2008). This dampening of the benefits of sleep quality due to the trauma and mental health problems induced by childhood maltreatment exposure (Greenfield et al., 2011; Kajeepta et al., 2015; Koskenvuo et al., 2010) is potentially critical for subsequent declines in functional limitations in old age, a novel finding from this study that demonstrates that improving sleep quality could be a potential target for future intervention efforts, particularly for the sexual abuse sub-group. Improved sleep behaviors could act as a resource (Chatburn, Coussens, & Kohler, 2013) against the ill-effects of co-occurring childhood maltreatment exposure on physical functional declines.

Moreover, sleep quality only explained part of the association between the two vulnerable sub-groups and physical functional limitations in late adulthood, indicating that additional factors may explain the association between multiple maltreatment exposures and physical functional limitations in late adulthood. Childhood maltreatment has consistently been related to several chronic illnesses in adulthood, such as higher rates of cardiovascular diseases, and greater risk for developing asthma, diabetes, bladder problems, and chronic fatigue (Leeb, Lewis, & Zoltor, 2011; Suglia, Clark, Boynton-Jarrett, Kressin, & Koenen, 2014)—conditions that have also been implicated in higher rates of physical functional limitations among adults (Fan et al., 2014; Taylor & Lynch, 2011). Other studies have also linked childhood maltreatment to poorer mental health outcomes, such as higher levels of depression (Li, D'Arcy, & Meng, 2016). Both physical (Martin et al., 2017; Stenholm et al., 2015; Taylor & Lynch, 2011) and mental health problems (Lenze et al., 2001) have been linked to greater physical functional limitations in adults and therefore should be examined in future research as additional pathways through which childhood maltreatment exposure may induce its documented influence on functional limitations in late adulthood.

Limitations

Interpretation of these results are informed by several limitations. First, reports of childhood maltreatment were retrospective, and measuring childhood maltreatment exposure with the CTQ (Bernstein & Fink, 1998) may introduce recall bias for maltreatment experiences. However, previous research demonstrates that recall of significant traumatic experiences during childhood remain fairly stable throughout the life course (Ferraro, Schafer, & Wilkinson, 2016; Hardt & Rutter, 2004). Along similar lines, measures of sleep and functional limitations were also self-reported, which could result in single-reporter bias. However, self-reports of health problems tend to be comparable to clinical reports (Kriegsman, Penninx, Van Eijk, Boeke, & Deeg, 1996). The PSQI (Buysse et al., 1989) is an extensively used measure of subjective sleep quality, and despite potential for recency effects to influence the recall of sleep quality, this measure covers multiple domains of sleep difficulties, increasing its utility (Smith & Wegener, 2003). Another limitation of the current research is that we were unable to account for whether participants were co-sleeping with a partner, which may play a role in self-reported sleep quality. Future research should explore co-sleeping and

other more objective measures of sleep to understand sleep problems on a continuum. Finally, the observed effect sizes, particularly for indirect effects, were small, although effect sizes for the direct effects were larger. It is worth noting, though, that even small effects have been shown to have epidemiological significance. For instance, changes in health conditions among at-risk individuals can drastically shift the population distribution for that problem (Braun, 2017). From a clinical perspective, patient perception of improved conditions can also contribute to better quality of life (Page, 2014); therefore small changes may also be important for meaningful improvement in the lives of individuals. Moreover, reported effects are observed above and beyond the effects of other midlife covariates included in our model, and are observed decades after exposure to childhood maltreatment. The mediation effects are multiplicative and therefore smaller than the direct effects.

Conclusion

Even with these limitations, the present study has several merits. The longitudinal nature of the analysis adds to the strength of the present study, allowing for the evaluation of long-term effects of childhood maltreatment on physical functional limitations in late adulthood. Moreover, we evaluate co-occurring childhood maltreatment types based on both type and chronicity of maltreatment. Given the high prevalence of co-occurring childhood maltreatment and the association of higher chronicity of exposure with worse outcomes (Debowska et al., 2017), such an evaluation helps capture the broader phenomena of childhood maltreatment and its role in the etiology of functional limitations in later adulthood. Finally, this study addressed a critical gap in the literature by identifying one potential pathway—subjective sleep quality in midlife—through which these combinations of childhood maltreatment exposures may exert their influence on physical functioning in adulthood.

The impact of childhood maltreatment is life-long and includes physical as well as mental impairments. The results of this study help to identify the survivors of childhood maltreatment who may be most vulnerable to the functional impairments in middle and later life (i.e., those who have experienced sexual abuse) and to illuminate a process—sleep quality in midlife—that explains at least part of the life-long reach of maltreatment in childhood. These results therefore highlight potential avenues for targeted interventions to enable survivors of childhood maltreatment to reduce their risk for functional decline with age.

Ethical approval

The study uses pre-existing data from the MIDUS study that was reviewed and deemed as a category 4 exemption for Human Subjects Research by the Purdue University IRB. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Disclosure statement

The authors declare that they have no conflict of interest.

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