



The role of dispositional mindfulness in a stress-health pathway among Parkinson's disease patients and caregiving partners

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Abstract

Purpose Parkinson's disease (PD) patients and their caregivers experience significant distress that impacts physical, emotional and social functioning in the patient, and in turn, has a significant impact on the caregiver. Lower levels of stress have been associated with a better prognosis in PD. The quality of dispositional mindfulness—innate present moment, non-judgmental awareness—has consistently been associated with less perceived stress, greater well-being, and better physical health in both clinical and healthy populations. To date, associations of mindfulness with distress, depression, sleep problems, and other variables that define health-related quality of life have not been examined in the context of PD patient/caregiver dyads.

Methods We investigated the impact of dispositional mindfulness in a stress-health model among eighteen dyads consisting of PD patients and their caregivers.

Results Multilevel linear modeling (actor–partner interdependence models) revealed significant associations between dispositional mindfulness and stress appraisal, interpersonal support, depressive symptoms, sleep, and health-related quality of life (HRQOL) within both dyadic partners. As expected, results demonstrated significant associations of distress with interpersonal support, depressive symptoms, sleep and HRQOL for both PD patients and caregivers.

Conclusions Dispositional mindfulness was associated with reduced distress and its downstream clinical consequences. These results support an ameliorative role for dispositional mindfulness among PD patients and caregivers, as a protective factor against psychosocial burdens imposed on couples related to disease and caregiving. Findings suggest future studies should explore mindfulness training as a therapeutic option.

Keywords Mindfulness · Parkinson's disease · Quality of life · Caregiver

Introduction

Parkinson's disease (PD) is a chronic neurodegenerative disease affecting approximately one million Americans, with nearly 50,000 new diagnoses each year [1] and more than 750,000 cases projected by 2040 [2]. This progressive, debilitating movement disorder is chiefly characterized by motor symptoms including tremor, bradykinesia, rigidity, and postural instability. However, motor symptoms are often accompanied by non-motor symptoms including emotional distress, cognitive decline, sleep disturbances, and fatigue—symptoms that receive less attention despite being similarly burdensome [3, 4]. Despite limited attention, these non-motor symptoms contribute to important clinical outcomes among PD patients including functional impairment, decreased quality of life, and accelerated disease progression [5].

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Given the cumulative burden of motor and non-motor symptoms, psychological impairments are highly prevalent among PD patients, including anxiety, depression, cognitive decline, and impulse control disorders [6, 7]. Using a stress-health model proposed by Salmon and colleagues [8], the present study investigated how dispositional mindfulness may relate to stress and associated variables including depression, social support, sleep, and quality of life in a sample of PD patients and their caregivers (Fig. 1). Based on Lazarus et al.'s transactional model of stress [9], this model proposes that mindfulness may be associated not only with stress appraisal, but also with downstream factors including mental and physical health outcomes.

Although motor symptoms often receive the greatest attention in treating PD, stress is prevalent and can affect adjustment to the disease. One study reported 69% of women and 67% of men with PD demonstrated elevated symptoms of psychological stress [10]. A common source of psychological stress among PD patients is uncertainty, due to the variable trajectory, unpredictable symptom patterns, medication-induced motor impairments, and treatment-related complications that accompany the disease [11]. In addition to decreased quality of life, sustained psychological stress can catalyze inflammation and increase neurodegeneration, which can further accelerate disease progression [12]. Additionally, PD is complicated by the social implications of the symptoms, such as the anticipation of having to rely on others for activities of daily living [13]. Importantly, social support has been shown to help mitigate the impact of both motor and non-motor/psychological symptoms among PD patients [14], as it may reduce social isolation in both patients and caregivers [15], in turn, reducing the risk of depression and psychological symptom severity among

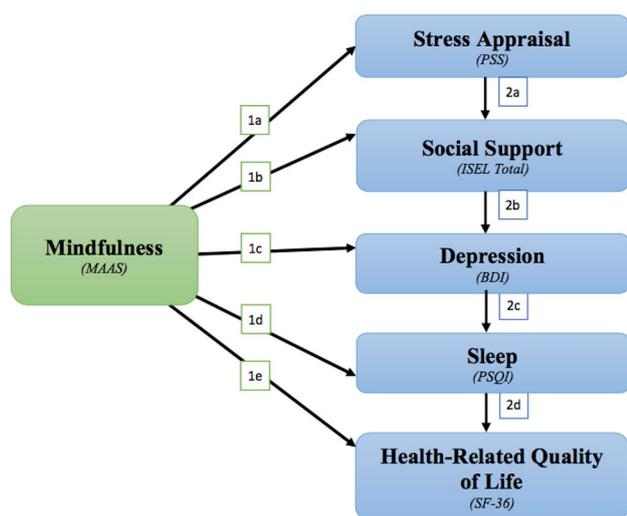


Fig. 1 Hypothesized associations between mindfulness and model factors of Parkinson's disease patients and caregiving partners

patients [14]. Taken together, the prevalence and implications of untreated stress among PD patients certainly warrants greater attention.

Depression is a common psychological manifestation of stress among PD patients. In one study, 23% of female and 18% of male PD patients reported depressive symptoms [10], and a more recent clinical trial reported the prevalence rate of depression and apathy to be greater than 50% [16]. However, inconsistent methods for assessing depression in PD patients have caused its prevalence to be under-recognized or underreported [17]. Moreover, disease-related physical deterioration can mask depressive somatic symptoms. Although the etiology of depression in PD is likely multicausal, with both functional (depressogenic adjustment to diagnosis and impact of the disease) and disease-related decreases in dopamine and noradrenaline [18], patients with PD who experience comorbid depression show poorer adaptation, marked by decreased motor function, impaired activities of daily living, more severe cognitive symptoms and poorer quality of life [7, 15, 19].

Stress-related sleep disturbances are also prevalent in PD [20], affecting between 74 and 98% of patients [21–24]. PD-specific sleep disturbances include nocturnal pain, sleep fragmentation, fatigue, and overwhelming physical exhaustion [25], the latter among the most prevalent (58–77%) and debilitating non-motor manifestations of the disease [25, 26]. Sleep disturbances are associated with both decreased functional capacity and poorer quality of life [27, 28].

The cumulative stress-related outcomes of diminished social support, more depressive symptoms, and poor sleep quality contribute to a downward cascade of diminished mental health and quality of life among PD patients. Indeed, poor mental health-related quality of life is evident among PD patients; in a large study of 887,750 veterans ($n = 14,530$) reported significantly lower mental health-related quality of life (HRQOL) compared to those with other serious health conditions including congestive heart failure, diabetes, arthritis, chronic low back pain, and stroke [29]. Determinants of poor HRQOL among PD patients include mood disturbances, disability, and motor complications [30]. Further, symptoms of PD can worsen quality of life throughout as the disease progresses, including hallucinations, fatigue, dribbling saliva, constipation, drug side effects, and sexual difficulties [5, 19].

Parkinson's disease caregivers

The psychosocial health of PD caregivers also warrants greater attention. As the disease progresses, and PD patients lose functional independence, demands on the caregiver(s) increase. Spouses or family members caring for PD patients report several stressors resulting from disease-related cognitive impairments, behavioral difficulties, functional

dependence, and informal hours of caregiving—all of which increase caregiver distress [31]. Thus, the physical and emotional toll of living with PD affects both patients and caregivers [32] and caregiving demands may exacerbate the physical and emotional burden surrounding the disease that affect both patient and caregiver. Therefore, it is not surprising that caregiver burden has been associated with a decline in the caregiver's well-being as well as poorer patient outcomes, including disease severity and depressed mood [33].

Caregivers may feel overwhelmed, helpless, and unable to provide for the needs of patients [19, 33]. Many report loss of valued activities, uncertainty about the future, discouragement about the disease progression, and feeling housebound and isolated from others [34]. If left unaddressed, caregiver burden and social isolation can predispose caregivers to poorer mental and physical health outcomes, including depressive symptoms [35–37]. For example, a meta-analysis examining caregiving outcomes reported the greatest effect size for depressive symptoms between caregivers and non-caregivers ($g = .58$) [38]. Risk of caregiver depressive symptoms appears to increase with the presence and severity of both motor and non-motor symptoms in PD patients [39], along with duration and amount of care provided [38]. Fortunately, perceived support and caregiving breaks may ameliorate caregiver burden [31]. Moreover, perceived quality of the caregiver–patient relationship helps offset caregiver burden and improve quality of life for all [31]. Thus, disease-driven increases in stress and subsequent health outcomes extend beyond the patient to their caregivers, which seem to affect the health and well-being of both members of the dyad.

While psychosocial stress is often the most prevalent form of stress reported by PD caregivers, their physical health may also be negatively impacted. For example, sleep patterns and circadian rhythms are frequently disrupted as a result of cumulative caregiving burden in addition to the patient's sleep disturbance and symptom severity [40, 41]. Overall, accumulated stress, lack of social support, depressive symptoms, and poor sleep may reduce caregiver quality of life [42]. Although the stress of living with and providing care for persons with PD is well established [10, 43], less is known about how to manage it. Evidence of pervasive psychological, social, and physical effects of PD among patients and caregivers warrants greater attention to dyadic psychosocial treatment options.

Mindfulness

Mindfulness-based interventions (MBIs) may be well-suited to target stress and related consequences in PD patients and caregivers. Mindfulness refers to awareness that arises from “paying attention in a particular way: on purpose, in the present moment, and nonjudgmentally” (p. 4) [44]. In

recent decades, mindfulness has been incorporated into medical and clinical settings to help patients manage stress, chronic pain, anxiety, and depression [45, 46]. MBIs have also been found to improve well-being and quality of life in diverse clinical populations facing stress-related difficulties [47]. Although research with PD patients is limited [48], three studies support the use of MBIs for this population [49–52]. Cash and colleagues [51] reported reduced depressive symptoms and improved communication patterns following an 8-week MBI for PD patients and caregivers. In a separate study, Kwok and colleagues demonstrated that a mindfulness-based yoga intervention for PD patients outperformed a stretching and resistance training intervention on outcomes of anxiety, depression, perceived hardship, equanimity, and HRQOL [52]. Changes in brain structure have also been demonstrated following an 8-week RCT MBI trial; an increase in hippocampal grey matter density was observed [49, 50]. Though limited in number, these studies are consistent in supporting use of MBIs in managing stress associated with PD.

Formal mindfulness training via MBIs is one avenue to reduce illness-related stress. Alternatively, dispositional or “innate” mindfulness (i.e., without formal training) may also have stress-protective benefits [53]. Dispositional mindfulness is considered a two-dimensional construct incorporating both the *focus* and *quality* of attention [54]. Ongoing work aims to capture the essence of dispositional mindfulness (i.e., basic tendency, characteristic adaptation); however, existing data suggests the construct is uniquely distinct from other forms of attention and personality traits [54]. Innately mindful individuals tend to focus more on immediate experiences than on past or future concerns which appears to reduce stress, anxiety, depression, and negative physiological health outcomes [55–57]. Being able to live more “in the moment” may be especially helpful in coping with PD, due to its unpredictable course and progressive loss of independence.

Dispositional mindfulness has also been linked to improved communication and greater relationship quality in non-clinical populations—two important considerations in the context of chronic illness [58, 59]. To date, the role of dispositional mindfulness as a protective factor against stress and poor health in PD patients or caregivers remains unexplored. Thus, the aims of the current study were to: (1) examine the cross-sectional associations of dispositional mindfulness on 4 factors within the stress-health model (perceived stress, interpersonal support, depressive symptoms, and HRQOL) among PD patients and caregivers; (2) assess cross-sectional associations between hypothesized consequential elements of the model (perceived stress, social support, depression, sleep, and HRQOL), (3) test for dyadic “crossover” (partner) effects of dispositional mindfulness on

model factors, and (4) assess possible “crossover” (partner) effects for consequential model factors.

Concerning Aim 1 (Fig. 1), we hypothesized greater dispositional mindfulness would be associated with (1a) less perceived stress, (1b) greater interpersonal support (1c) fewer depressive symptoms, (1d) better sleep quality, and (1e) greater HRQOL for patients and caregivers. In Aim 2, we hypothesized patients and caregivers with less perceived stress would have (2a) greater social support and, as a result (2b) fewer depressive symptoms associated with (2c) better sleep quality, and subsequent (2d) greater HRQOL. Predictions for Aims 3 and 4 were similar to 1 and 2, except that the analyses employed methods to test for possible crossover effects in which PD patients’ outcomes were significantly associated with their caregiver and vice versa.

Method

Participants

Eighteen dyads, each of which was comprised of one PD patient and one caregiving partner, participated in the study. The sample consisted of 36 individuals who were a member of a PD patient-caregiving partner dyad ($k=18$). Patients and caregiving partners ranged in age from 48 to 71 and 36 to 76, respectively. The majority of dyads (17 of 18) were married; one dyad identified as two very close friends. With the exception of one individual, PD patient participants did not have significant movement limitations as determined by self-report and qualitative observation during study participation. Thus, despite our use of the term ‘caregiving partner’ their high functional level necessitated low levels of caregiving. Table 1 presents demographic information from this sample.

Table 2 presents descriptive statistics for all independent and dependent variables, split by patient/caregiver status. The only significant difference between dyad members involved perceived stress, which was higher in PD patients. Table 2 also provides normative comparison groups of healthy older adults from recent research to provide a reference for the current sample [60–64]. Our sample may differ from normative samples in a few key ways. PD patients in this sample reported greater perceived stress and depressive symptoms than healthy older adult samples. Both PD patients and caregivers reported less dispositional mindfulness and poorer physical and mental HRQOL than the comparison samples.

Procedure

Dyads were recruited from the University of Louisville Movement Disorder Clinic at a university-affiliated

Table 1 Sample characteristics ($N=36$)

Demographic variables	Patient	Caregiving partner
Age at study entry, mean (SD)	63.67 (7.029)	62.22 (10.435)
Gender ($N=36$)		
Female	8	9
Male	10	9
Marital status ($N=36$)		
Currently married	16	16
Widowed	1	0
Never married	1	1
Other	0	1
Race ($N=36$)		
White	17	18
Other	1	0
Education ($N=29$)		
High school	4	6
AA/technical	5	1
B.A. or B.S.	5	3
M.A. or M.S.	1	1
Ph.D., M.D., J.D.	2	1
Income ($N=20$)		
< \$20,000	0	1
\$20,000–39,999	2	0
\$40,000–59,999	4	2
\$60,000–79,999	1	2
\$80,000–99,999	2	1
≥ \$100,000	4	1
Current employment status ($N=25$)		
Full-time	6	2
Part-time	1	1
Homemaker or caregiver	1	0
Retired	9	3
Permanently disabled	1	1
Living situation ($N=25$)		
Live alone	2	2
Live w/significant other	15	5
Live w/children/other relatives	1	0

rehabilitation facility specializing in PD care as part of a larger parent study. Inclusion criteria consisted of: (1) a diagnosis of idiopathic PD of at least 3 years duration, based on the UK PD Brain Bank (UKPDBB) criteria [65]; (2) adequate cognitive functioning Mini-Mental Status Examination (MMSE) score ≥ 25 [66]; (3) Stage II or III on the Hoehn and Yahr Parkinson’s disease severity scale [67]; (4) age greater than 40; and (5) proficiency in written and spoken English. Caregivers were also required to demonstrate adequate cognitive functioning (MMSE score ≥ 28) and proficiency in written and spoken English. Exclusion criteria for both patients and caregivers included: (1) medical

Table 2 Descriptive statistics of self-report measures with healthy older adult comparison means

Self-report measures	PD patients	PD partners	Healthy older adult comparison samples	
	Mean (SD)	Mean (SD)	Mean (SD)	References #
Mindfulness (MAAS)	4.40 (1.11)	4.60 (.86)	5.3 (.7)	[60]
Perceived stress (PSS)	19.89 (7.67)	15.78 (6.57)	13.34 (6.39)	[61]
Interpersonal Support Evaluation List (ISEL)	97.51 (13.77)	102.72 (14.51)	95.08 (18.87)	[62]
Beck Depression Inventory (BDI)	8.22 (7.57)	5.55 (5.53)	4.21 (4.25)	[62]
The Pittsburgh Sleep Quality Index (PSQI)	6.28 (2.61)	4.94 (2.15)	5.00 (3.20)	[63]
SF-36 Physical Health Composite	41.21 (10.06)	49.98 (10.01)	79.0 (15.6)	[64]
SF-36 Mental Health Composite	51.88 (10.00)	55.12 (8.28)	77.4 (15.3)	[64]

Note: Reference # corresponds with citation listed in References

and/or psychological impairments of sufficient severity judged by the senior medical director that could interfere with participation, (2) current use of systemic hydrocortisone-based steroids, or (3) deep brain stimulation (DBS) treatment. Given that the larger parent study included an intervention with components of yoga, careful consideration of physical ability was given during dyad selection by the lead rehabilitation specialist. A total of 141 dyads were referred, 86 of which were eligible, and 19 of which provided informed consent; however, one dyad dropped out due to time and schedule constraints. Eligible dyads were interviewed and provided with information about the study, which was approved by the University of Louisville Institutional Review Board, Human Studies Protection Program (HSPP). Each dyad attended two preliminary sessions, the first to obtain informed consent, conduct cognitive testing, and distribute study questionnaires for completion at home; the second to return completed questionnaires.

Measures

Information contained in the questionnaire packet included demographic information, questionnaires regarding mindfulness, perceived stress, interpersonal support, depressive symptoms, sleep, and HRQOL. Measurements of disease status (Hoehn and Yahr stage) and disease duration (in months) were also obtained through medical chart review.

Demographic characteristics

Demographic data were collected via questionnaire. Participants reported their age, gender, marital status, race, education, income, current employment status, and living situation. Caregivers reported on duration of (in months) and time spent caregiving (in hours/day). Due to inadvertent changes in demographic items on questionnaires, 11 caregivers were not assessed for income, employment status or living situation resulting in slightly smaller samples for some demographics.

Dispositional mindfulness

Mindfulness was assessed using the Mindfulness Attention and Awareness Scale (MAAS) [55]. The MAAS is a 15-item self-report scale measuring general attentiveness and awareness of the present moment in everyday life. Greater scores on this measure indicate a greater degree of dispositional mindfulness. This instrument has been independently used to measure dispositional mindfulness among individuals with and without meditation experience and has been effectively used with an older adult sample [68] and disease populations [69]. Among this sample of PD patients and caregivers, the MAAS demonstrated excellent internal consistency, $\alpha = .93$.

Stress appraisal

Stress appraisal was assessed using the Perceived Stress Scale (PSS) [70]. This ten-item self-report measure assesses the degree to which situations in one's life are appraised as stressful. Higher scores on the PSS indicate greater stress appraisal. This measure has been widely used and well validated [70]. Among the current sample, the PSS demonstrated good internal consistency, $\alpha = .84$.

Social support

Social support was measured using the Interpersonal Support Evaluation List (ISEL) [71]. This scale consists of 40-items measuring the perceived availability of support resources. This scale contains four subscales (tangible, appraisal, self-esteem, and belonging). Higher scores indicate a greater degree of perceived social support. The ISEL demonstrated low internal consistency in the current sample, $\alpha = .50$. Use of a separate measure of internal consistency shows marginal reliability, Guttman's $\lambda = .65$.

Depressive symptoms

Depressive symptoms were assessed using the 21-item Beck Depression Inventory (BDI) [72]. This widely used, well-validated measure assesses for the presence of depressive symptoms. Higher scores on the BDI suggest greater severity of symptoms of depression. Among the current sample, the BDI demonstrated excellent internal consistency, $\alpha = .89$.

Sleep quality

Sleep quality was measured using the Pittsburgh Sleep Quality Index (PSQI) [73]. The PSQI contains 9-items measuring the quality and patterns of sleep including seven components of sleep: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. Higher scores on the PSQI reflect poorer sleep quality. This measure has frequently been used with older adult and disease populations [74, 75]. In the current sample, the PSQI demonstrated marginal/low reliability, $\alpha = .51$, $\lambda = .57$.

Health-related quality of life

HRQOL was measured using the Short-Form Health Survey-36 (SF-36) [76]. This 36-item self-report measure assess health status and related quality of life. The SF-36 measures eight health concepts: limitations in physical activities due to health problems, limitations in social activities due to physical/emotional problems, limitations in usual activities because of physical health problems, limitations in usual activities because of emotional problems, bodily pain, general mental health, vitality, and general health perceptions. These domains are aggregated and summed to calculate the Mental and Physical Health Composite (MCS; PCS). The SF-36 has been validated on an older adult population [77] and demonstrated good internal consistency in the current sample, $\alpha = .725$.

Data analytic strategy

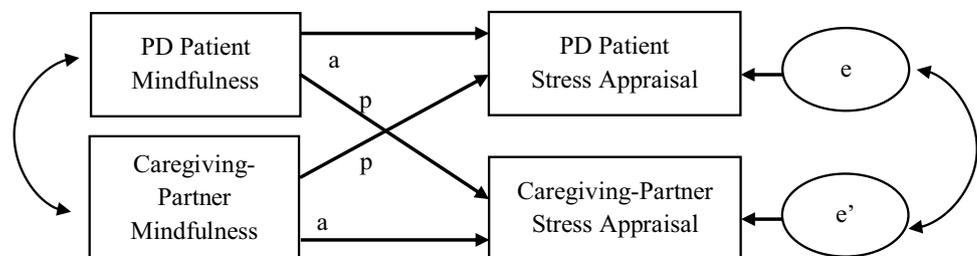
A commonly used conceptual and statistical model for assessment of dyadic data—the actor–partner

interdependence model (APIM)—was selected as the data analytic strategy for the current study [78]. APIM highlights the interdependence of dyad members and the potential for certain characteristics of one dyad member to affect the outcomes of both dyad members. APIM outlines two variables of interest—a predictor variable and an outcome variable—that are separately measured within each dyad member. APIM analyses calculate both actor and partner effects within the model. Actor effects examine the influence of one’s predictor score on his/her own outcome and partner effects examine the influence of one’s predictor score on his/her partner’s outcome. Importantly, actor and partner effects are distinct from the role of PD patient and caregiver such that actor effects exist for both PD patients and caregiver. The APIM provides a strong framework for hypotheses centered on both individual (i.e., actor) and “crossover” (i.e., partner) associations among both PD patients and their corresponding caregivers.

Data preparation and analyses were conducted using IBM SPSS v22.0. The dataset containing cleaned summary scores was transformed from an individual-level dataset, wherein each row contains data for one individual, to a pairwise dataset, wherein each row contains data for both the PD patient and his/her caregiver. An individual’s own data within the pairwise dataset was labeled as “actor” variables and the individual’s dyadic partner’s data (i.e., if PD patient, his/her caregiver; if caregiver, the PD patient) within the pairwise dataset was labeled as “partner” variables.

Prior to analyses, actor and partner predictor variables were grand-mean centered, consistent with Enders and Tofghi’s procedure to aid in the clarity of interpretation of predictor variable coefficients [79]. Dyads in the current study were considered “distinguishable,” as there is a systematic factor (i.e., only one member in each dyad is a PD patient) that distinguishes members within the dyad; the variable ‘role’ was created to distinguish patients and caregiver (role was coded as 1 = patient, -1 = caregiver). Prior to running analyses, the assumption of non-independence for distinguishable dyads was tested for each predictor variable using Pearson product-moment correlation. Non-independence between predictor scores demonstrates that the dyad members are more similar or more dissimilar to one another on

Fig. 2 Actor–partner interdependence model approach examining hypothesis 1a: PD patient and caregiving partner mindfulness on each individual’s stress appraisal (a; actor effect) and the stress appraisal of their partner (p; partner effect)



the variable of interest than are two individuals outside of the dyad.

Although the APIM is traditionally and conceptually illustrated as a structural equation model (see Fig. 2 for illustration of Hypothesis 1a), the parameters of APIM can also be estimated using linear models, particularly for smaller sample sizes that cannot withstand SEM. With conservative intent in the context of this relatively small sample, multilevel modeling with restricted maximum likelihood was utilized to estimate a series of APIM analyses to assess hypothesized associations. The variable ‘Dyad,’ which denotes each patient/caregiver dyad, was entered as an upper-level variable, with each individual participant scores entered as lower-level variables. As noted above, preliminary analyses used maximum likelihood estimation to assess ‘role’ as a systematic factor that distinguishes the two individuals within a dyad from one another. For associations distinguishable by role, the residual structure in APIM analyses was heterogeneous compound symmetry. For associations that were not distinguishable by role, the residual structure in APIM analyses was compound symmetry with correlation parameterization.

Results

Aim 1

Non-independence was found for all predictor variables of interest, providing support for use of dyadic data analyses. Consequently, APIM analyses were used to assess all four study aims. Results of APIM analyses are presented in Table 3 demonstrating fixed effects of dispositional mindfulness on outcome variables of interest. Interpretation of the *t*-statistic demonstrates the statistical significance of actor and partner effects within each model. APIM analyses assessing dispositional mindfulness as a predictor of hypothesized stress-health relationships (1a–1e) revealed significant actor effects for each association. When holding partner dispositional mindfulness constant, individuals with greater dispositional mindfulness showed significantly less perceived stress, greater social support, fewer depressive symptoms, better sleep quality, and greater HRQOL.

Aim 2

APIM analyses of downward associations between hypothesized factors (Fig. 1) revealed significant actor effects for each association. When holding their partner’s level of perceived stress constant, individuals with greater perceived

Table 3 Multilevel regression coefficients estimating actor and partner effects of mindfulness on perceived stress, social support, depression, sleep, and health-related quality of life

	Perceived stress (PSS)		Social support (ISEL)		Depression (BDI)		Sleep (PSQI)		Health-related quality of life SF-36 MCS			
	<i>b</i>	β	<i>b</i>	β	<i>b</i>	β	<i>b</i>	β	<i>b</i>	β		
Intercept	17.75		100.12		6.89		5.61		53.50			
Role	1.63	.22	2.89 (15)*	-	-	-	-	-	-	-		
Actor mindfulness	-4.90	-.66	-5.14 (21)***	.45	2.6 (27)*	-.83	-6.26 (27)***	-1.64	-.66	-3.76 (27)***	.78	6.07 (28)***
Partner mindfulness	-.69	-.09	-.82 (29)	.17	1.02 (27)	.12	.89 (27)	.94	.38	2.16 (27)*	-.21	-.02
Role*actor mindfulness	-.77	-.10	-.60 (16)	-	-	-	-	-	-	-	-	-
Role *partner mindfulness	.01	.01	.01 (17)	-	-	-	-	-	-	-	-	-

p* < .05, *p* < .01, ****p* < .001. Entries marked with dashe (-) were not estimable, as these associations were not distinguishable by ‘Role’. ‘*b*’: unstandardized beta; ‘ β ’: standardized beta

stress reported less social support (2a), $t(30) = -2.86$, $p < .001$. When their partner's level of social support is held constant, individuals with less social support reported greater symptoms of depression (2b), $t(30) = -4.11$, $p < .001$. When holding their partner's depressive symptoms constant, individuals with greater symptoms of depression reported poorer sleep quality (2c), $t(31) = 2.92$, $p < .01$. Finally, when holding their partner's sleep quality constant, individuals with poorer sleep quality had poorer HRQOL (2d), $t(27) = -3.32$, $p < .01$.

Aim 3

APIM analyses assessing an individual's level of dispositional mindfulness as a predictor of his/her partner's level of stress-health variables (3a–3e) revealed one significant partner effect. When holding the partner's level of dispositional mindfulness constant, an individual's level of dispositional mindfulness was significantly associated with his/her partner's sleep quality (3d).

Aim 4

No significant findings emerged in APIM analyses assessing partner effects on downward associations between hypothesized factors.

Discussion

These results demonstrate that PD patients and caregivers who reported greater dispositional mindfulness also reported less perceived stress, greater social support, fewer depressive symptoms, greater sleep quality, and greater HRQOL. Given the limited sample size, results are interpreted with caution. First, Aim 1 findings suggest a potential ameliorative role of dispositional mindfulness on stress-health pathways among PD patients and caregivers. These associations of dispositional mindfulness have been previously demonstrated in older adult [68] and other patient populations [80]; however, the current findings are novel in the context of PD. The results of Aim 1 suggest that dispositional mindfulness may not only be protective against psychological distress among PD patients, but also among their caregivers. The high number of statistically significant associations found here support the continued utility of the theoretical model we tested [8]. This model posits that mindfulness may have beneficial effects on mental and physical health outcomes by way of multiple pathways including direct effects on biobehavioral outcomes such as sleep and HRQOL among patients and caregivers. It is also possible that PD patients and caregivers who possess greater dispositional mindfulness may have increased awareness and acceptance of the

disease—reducing their perception of stress and beneficially influencing downstream factors of the model.

Individuals who do not manage their stress via mindfulness-based approaches, or other avenues, may experience negative downstream effects of stress on mental and physical health as explored via Aim 2. Findings from Aim 2 demonstrate evidence of an association between lower perceived stress and greater social support, which in turn, was associated with fewer depressive symptoms. Because data were collected at a single time point, the direction of association between dispositional mindfulness and social support is unknown. It is possible that increased social support within a dyad contributes to the dispositional mindfulness of its members. Indeed, no directionality may be implied from any of the results obtained. As expected, there were significant interrelationships among depressive symptoms, sleep quality, and HRQOL. These data are novel in this population and highlight the importance of early intervention to mitigate the possible cascading effects of stress on important health outcomes and well-being; however, longitudinal assessment is necessary.

Dyadic implications

Understanding the influence PD patients and their caregivers have on one another is critical, particularly given the demand for formal or informal caregiving throughout the PD disease trajectory. Importantly, the nature of the dyadic relationship between PD patients and their caregivers demands interaction; the influence between dyad members is unavoidable. However, previous studies that have attempted to understand the potential for caregiving to influence patient outcomes or for patient factors to influence caregivers have often enrolled or assessed each member of the dyad separately. The lack of dyadic enrollment and dyadic assessment fails to acknowledge the mutual influence that two individuals may have on study outcomes. Moreover, studies that collect data from two dyad members, but fail to account for the variance that may be due to dyadic relationship factors can contribute to findings that lack holistic understanding. Thus, research examining patient-caregiving relationships must statistically account for the impact of this influence on study outcomes.

To our knowledge, the current study is the first to require dyadic enrollment and participation, the first to assess the same factors using the same measures, and the first to use sophisticated modeling techniques to account for the inherent influence between dyad members in a cohort of PD patients and corresponding caregivers. Findings of Aim 3 demonstrated an inverse partner effect, such that the dispositional mindfulness of one partner was negatively associated with sleep quality in the corresponding dyad member. Visual examination of our data suggests that this relationship may be driven by PD patients—patients who reported greater

dispositional mindfulness also had caregivers with poorer sleep quality. Further research is warranted to explore the nature of this relationship. Moreover, caution should be used in interpretation of this partner effect, as dysregulated sleep is a common symptom of PD progression [25]. Thus, our finding may perhaps be indicative of disease-related change than a true effect of the patient's dispositional mindfulness on their partner's sleep quality.

Overall, the assessment of the dyadic unit in the present study may contribute to increased understanding of the mutual influence of stress-health factors, including the beneficial role that mindfulness may serve for both patients and caregivers. Results identified dispositional mindfulness as a quality that may be associated with greater psychosocial health outcomes among both PD patients and their caregivers. These findings illuminate the potential value of including both members of the PD patient/caregiver dyad in interventions.

Limitations

Limitations to the current investigation include a small sample size, the potential for sampling bias (e.g., motivated volunteer participants), and use of cross-sectional analyses of data collected at a single time point. It is possible these patients and their caregivers were willing to participate because they were more dispositionally mindful. Thus, the generalizability of the results is limited to dyads who may similarly choose to participate in a mindfulness study. Alternatively, it remains unknown if participants' willingness to partake in the study was influenced by other individual factors, such as positive and supportive relationship qualities. Thus, although participants with PD may have been relatively early in disease progression and perhaps higher functioning compared to more progressed samples, PD patients early in the disease trajectory are severely understudied. Nonetheless, given the nature of this sample, findings of this study may not be immediately generalizable to more advanced PD patients and caregivers. This sample provides unique insight into the downstream effects of stress-pathways as well as dyadic functioning prior to onset of significant motor-related symptoms, which is a current gap in the literature. Nonetheless, this sample restricts generalizability for PD patients experiencing more progressed disease, caregivers who have not yet transitioned into extensive caregiving roles. Although our small pilot-level sample may limit statistical power, the rigor of our methodology and choice of statistical analyses may be seen as a strength.

Future directions

These results lay important groundwork for future investigations of dyadic interactions in the context of chronic disease. We have demonstrated use of statistical modeling techniques to assess interactions between patients and caregivers across a range of psychological variables. Furthermore, we demonstrate how mindfulness may ameliorate some of the more distressing aspects of a chronic, deteriorative disease in both patients and caregivers. Overall, robust findings in a relatively small sample (18 dyads) are suggestive of great promise for future research. Possible avenues include the following: First, exploration of dyadic effects among PD patients and caregivers at more advanced stages of the disease. Second, further clarify how caregiver's stress can impact the patient's symptom progression. And third, conduct additional analyses to determine the nature of the protective effects dispositional mindfulness appears to have on patients and caregivers. Future investigations should supplement self-report questionnaire data with biomarkers to elucidate potential mechanisms by which dispositional mindfulness protects those afflicted with this disease, including dyadic partners.

Conclusion

Population estimates suggest the rate of PD may double in the next decade [81]. With global increases in PD, and its associated stressors, research aimed at reducing the psychosocial burden of the disease in both patients and caregivers is timely. To our knowledge, the current research is the first to explore the role of dispositional mindfulness in PD patients and their caregivers. Results of this study support a model of stress linking mindfulness with stress and its associated health outcomes.

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Compliance with ethical standards

Conflict of interest The authors declare they have no conflict of interest.

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