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Prospective predictors of care partner burden and depression in Parkinson's disease

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Abstract

Objectives: Care partners who provide informal care to individuals with Parkinson's disease (PD) report higher levels of burden and depression; however, longitudinal research on these symptoms is scarce. The current study assessed changes in care partner burden and depression, and patient and care partner predictors of these symptoms over time. Such knowledge may provide important information for assessment and treatment of depression and burden in care partners of individuals with PD.

Research Design and Methods: Participants were 88 PD patients without dementia and their self-identified care partner ($n = 88$). Care partners completed the Geriatric Depression Scale and Zarit Burden Interview. PD participants completed mood questionnaires and a motor exam at baseline and 2 year follow-up. Relationships among care partner burden and depression over time with patient and care partner predictors (i.e., demographic, mood, and disease characteristics) were assessed using correlations and regression analyses.

Results: Care partner burden and depression significantly increased over an approximate 2 year period. Greater baseline disease severity predicted worsening of care partner burden ($p = 0.028$), while baseline patient depression predicted worsening of care partner depression ($p = 0.002$).

Conclusions: Results highlight differential impacts of specific PD symptoms on worsening care partner burden compared to depression; increased PD disease severity predicts increased burden, while patient mood predicts worsening of depression over time. Targeting PD disease severity and mood symptoms may prevent the progression of care partner burden and depression.

KEYWORDS

caregiver, caregiver outcomes, longitudinal, movement disorders

Key points

- Care partners who provide informal care to individuals with Parkinson's disease (PD) often report higher levels of burden and depression; however, longitudinal research on these symptoms is scarce.

- Study results revealed that both care partner burden and depression worsen over time, and are differentially predicted by specific PD symptoms.
- Greater baseline PD disease severity best predicted significant increases in care partner burden over an approximate 2 year period, while baseline patient depression was the primary predictor of increases in care partner depression over time.
- Findings suggest that interventions targeting PD disease severity and mood symptoms may prevent the progression of care partner burden and depression over time.

1 | INTRODUCTION

Parkinson's disease (PD) is a neurodegenerative disease characterized by motor and non-motor symptoms. PD patients often rely on informal caregivers (i.e., those without formal training) or care partners, (i.e., friends and family) for physical, emotional, social, and economic support.[1,2] The terms 'caregiver' and 'care partner' are frequently used interchangeably given that caretaking may increase as the disease progresses and care partners subsume the role of 'caregiver'. The term 'care partner' herein describes one who provides informal care for an individual with a chronic disease.[3,4] Care partners are at risk for medical[5,6] and psychological problems, including burden and depression,[7,8] which can reduce quality of life in both care partners and patients.[9] While cross-sectional studies have examined the relationships among PD patient and care partner factors, care partner burden, and depression, no prospective studies have investigated longitudinal changes in care partner burden and depression or predictors of these changes in the same sample. Due to the progressive nature of PD and its impact on patients and care partners, there is a need to clarify the trajectory of these symptoms and their risk in PD partners to identify specific patient and/or care partner treatment targets to ameliorate these symptoms.

1.1 | Care partner burden

Higher care partner burden (i.e., perceived level of physical, mental, emotional, and socioeconomic stress due to care taking[10,11]) is associated with more severe motor and non-motor symptoms of PD, including worse motor functioning, worse mood, and worse cognitive functioning.[11,12] Leiknes and colleagues' (2015) review of cross-sectional studies of PD care partner burden,[13] and additional studies[8,12,14-18] concluded that PD non-motor symptoms, particularly greater cognitive decline and higher levels of apathy and depression, showed stronger associations with greater care partner burden compared to motor symptoms. Care partner characteristics, such as higher education levels and greater levels of depression, have also been shown to be associated with greater care partner burden.[8,15,17,19]

Research on changes in PD care partner burden over time is limited and contradictory, with one study finding PD care partners reported stable burden over a 1 year period,[20] while another study reported significant increases in care partner strain (e.g., 'difficulty in fulfilling family care role') over a 10 year period.[21] The latter study found that female care partners and lower levels of baseline general optimism predicted worse care partner strain in PD at a 10 year follow-up after controlling for disease stage.[21] However, little is known about the evolution of the relationship between patient factors and care partner burden over time.

1.2 | Care partner depression

Depression is common in care partners of PD[22] and has been described as feelings of sadness, irritability, and fear of the future. A review by Greenwell and colleagues[23] (2015) summarized that PD care partner depression is associated with patient demographics (i.e., lower education), motor (i.e., increased PD severity), and non-motor symptoms (i.e., cognitive and functional impairment; neuropsychiatric symptoms). Similar to care partner burden, non-motor symptoms, including patient cognition (i.e., delayed recall memory) and depression, were stronger predictors of care partner depression compared to motor symptoms.[24,25] Likewise, the few longitudinal studies that have been conducted assessing these relationships revealed mixed findings about care partner depression over time. While O'Connor and McCabe[26] (2011) found care partner mood remained stable over a 1 year period, Lyons and colleagues[27] (2004) found care partner depressive symptoms increased significantly over a 10 year period, and lower levels of optimism predicted greater levels in care partner depression. Further research would clarify the impact of these symptoms on care partner depression over time.

Although distinguishable, research demonstrates that care partner burden and depression are closely linked.[6,8,15,17,23] However, no studies to date have examined the relationship between these two constructs in the same PD-care partner sample over time. Such information could provide a clearer picture of the care partner experience and may guide potential interventions to target care partner depression and/or burden.

1.3 | Study rationale and aims

Due to the progressive nature of PD and potential for long-term negative impact on care partners, the current study sought to (1) examine changes in, and the relationship between, care partner burden and depression over time; and (2) identify baseline PD patient

factors (demographics, disease characteristics, mood, and global cognition) and care partner characteristics (demographics, mood) that may predict changes in care partner burden and depression over time. We hypothesized that: (1) care partners will report significant increases in burden and depression and both factors will be associated over time, and (2) higher care partner (i.e., depression) and patient mood symptoms (i.e., depression, apathy), and worse patient global cognition at baseline will best predict changes in both care partner burden and depression over time.

2 | METHODS

2.1 | Participants

Eighty-eight non-demented individuals with PD and their self-identified informal care partners (88.64% spouses, 6.82% children, 3.41% friends, and 1.14% siblings) were included in the present study. Participants were recruited from Movement Disorder Clinics at the University of California, San Diego, the Veterans Affairs San Diego Healthcare System (VASDHS), and through community outreach. The VASDHS IRB approved this study, and all participants provided written informed consent. PD diagnosis was verified by board-certified neurologists specializing in movement disorders and met the UK Brain Bank criteria for PD diagnosis[28]; one participant's diagnosis changed to 'questionable PD' at follow-up. PD participants completed health questionnaires (demographic and disease information), a global cognition assessment, self-report mood questionnaires, and a motor exam. All participants were assessed on their normal doses of medication, unless otherwise indicated. Levodopa equivalent dose (LED) was calculated using the online Parkinson's Measurement calculator.[29] Exclusion criteria included history of alcohol or substance use disorders; neurological diagnoses other than PD (e.g., stroke); serious mental illness (e.g., schizophrenia); and neurosurgery (e.g., Deep Brain Stimulation; DBS) upon enrollment. One PD participant received DBS surgery between baseline and follow-up testing. Sensitivity analyses revealed no significant differences when the DBS dyad, or questionable PD at follow-up, were excluded.

Care partners completed self-report mood and burden questionnaires at baseline and follow-up. Inclusion criteria included the ability to answer questions regarding the enrolled PD patient.

3 | MATERIALS

3.1 | Care partner measures

Care partner burden was evaluated with the 22-item Zarit Burden Inventory (ZBI).[30] Items are rated on a 5-point Likert scale ranging from 0 (never) to 4 (nearly always). The total scores range from 0 to 88, with higher scores indicating greater burden. Scores ≥21 are considered clinically significant.[31] This scale is commonly used and validated for PD care partners.[32]

Care partner depression was assessed with the 30-item Geriatric Depression Scale (GDS).[33] Yes/no self-report items are summed for a total score ranging between 0 and 30. Higher scores denote greater depressive symptomatology; scores ≥11 suggests clinically significant depression.[33]

3.2 | PD patient measures

PD depressive symptoms were assessed with the GDS.[33] The GDS has been validated in PD with total scores of 9–10 indicating clinically significant levels of depression.[34,35] Patient self-reported anxiety was assessed with the State-Trait Anxiety Inventory—Trait Anxiety Scale (STAI-Trait)[9]; a scale with convergent and discriminant validity in PD.[36] Higher scores indicate greater levels of trait anxiety, with a total range of 20–80. Patient-reported apathy was assessed using the Starkstein Apathy Scale (SAS), which has been validated in PD.[37] Total scores range from 0 to 42 with higher scores indicating greater levels of apathy.

A minimally modified version of the Mattis Dementia Rating Scale (MDRS)[38] was administered to PD patients to assess global cognition; dementia was considered per indication on eligibility screening, or <124 on the MDRS.[39] The MDRS is widely used and validated in PD.[40] Motor function was assessed by a board-certified neurologist using the Movement Disorder Society—Unified Parkinson's Disease Rating Scale (MDS-UPDRS-Part III)[41] motor exam including the modified Hoehn and Yahr disease stage (H&Y).[42,43] At the baseline assessment of the MDS-UPDRS-Part III, 59.1% ($n = 52$) participants were tested 'off' medications (i.e., after a nighttime washout) or were drug naïve, 38.6% ($n = 34$) were tested on their normal dosages of medications, and two participants were unknown in their medication status. Correlations between care partner burden/depression and MDS-UPDRS-Part III medication use (i.e., on v. off) were not significant (all p's > 0.300) and thus, total MDS-UPDRS-Part III scores for the whole sample were used in the analyses.

All participants and their care partners were reassessed with the same measures approximately 2 years after baseline (mean years between evaluations = 2.42, SD = 0.61).

3.3 | Data analyses

IBM SPSS Version 26[44] was used for all analyses. All variables were assessed for normality and outliers and fell within acceptable skewness and kurtosis limits as outlined by Kline,[45] except for LED (kurtosis >7). Disease duration, baseline and follow-up care partner burden, and baseline and follow-up care partner depression did not pass visual inspection; therefore, non-parametric statistics were used for bivariate analyses involving these variables. Residuals were within normal limits for all regression analyses.

Wilcoxon signed rank tests were conducted to assess differences between baseline and follow-up scores for care partner depression

and burden. To quantify differences between baseline and follow-up ratings, a change score was calculated for both depression and burden (follow-up score minus baseline score), with higher change scores denoting greater increases in burden or depression. To examine the relationships between depression change, burden change, and identify potential baseline predictors, and for consistency, Spearman correlation analyses were conducted between patient/care partner factors (baseline demographics, disease characteristics, and mood) and care partner burden and depression change scores. Correlation coefficient strength was interpreted as small = 0.1, medium = 0.3, and large = 0.5, and standardized mean differences (*d*) were considered small = 0.2, medium = 0.5, and large = 0.8.[46] Cramer's *V* values were interpreted as small = 0.10, medium = 0.30, and large = 0.50.[46] Variables showing significant correlations ($p \leq 0.050$) with the criterion of interest were entered as predictors into two stepwise regression analyses, with care partner burden and depression change scores serving as respective criterions. Multicollinearity diagnostics were within acceptable limits (Tolerance <0.10 and VIF >10).[47] *P*-values ≤ 0.050 were considered significant.

4 | RESULTS

4.1 | Care partner and participant characteristics

Care partners were mostly females (71%), over 60 years of age ($M = 63.60$), and college educated (*M* years of education = 15.98). PD patients were primarily male (72%), over 65 years of age ($M = 67.39$), and college educated (*M* years of education = 16.49). At baseline, patients had been diagnosed with PD for an average of 5 years ($M = 5.61$). Baseline patient GDS scores were below the clinical cut-off ($M = 6.17$, SD = 5.16). Mean follow-up GDS scores were also below the clinical cut-off ($M = 6.92$, SD = 6.35). At baseline, 27.6% ($n = 24$) of the care partners and 27.3% at follow-up met clinical criteria for depression. Based on these clinical cut-offs, all participants remained relatively stable from baseline to follow-up. Median H&Y rating of 2, and median MDS-UPDRS-Part-III of 18.50, indicated participants were primarily in the PD stage characterized by bilateral involvement without postural instability. There was no significant difference between patient baseline and follow-up MDS-UPDRS Part-III, $t(76) = 1.19$, $p = 0.237$, $d = 0.14$, or LED total, $t(81) = -0.09$, $p = 0.928$, $d = 0.01$. There was a small, significant decline in PD MDRS scores from baseline to follow-up, $t(87) = 2.54$, $p = 0.013$, $d = 0.27$. Compared to the PD group, the care partner group was significantly younger with a small-medium effect size ($t(163.24) = 2.66$, $p = 0.009$, $d = 0.40$), and had fewer males (medium effect size), χ^2 (1, $n = 88$) = 29.46, $p < 0.001$, $V = 0.42$). There was no significant difference between groups for years of education ($t(174) = 1.41$, $p = 0.162$, $d = 0.21$). Sample demographic information is provided in Table 1.

On average, baseline ZBI total scores indicated mild-moderate burden based on the established cut-off scores ($M = 13.12$, SD = 12.35), with 20.5% ($n = 18$) of the care partners scoring within the clinically significant range. Follow-up ZBI scores also indicated mild-moderate burden ($M = 17.60$, SD = 15.39), with 33.0% ($n = 29$) of the care partners scoring within the clinically significant range. Notably, 13 care partners who were not clinically burdened at baseline became clinically burdened at follow-up, and two care partners who were considered clinically burdened at baseline did not meet the criteria for clinical burden at follow-up. There was no significant difference in the proportion of care partners who exhibited clinical levels of burden versus those who did not between follow-up and baseline, $X^2(1, 88) = 3.51$, $p = 0.061$. Mean baseline and follow-up care partner GDS scores were below cut-offs for clinically significant depression (baseline $M = 3.93$, SD = 4.34; follow-up $M = 4.91$, SD = 6.01), with 9.1% ($n = 8$) and 12.5% ($n = 11$) meeting clinically significant depression at baseline and follow-up, respectively. Notably, five participants' depressive symptoms increased to reach clinical significance from baseline to follow-up, and two participants were no longer clinically significant at follow-up. There was no significant difference in the proportion of care partners who exhibited clinical levels of depression versus those who did not at follow-up compared to baseline, $X^2(1, 88) = 0.53$, $p = 0.466$. Compared to the PD group (*Median* = 5, $n = 87$), the care partner group (*Median* = 2, $n = 88$) had significantly fewer depressive symptoms ($z = -3.30$, $p < 0.001$, $r = -0.25$); individual group means can be found in Table 1.

4.2 | Changes in care partner burden and depression over time

Wilcoxon Signed Rank tests revealed significantly greater levels of care partner burden ($Z = -4.58$, $p < 0.001$) and depression ($Z = -2.41$, $p = 0.016$) at follow-up compared to baseline. Of the current sample, 61.5% experienced increased burden, 8% remained stable, and 31% decreased over follow-up. Depression in care partners increased for 45%, remained stable in 25%, and declined in 30% of the sample. Baseline care partner depression and burden were significantly related at baseline ($r_s = 0.523$, $p < 0.001$) and at follow-up ($r_s = 0.440$, $p < 0.001$). Changes in care partner burden and care partner depression over the 2 year period were also significantly associated ($r_s = 0.28$, $p = 0.008$; Figure 1).

4.3 | Baseline predictors of changes in care partner burden and depression

Higher baseline H&Y ($r_s = 0.27$, $p = 0.013$, 95% CI [0.06, 0.45]), LED ($r_s = 0.25$, $p = 0.020$, 95% CI [0.04, 0.44]), and longer disease duration ($r_s = 0.24$; at $p = 0.024$, 95% CI [0.03, 0.43]), were significantly correlated with increased care partner burden over the 2 year follow-up period (Table 2). All other patient and care partner demographics and patient psychiatric variables were not related to care partner burden change scores (*p*'s ≥ 0.090). Notably, baseline care partner burden was not associated with care partner burden change scores ($p = 0.904$). Increases in care

TABLE 1 PD participant and care partner demographics and characteristics at baseline and follow-up (n = 88)

	Patients			Care partners		
	Baseline	Follow-up	Change from baseline to follow-up	Baseline	Follow-up	Change from baseline to follow-up
Demographic characteristics						
Age (years)	67.39 (8.15)	70.05 (8.05)[a]	t = −31.88*** (d = 3.40)	63.60 (10.60)	66.03 (10.89)	t = −5.79*** (d = 0.62)
Education (years)	16.49 (2.45)	—	—	15.98 (2.44)	—	—
Sex (total M:F)	63:25	—	—	26:62	—	—
Years known patient	—	—	—	37.66 (14.08)	—	—
Disease characteristics						
Disease duration (years)	5.61 (4.43)[b]	7.80 (4.81)[c]	t = −8.82*** (d = 1.11)	—	—	—
UPDRS part III total	20.68 (12.19)	19.39 (11.95)[d]	t = 1.19 (d = 0.14)	—	—	—
Total LED (mg/day)	708.34 (632.65)	725.89 (440.07)[e]	t = −0.09 (d = 0.01)	—	—	—
H&Y stage[f]						
Stage 0	2	2	χ^2 = 85.88*** (V = 0.47)	—	—	—
Stage 1	20	10				
Stage 1.5	1	0				
Stage 2	52	49				
Stage 2.5	3	5				
Stage 3	9	9				
Stage 4	1	2				
Stage 5	0	0				
Mood & cognition						
MDRS	138.42 (4.10)	136.56 (7.81)[g]	t = 2.54* (d = 0.27)	—	—	—
SAS	11.53 (5.45)	12.73 (6.52)	t = −2.19* (d = 0.23)	—	—	—
STAI-T	33.60 (9.38)	35.32 (9.71)[h]	t = −2.43* (d = 0.26)	—	—	—
GDS[i]	6.17 (5.16)	6.92 (6.35)	t = −1.47 (d = 0.16)	3.93 (4.34)	4.91 (6.01)	Z = −2.41* (r = 0.26)
ZBI	—	—	—	13.12 (12.35)	17.60 (15.39)	Z = −4.58***, (r = 0.49)

Note: Wilcoxon signed-rank tests (Z) were performed on data that violated normality assumptions; all other analyses conducted above used t-tests (t) or Chi-square (χ^2).

Abbreviations: GDS, Geriatric Depression Scale; LED, Levodopa equivalent dose; MDRS, Mattis Dementia Rating Scale; MFIS, Modified Fatigue Inventory Scale; SAS, Starkstein Apathy Scale; STAI-T, State-Trait Anxiety Inventory - Trait Anxiety Scale; UPDRS, Unified Parkinson's Disease Rating Scale; ZBI, Zarit Burden Interview.

[a]Patient follow-up age n = 87.

[b]Range (years) = 0.08–23.

[c]Patient follow-up disease duration (years) n = 62.

[d]Patient follow-up UDPRS Part III total n = 77.

[e]Patient follow-up Total LED n = 81.

[f]Patient follow-up H&Y n = 77.

[g]Patient follow-up MDRS n = 87.

[h]Patient follow-up STAI-T n = 87.

[i]Patient baseline GDS n = 87.

*p < 0.05, **p < 0.01, ***p < 0.001.

partner depression over the 2 year follow-up period were significantly correlated with higher levels of baseline patient apathy (r_s = 0.33, p = 0.002, 95% CI [0.12, 0.51]), anxiety (r_s = 0.23, p = 0.029, 95% CI [0.02, 0.43]), and patient depression (r_s = 0.31, p = 0.003, 95% CI [0.11, 0.50]). All other care partner characteristics were not significantly related to changes in care partner depression over time (p's ≥ 0.110), including baseline care partner depression (p = 0.638) (Table 2).

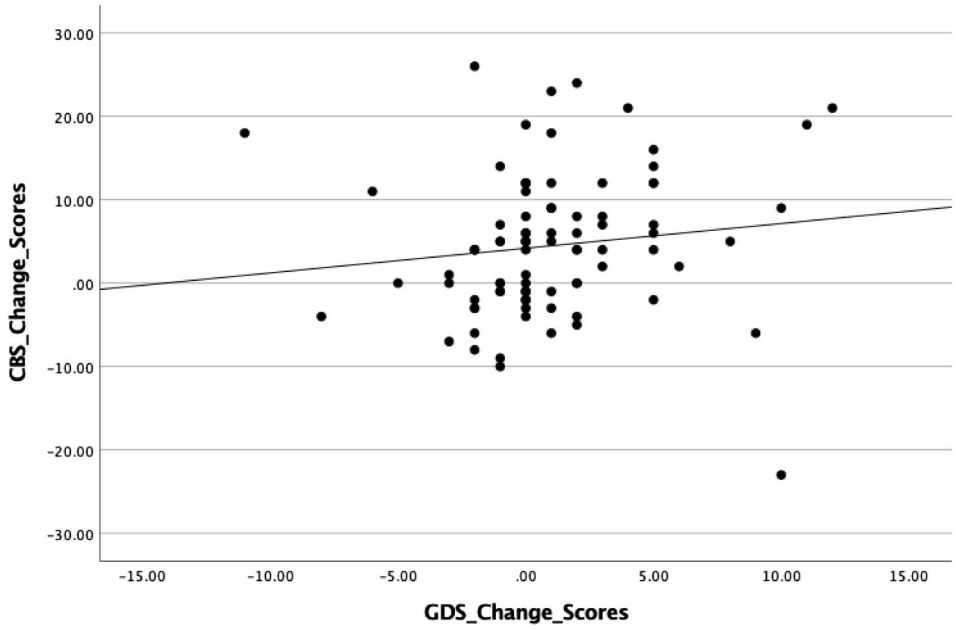

FIGURE 1 Care giver burden and depression change scores. Pearson bivariate correlations between care partner Geriatric Depression Scale (GDS) and Zarit Burden Inventory (ZBI) change scores (follow-up score minus baseline score). For both the ZBI and GDS total scores, higher change scores indicate greater increases in burden or depression over an approximate 2 year period

To determine the best predictor(s) of care partner burden over time, a stepwise regression with baseline predictors that evidenced significant bivariate relationships (i.e., H&Y disease stage, total LED, and disease duration) entered as predictors and care partner burden change score as the criterion, was conducted. The resulting model was significant, with only greater H&Y (disease stage) predicting increased care partner burden over time (Table 3).

To determine the best predictor(s) of care partner depression over time, a stepwise regression with baseline predictors that evidenced significant bivariate relationships (i.e., baseline patient apathy, anxiety, depression) entered as predictors and care partner depression change score as the criterion, was conducted. The model was significant, and only higher levels of baseline patient depression significantly predicted higher care partner depression over time (Table 3). Multicollinearity was within acceptable limits for all regressions (VIF < 5, minimum tolerance = 1.00).[47]

5 | DISCUSSION

This is the first longitudinal study to examine changes in and predictors of care partner burden and depression in PD over time, in the same sample. PD care partner burden and depression significantly increased over an approximate 2 year period and were moderately associated. Higher baseline disease stage best predicted increased care partner burden, while baseline patient depression best predicted increased care partner depression.

Despite worsening over time, burden and depression levels remained subclinical from baseline to follow-up. This may be due to our sample, who were early in their disease course (average disease duration <5 years) and may have experienced minimal decline over a 2 year period. Further research assessing longer assessment intervals may reveal when burden and depression become clinically significant. Moreover, findings that burden and depression were associated modestly align with prior studies demonstrating that care partner burden and depression are strongly related, yet unique constructs.[23] Results underscore the importance of monitoring care partner burden and depression over time as this may allow providers to intervene before symptoms reach a clinical threshold. Given that PD care partners often provide caregiving for several years,[27] earlier intervention may aid in the emotional wellbeing of the patient and longevity of the care partner.

Greater baseline patient disease stage, higher LED, and longer disease duration were related to increases in burden over time. Thus, motor/disease characteristics appear to be particularly relevant for worsening care partner burden, as opposed to non-motor symptoms. This was surprising given that most prior studies found non-motor symptoms (cognition and depression) best predicted increased levels of care partner burden.[13,15] However, our sample was comparatively less depressed, which could account for these differential findings. Of these motor/disease characteristics, disease severity (H&Y) emerged as the best predictor, which stresses the importance of disease staging in understanding the impact of PD on care partners' well-being. H&Y stages encompass various facets of functional impairment, incorporating both functional and objective deficits to classify clinical severity in PD.[42] The H&Y rating may capture unique features of PD relevant to decrements in care partner burden that may be

TABLE 2 Spearman correlations between care partner zarit burden inventory (ZBI) and geriatric depression scale (GDS) change scores and baseline patient and care partner characteristics

	ZBI change		CP GDS change	
	r_s	*p*-value	r_s	*p*-value
Baseline PD characteristics				
Age	0.04	0.747	0.09	0.426
Education	0.05	0.625	0.10	0.342
Sex	0.11	0.300	−0.07	0.504
Disease duration (Months)	0.24	**0.024**	0.15	0.159
UPDRS-part III	0.07	0.548	−0.09	0.408
Hoehn and Yahr	0.27	**0.013**	0.06	0.583
Total LED (mg/day)	0.25	**0.020**	0.09	0.426
MDRS	−0.12	0.274	−0.13	0.242
GDS[a]	0.19	0.087	0.31	**0.003**
SAS	0.17	0.105	0.33	**0.002**
STAI-T	0.12	0.282	0.23	**0.029**
Baseline care partner characteristics				
Age	0.13	0.243	0.17	0.120
Education	0.02	0.885	−0.10	0.348
Sex	−0.09	0.410	0.07	0.521
ZBI	−0.01	0.904	0.17	0.111
GDS	0.05	0.638	0.07	0.546

Note: Sensitivity analyses were run for normally distributed variables using Pearson's correlations and results were comparable. Bolded values signify statistical significance ($p < 0.05$).

[a]PD GDS $n = 87$.

missed by other measures of motor function (e.g., UPDRS Part III) or PD symptoms. In particular, H&Y stage may better encompass broader aspects of motor function, including gait and balance, compared to other measures. As gait and balance are associated with fall risk, this might explain the unique and predominant association between the H&Y and care partner burden.[42,48,49] This finding suggests that targeting PD disease severity and improving patient autonomy (e.g., through physical therapy or exercise), may alleviate burden symptoms in care partners. Future research on the efficacy of these types of interventions in reducing care partner burden is warranted.

In contrast to the findings with burden, baseline patient mood symptoms (i.e., patient depression, anxiety, and apathy), not disease severity, were related to increased care partner depression. Of those significant correlates, baseline patient depression was the best predictor of changes in care partner depression. These findings are consistent with research which has shown that depression can be 'contagious', such that those who are exposed to depressed individuals (i.e., roommates, spouses), may become depressed themselves.[50] Similar to previous cross-sectional studies,[22,51] our sample mainly consisted of spouses of the PD participants; thus, cohabitation (rather than the caring role) may explain depressive symptoms in care partners. Difficulties with mood symptoms and lack of physical and emotional activity in the patient may place greater social and emotional demands on the care partner, which may exacerbate the carer's depressive symptoms. Screening and implementing early treatment for depression in patients may combat future development of depression in care partners.

Unlike previous studies, we did not find a relationship between PD cognition and care partner depression in our sample. Prior studies included various measures and levels of cognitive functioning (e.g., no impairment, MCI, dementia), while the current study used a brief measure of global cognition (MDRS) and only included PD participants without dementia. These methodological differences may explain why cognition was not associated with depression in our study. Future research should consider comprehensive cognitive testing, or inclusion of patients with dementia, to determine if specific cognitive functions are associated with care partner depression. Additionally, neither baseline care partner burden nor baseline depression were related to changes in burden or depression, respectively. Although unexpected, previous studies have shown that patient factors are more strongly related to burden and depression in PD care partners.[13,23]

5.1 | Limitations

Our study had several limitations. First, due to the homogeneity of our sample (White males with female care partners and college educated), our results may not be generalizable to all individuals with PD or to all PD care partners. Future research should examine these relationships in more diverse groups of PD patients and care partners. Second, our sample of care partners was not clinically depressed or burdened overall; thus, additional research is needed in care partners with more severe burden and depression, or with more advanced stages of PD, over a longer period. Third, as self-reported measures may be susceptible to under- or over-reporting, the use of clinician-administered measures of depression could confirm our findings in future studies. In addition, the care partners did not complete measures of cognition, anxiety, or apathy in this study. Such information could provide further insight into the relationship between caregiver factors and their levels of burden or depression. Future research examining these symptoms in mild, moderate, and/or severely depressed or burdened care partners, and using a more comprehensive neuropsychological battery, may lend an increased understanding of the longitudinal changes in care partner symptoms. More research is needed to explore other factors that may negatively impact (e.g., hours spent care taking, patient comorbidities, quality of life) or attenuate (e.g., care partner support groups, psychotherapy) burden and depression in care partners.

TABLE 3 Predictors of change in care partner burden and care partner depression

Predictor	*B*	*SE B*	β	*p*	R^2	ΔR^2
ZBI change					0.055	0.055
H & Y	2.941	1.310	0.235	**0.027**		
Excluded						
Total LED			0.160	0.140		
Disease duration (months)			0.144	0.185		
GDS change					0.105	0.105
Patient GDS	0.232	0.073	0.324	**0.002**		
Excluded						
SAS			0.050	0.696		
STAI-T			0.014	0.930		

Note: Bolded values signify statistical significance ($p < 0.05$).

5.2 | Conclusions

The current study demonstrated that while increases in care partner burden and depression over time are related, they are differentially predicted by motor (i.e., disease stage) and non-motor (i.e., patient depression) symptoms, respectively. The best predictors of care partner burden and depression were both PD patient symptoms, rather than care partner factors, suggesting that these distinct phenomena could benefit from different, targeted treatments. Treatments aimed at controlling disease severity associated with disease stage (e.g., medication management) may prevent worsening of care partner burden, while interventions focused on ameliorating patient depression could prevent future care partner depression.

Given that patients with PD require extensive support and care from informal care partners, which impacts the financial, social, and psychological wellbeing of care partners, treatments targeting the predictive factors of disease stage and patient depression is critical to the longevity and quality of care provided. With patient and care partner psychoeducation, earlier assessment of patient depression, and preventative treatments to maintain motor symptom control as the disease progresses in patients, clinicians can improve the lives of patients with PD and the lives of those who provide their care.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from U.S. Department of Veterans Affairs. Restrictions apply to the availability of these data, which were used under license for this study. Data are available from the author(s) with the permission of U. S. Department of Veterans Affairs.

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REFERENCES

1. Hagell P, Alvariza A, Westergren A, Årestedt K. Assessment of burden among family caregivers of people with Parkinson's disease using the Zarit burden Interview. *J Pain Symptom Manage*. 2017;53(2):272-278. https://doi.org/10.1016/j.jpainsymman.2016.09.007
2. McLaughlin D, Hasson F, Kernohan WG, et al. Living and coping with Parkinson's disease: perceptions of informal carers. *Palliat Med*. 2010;25(2):177-182. https://doi.org/10.1177/0269216310385604
3. Bursack C. When adult grandchildren become the primary caregiver; 2018. Accessed November, 11 2020. https://www.agingcare.com/articles/grandchildren-caring-for-their-grandparents-149490.htm
4. Robb A. How are the terms care partner and caregiver different? *Parkinsons Disease.net*. 2017. https://parkinsonsdisease.net/caregiver/care-partner-and-caregiver-differences
5. O'Reilly F, Finnan F, Allwright S, Smith GD, Ben-Shlomo Y. The effects of caring for a spouse with Parkinson's disease on social, psychological and physical well-being. *Br J Gen Pract*. 1996:6.
6. Martinez-Martin P, Arroyo S, Rojo-Abuin JM, Rodriguez-Blazquez C, Frades B, Cuesta JdeP. Burden, perceived health status, and mood among caregivers of Parkinson's disease patients. *Mov Disord*. 2008;23(12):1673-1680. https://doi.org/10.1002/mds.22106
7. Edwards NE, Scheetz PS. Predictors of burden for caregivers of patients with Parkinson's disease. *J Neurosci Nurs*. 2002;34(4):184-190. https://doi.org/10.1097/01376517-200208000-00003
8. Grün D, Pieri V, Vaillant M, Diederich NJ. Contributory factors to caregiver burden in Parkinson disease. *J Am Med Dir Assoc*. 2016;17(7):626-632. https://doi.org/10.1016/j.jamda.2016.03.004
9. Schrag A, Hovris A, Morley D, Quinn N, Jahanshahi M. Caregiver-burden in Parkinson's disease is closely associated with psychiatric symptoms, falls, and disability. *Parkinsonism Relat Disord*. 2006;12(1):35-41. https://doi.org/10.1016/j.parkreldis.2005.06.011
10. Macchi ZA, Koljack CE, Miyasaki JM, et al. Patient and caregiver characteristics associated with caregiver burden in Parkinson's disease: a palliative care approach. *Ann Palliat Med*. 2020;9(Suppl 1):S24-S33. https://doi.org/10.21037/apm.2019.10.01

11. Mosley PE, Moodie R, Dissanayaka N. Caregiver burden in Parkinson disease: a critical review of recent literature. *J Geriatr Psychiatry Neurol*. 2017;30(5):235-252. https://doi.org/10.1177/0891988717720302
12. Bhimani R. Understanding the burden on caregivers of people with Parkinson's: a scoping review of the literature. *Rehabil Res Pract*. 2014;2014(718527):8. https://doi.org/10.1155/2014/718527
13. Leiknes I, Lien UT, Severinsson E. The relationship between caregiver burden, demographic variables, and the clinical characteristics of patients with Parkinson's disease – a systematic review of studies using various. *Caregiver Burden Instruments*. 2015;5(10):855-877. https://doi.org/10.4236/ojn.2015.510091
14. D'Amelio M, Terruso V, Palmeri B, et al. Predictors of caregiver burden in partners of patients with Parkinson's disease. *Neurol Sci*. 2009;30(2):171-174. https://doi.org/10.1007/s10072-009-0024-z
15. Smith ER, Perrin PB, Tyler CM, Lageman SK, Villaseñor T. Parkinson's symptoms and caregiver burden and mental health: a cross-cultural mediational model. *Behav Neurol*. 2019;2019:e1396572. https://doi.org/10.1155/2019/1396572
16. Martinez-Martin P, Rodriguez-Blazquez C, Forjaz MJ. Quality of life and burden in caregivers for patients with Parkinson's disease: concepts, assessment and related factors. *Expert Rev Pharmacoecon Outcomes Res*. 2012;12(2):221-230. https://doi.org/10.1586/erp.11.106
17. Martinez-Martin P, Rodriguez-Blazquez C, Forjaz MJ, et al. Neuropsychiatric symptoms and caregiver's burden in Parkinson's disease. *Parkinsonism Relat Disord*. 2015;21(6):629-634. https://doi.org/10.1016/j.parkreldis.2015.03.024
18. Zhong M, Peppard R, Velakoulis D, Evans AH. The relationship between specific cognitive defects and burden of care in Parkinson's disease. *Int Psychogeriatr*. 2016;28(2):275-281. https://doi.org/10.1017/S1041610215001593
19. Martínez-Martín P, Forjaz MJ, Frades-Payo B, et al. Caregiver burden in Parkinson's disease. *Mov Disord*. 2007;22(7):924-931. https://doi.org/10.1002/mds.21355
20. Klietz M, von Eichel H, Schnur T, et al. One year trajectory of caregiver burden in Parkinson's disease and analysis of gender-specific aspects. *Brain Sci*. 2021;11(3):295. https://doi.org/10.3390/brainsci11030295
21. Lyons KS, Stewart BJ, Archbold PG, Carter JH. Optimism, pessimism, mutuality, and gender: predicting 10-year role strain in Parkinson's disease spouses. *Gerontologist*. 2009;49(3):378-387. https://doi.org/10.1093/geront/gnp046
22. Miller E, Berrios Ge, Politynska Be. Caring for someone with Parkinson's disease: factors that contribute to distress. *Int J Geriatr Psychiatry*. 1996;11(3):263-268. https://doi.org/10.1002/(SICI)1099-1166(199603)11:3<263::AID-GPS316>3.0.CO;2-P
23. Greenwell K, Gray WK, van Wersch A, van Schaik P, Walker R. Predictors of the psychosocial impact of being a carer of people living with Parkinson's disease: a systematic review. *Parkinsonism Relat Disord*. 2015;21(1):1-11. https://doi.org/10.1016/j.parkreldis.2014.10.013
24. Meara J. Use of the GDS-15 geriatric depression scale as a screening instrument for depressive symptomatology in patients with Parkinson's disease and their carers in the community. *Age Ageing*. 1999;28(1):35-38. https://doi.org/10.1093/ageing/28.1.35
25. Happe S, Berger K. The association between caregiver burden and sleep disturbances in partners of patients with Parkinson's disease. *Age Ageing*. 2002;31(5):349-354. https://doi.org/10.1093/ageing/31.5.349
26. O'Connor EJ, McCabe MP. Predictors of quality of life in carers for people with a progressive neurological illness: a longitudinal study. *Qual Life Res*. 2011;20(5):703-711. https://doi.org/10.1007/s11136-010-9804-4
27. Lyons KS, Stewart BJ, Archbold PG, Carter JH, Perrin NA. Pessimism and optimism as early warning signs for compromised health for caregivers of patients with Parkinson's disease. *Nurs Res*. 2004;53(6):354-362. https://doi.org/10.1097/00006199-200411000-00002
28. Hughes AJ, Daniel SE, Kilford L, Lees AJ. Accuracy of clinical diagnosis of idiopathic Parkinson's disease: a clinico-pathological study of 100 cases. *J Neurol Neurosurg Psychiatry*. 1992;55(3):181-184. https://doi.org/10.1136/jnnp.55.3.181
29. Parkinson's T. Disease Measurement: PwP, surveys, trials, analysis. Accessed 11 November 2020. https://www.parkinsonsmeasurement.org/toolBox/levodopaEquivalentDose.htm
30. Zarit S, Orr NK, Zarit JM. *The Hidden Victims of Alzheimer's Disease: Families under Stress*. NYU Press; 1985.
31. Jones AJ, Kuijer RG, Livingston L, et al. Caregiver burden is increased in Parkinson's disease with mild cognitive impairment (PD-MCI). *Transl Neurodegener*. 2017;6(1):17. https://doi.org/10.1186/s40035-017-0085-5
32. Bachner YG, RPsych NO'RPD. Reliability generalization of responses by care providers to the Zarit Burden Interview. *Aging Ment Health*. 2007;11(6):678-685. https://doi.org/10.1080/13607860701529965
33. Yesavage JA, Brink TL, Rose TL, Adey M. The Geriatric Depression Rating Scale: comparison with other self-report and psychiatric rating scales. *Assess Geriatr Psychopharmacol*. 1983;25(12):153-167.
34. McDonald WM, Holtzheimer PE, Haber M, Vitek JL, McWhorter K, DeLong M. Validity of the 30-item geriatric depression scale in patients with Parkinson's disease. *Mov Disord*. 2006;21(10):1618-1622. https://doi.org/10.1002/mds.21023
35. Ertan FS, Ertan T, Uygucgil H. Reliability and validity of the geriatric depression scale in depression in Parkinson's disease. *J Neurol Neurosurg Psychiatry*. 2005;76(10):1445-1447. https://doi.org/10.1136/jnnp.2004.057984
36. Pirogovsky-Turk E, Moore RC, Filoteo JV, et al. Neuropsychiatric predictors of cognitive decline in Parkinson disease: a longitudinal study. *Am J Geriatr Psychiatry Off J Am Assoc Geriatr Psychiatry*. 2017;25(3):279-289. https://doi.org/10.1016/j.jagp.2016.10.004
37. Starkstein SE, Mayberg HS, Preziosi TJ, Andrezejewski P, Leiguarda R, Robinson RG. Reliability, validity, and clinical correlates of apathy in Parkinson's disease. *J Neuropsychiatry Clin Neurosci*. 1992;4(2):134-139.
38. Mattis S. *Dementia Rating Scale: Professional Manual*. Psychological Assessment Resources; 1988.
39. Llebaria G, Pagonabarraga J, Kulisevsky J, et al. Cut-off score of the Mattis dementia rating scale for screening dementia in Parkinson's disease. *Mov Disord*. 2008;23(11):1546-1550. https://doi.org/10.1002/mds.22173
40. Brown GG, Rahill AA, Gorell JM, et al. Validity of the dementia rating scale in assessing cognitive function in Parkinson's disease. *J Geriatr Psychiatry Neurol*. 1999;12(4):180-188. https://doi.org/10.1177/089198879901200403
41. Goetz CG, Tilley BC, Shaftman SR, et al. Movement disorder society-sponsored revision of the unified Parkinson's disease rating scale (MDS-UPDRS): scale presentation and clinimetric testing results. *Mov Disord*. 2008;23(15):2129-2170. https://doi.org/10.1002/mds.22340
42. Goetz CG, Poewe W, Rascol O, et al. Movement disorder society task force report on the hoehn and yahr staging scale: status and recommendations the movement disorder society task force on rating scales for Parkinson's disease. *Mov Disord*. 2004;19(9):1020-1028. https://doi.org/10.1002/mds.20213
43. Hoehn MM, Yahr MD. Parkinsonism: onset, progression and mortality. *Neurology*. 1967;17(5):427-442. https://doi.org/10.1212/wnl.17.5.427
44. SPSS I. *IBM SPSS Statistics for Windows*. IBM SPSS; 2013.
45. Kline RB. *Principles and Practice of Structural Equation Modeling*. 4th ed. Guilford Publications; 2015.
46. Cohen J. *Statistical Power Analysis for Behavioral Sciences*. 2nd ed. Lawrence Erlbaum Associates, Publishers; 1988.

47. Menard S. *Applied Logistic Regression Analysis*. Sage; 1995.
48. Martinez-Martin P, Skorvanek M, Rojo-Abuin JM, Gregova Z, Stebbins G, Goetz CG. Validation study of the hoehn and yahr scale included in the MDS-UPDRS. *Mov Disord*. 2018;33(4):651-652. https://doi.org/10.1002/mds.27242
49. Skorvanek M, Martinez-Martin P, Kovacs N, et al. Differences in MDS-UPDRS scores based on hoehn and yahr stage and disease duration. *Mov Disord Clin Pract*. 2017;4(4):536-544. https://doi.org/10.1002/mdc3.12476
50. Goodman CR, Shippy RA. Is it contagious? affect similarity among spouses. *Aging Ment Health*. 2002;6(3):266-274. https://doi.org/10.1080/13607860220142431
51. Aarsland D, Larsen JP, Karlsen K, Lim NG, Tandberg E. Mental symptoms in Parkinson's disease are important contributors to caregiver distress. *Int J Geriatr Psychiatry*. 1999;14(10):866-874. https://doi.org/10.1002/(SICI)1099-1166(199910)14:10<866::AID-GPS38>3.0.CO;2-Z

SUPPORTING INFORMATION

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

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