

Examining the Impact of Different Components of Sleep Quality on Anxiety Among Family Carers of People with Dementia

Journal of Geriatric Psychiatry
and Neurology
2023, Vol. 36(1) 63–72
© The Author(s) 2022



Article reuse guidelines:
sagepub.com/journals-permissions
DOI: 10.1177/08919887221093359
journals.sagepub.com/home/jgp



Elien Van Hout, MSc¹ , Milena Contreras, PhD¹, Eneida Mioshi, PhD¹, and Naoko Kishita, PhD¹ 

Abstract

Existing interventions for family carers of people with dementia tend to be less effective for anxiety than for depression. Therefore, identifying factors affecting carer anxiety is important to inform future interventions. This study conducted 2 multiple regression analyses using a sample of 91 family carers. The first regression model ($\Delta R^2 = .24$), exploring the impact of demographic variables and carer stressors, demonstrated that hours of caring ($\beta = .33$) and overall sleep quality ($\beta = .28$) were significant predictors of anxiety. To further investigate the impact of sleep quality, the second model ($\Delta R^2 = .24$) focussed on exploring the differential impact of various components of sleep quality on anxiety. Findings demonstrated that subjective sleep quality ($\beta = .33$) and sleep disturbances ($\beta = .22$) were significant predictors. Hours of caring per week, subjective sleep quality and sleep disturbances seem to be critical for treating anxiety in family carers. Future studies should investigate whether targeting these variables could improve carer anxiety.

Keywords

caregivers, Alzheimer's disease, insomnia, depression, care burden, mindfulness

Introduction

There is considerable evidence supporting that caring for a person with dementia has a significant impact on the well-being of family carers¹⁻³ and anxiety and depression are highly prevalent among this population.⁴⁻⁶ These prevalence rates are estimated to be much higher than in the general population.⁷ Furthermore, the estimated prevalence of anxiety in family carers of people with dementia is greater than in family carers of people with other conditions, such as cancer⁸ and stroke.⁹

Despite this, anxiety is somewhat neglected in the carer literature.⁵ Most research and existing interventions for family carers are built around the outcome measures of carer depression and burden.¹⁰⁻¹² Current evidence suggests that Cognitive Behavioural Therapy (CBT), the most commonly used psychological approach in dementia carer research, is effective for targeting depression but does not effectively treat anxiety in family carers of people with dementia.^{10,13} Understanding factors affecting anxiety can help refine existing carer interventions, and consequently,

further improve the well-being of family carers of people with dementia.

Factors associated with anxiety among family carers of people with dementia are understudied in the current literature.¹⁴ Those small number of studies that do investigate factors affecting carer anxiety report inconsistent findings.^{5,14-17} However, there is substantial evidence on common factors affecting other negative psychological outcomes, such as carer depression. Factors associated with greater depression include female carer gender,^{1,15} younger carer age,¹⁸ greater hours of caring per week,¹⁹ worse carer physical health,⁶ poor quality of sleep,²⁰ greater dementia severity²¹ and more behavioural and

¹School of Health Sciences, University of East Anglia, Norwich, UK

Corresponding Author:

Dr. Naoko Kishita, School of Health Sciences, Faculty of Medicine and Health Sciences, University of East Anglia, Norwich Research Park, Norwich NR4 7TJ, UK.
Email: N.Kishita@uea.ac.uk

psychological symptoms of dementia.^{17,22} However, little is known about whether these factors are associated with carer anxiety in the same way. For example, there is a study that demonstrated younger carers are more vulnerable to anxiety,²³ while another study demonstrated that older carers have a higher chance of developing anxiety symptoms.⁵ Thus, this study aims to investigate whether these demographic variables and carer stressors, known to have an impact on carer depression, affect anxiety in a multiple regression model.

The current study particularly focusses on the impact of sleep quality on carer anxiety. A strong relationship between sleep quality and anxiety has been established in previous studies among the general population^{20,24} and dementia carers.^{25,26} Generally, subjective sleep quality is described as a person's perception on how well they sleep without any disturbances. Various aspects of the quality and patterns of sleep such as subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication and daytime dysfunction are considered to contribute to overall sleep quality, and these different aspects can be assessed using standardised measures such as the Pittsburgh Sleep Quality Index (PSQI).²⁷ Despite this, previous studies on sleep quality have often used unstandardised measures, such as one single question²⁸ or short instruments with one to four questions²⁹ to assess the complex concept of sleep quality.

The different aspects of sleep quality are considered to have a differential impact on the mental health of individuals.³⁰ Previous studies demonstrated that higher values of sleep latency, sleep disturbances and daytime dysfunctions contributed to higher levels of psychological distress in comparison with other sleep aspects, such as the use of sleep medication and sleep efficiency (i.e. the ratio of total sleep to time in bed) among a non-clinical community sample^{30,31} and carers of people with multiple sclerosis.³² Understanding the impact of different aspects of sleep quality can lead to the development of interventions targeting individuals with disturbances in different aspects of sleep quality.^{27,33} Although previous literature reports that more than half of family carers have poor sleep quality due to their caregiving role,³⁴ the differential impacts of sleep quality in family carers of people with dementia have yet to be studied. In this regard, a recent systematic review on sleep interventions for family carers of people with dementia demonstrated that most existing interventions did not have significant effects on sleep health.³⁵

Therefore, the current study aims to address the following two research questions:

- (1) Which carer-related (i.e. carer age, gender, hours of caring per week, comorbidities and sleep quality) and patient-related (i.e. dementia severity

and neuropsychiatric symptoms of dementia) demographics and stressors known to have an impact on carer depression predict anxiety symptoms in family carers of people with dementia?

- (2) If sleep quality is found to be a significant predictor, which aspects of sleep quality (i.e. subjective sleep quality, sleep duration, daytime dysfunction, sleep latency, habitual sleep efficiency, sleep disturbances and use of sleep medication) predict anxiety symptoms in family carers of people with dementia?

Considering the well-established associations between demographic variables, caregiving-stressors and depression, we hypothesised that all proposed variables would correlate with carer anxiety (i.e. greater anxiety symptoms are associated with female carer gender, younger carer age, greater hours of caring per week, worse carer physical health, poor quality of sleep, greater dementia severity and more behavioural and psychological symptoms of dementia). Furthermore, based on studies investigating the impacts of different aspects of sleep quality in non-clinical community samples, we hypothesised that worse subjective sleep quality, greater sleep latency, greater sleep disturbances and more daytime dysfunctions would be significantly associated with greater anxiety symptoms.

Material and Methods

Study Design and Sampling

This study is a secondary analysis of data from a cross-sectional study that aimed to identify factors affecting the quality of life in family carers of people with dementia. The original study took place between July 2017 and February 2020. Written consent was obtained from all participants involved. Full ethical approval was received from the NHS Health Research Authority and Research Ethics Committee (17/LO/0564).

The participants had to be at least 18 years old and be unpaid carers with a first-degree relationship (parent, spouse/partner, sibling or adult child) with a person with dementia. The original study recruited 91 family carers through clinician referrals from a local NHS mental health trust, referrals from other ethically approved dementia studies and Join Dementia Research, a UK-based online service for matching people with researchers looking for volunteers.

Procedure

Potential participants were contacted by the research team via telephone or email to check for eligibility. Participants meeting the eligibility criteria were sent an invitation letter

and participant information sheet. An appointment for the assessment session was made at the participant's own home, the university or local NHS premises depending on the participant's preference. Participants completed all self-reported questionnaires in the presence of a researcher during the assessment session. The Frontotemporal Dementia Rating Scale (FRS), which is an interview-based measure, was conducted by researchers trained to administer the tool.

Measures

Demographic Information. Demographic information including the carer age, gender, relationship with the person with dementia and cohabitation status were collected to characterise the sample. Carers' gender was coded as: 1 = female and 2 = male. The cohabitation status was coded as: 1 = carers living separately from the person with dementia and 2 = carers living in the same house as the person with dementia.

Anxiety. The Generalised Anxiety Disorder Scale (GAD-7)³⁶ is a 7-item self-report questionnaire that measures the severity of anxiety symptoms. Participants were asked how often during the last two weeks they had experienced common anxiety symptoms (eg, 'worrying too much about different things'). The GAD-7 is rated on a 4-point scale ranging from 0 (*not at all*) to 3 (*nearly every day*). Depending on the sum of scores, the severity of symptoms can be categorised as minimal (0–4), mild (5–9), moderate (10–14) or severe (15–21). The GAD-7 has good psychometric properties with good internal consistency (Cronbach Alpha = .89).³⁶

Number of Hours of Caring. The number of hours of caring per week was assessed using the following response options: 0–2 h, 3–10 h, 11–20 h, 21–40 h, 41–80 h and 81 or more hours.

Physical Health. The Charlson Comorbidity Index (CCI)³⁷ is a measure that assesses comorbidities based on the presence or absence of certain medical conditions. The updated Charlson Comorbidity Index of 12 comorbidities³⁸ was used in an interview format to assess the physical health of the carers in this study. The 12 medical conditions included were: congestive heart failure, dementia, chronic pulmonary disease, rheumatologic disease, mild liver disease, diabetes with chronic complications, hemiplegia or paraplegia, renal disease, any malignancy, moderate or severe liver disease, metastatic solid tumour and AIDS/HIV. Each condition represents a score (1, 2, 3, 4 or 6) in agreement with its weighted prognostic value. This risk-adjusted hazard ratio of the conditions could vary between ≥ 1.2 and ≤ 6 . The calculated total number of these scores had a range from 0 to 24, with the highest score

indicating higher comorbidity, higher risk for mortality, and thus worse physical health. The CCI has good psychometric properties³⁸ with moderate to good internal consistency (Cronbach Alpha Range = .74–.95).³⁹

Sleep Quality. The Pittsburgh Sleep Quality Index (PSQI)²⁷ is a 19-item self-reported questionnaire designed to assess sleep quality and disturbances over a 1-month time interval. The PSQI consists of 7 components: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication and daytime dysfunction. Each item is weighted on a 0–3 interval scale. The sum of component scores generates a single global score, which has a range of 0–21. A global score of 5 or greater is indicative of poor sleep quality. The PSQI has good psychometric properties²⁷ and moderate to good internal consistency (Cronbach's Alpha Range = .70–.83).⁴⁰

Dementia Severity. The Frontotemporal Dementia Rating Scale (FRS)⁴¹ is a 30-item proxy-informant interview-based measure that assesses the severity of dementia. The FRS provides logit scores, which are subdivided into 6 stages of dementia severity: very mild, mild, moderate, severe, very severe and profound. In the current study, these stages were combined to create 3 groups of participants: mild (including very mild), moderate and severe (including very severe and profound). The FRS has good psychometric properties with good internal consistency (Cronbach Alpha = .95).⁴¹

Neuropsychiatric Symptoms. The Mild Behavioural Impairment Checklist (MBI-C)⁴² is a 38-item proxy-informant interview-based questionnaire measuring the neuropsychiatric symptoms within 5 domains: apathy/drive/motivation; mood/affect; impulse control/agitation; social appropriateness; and thoughts/perception. The MBI-C is a comprehensive measurement and is considered to detect behavioural changes that are also common in non-Alzheimer's dementia.⁴² The total score ranges from 0 to 102, with higher scores indicating higher levels of neuropsychiatric symptoms. The MBI-C has good psychometric properties with good internal consistency (Cronbach Alpha = .94).⁴³

Statistical Analysis

A descriptive analysis was conducted to categorise the sample using demographic information. Two separate regression analyses were conducted to address 2 research questions. Analyses were performed using SPSS statistical software (Version 25).

To address the first research question, a single regression analysis was conducted for each potential

independent variable with carer anxiety as a dependent variable first. These independent variables included 5 carer-related factors (age, gender, hours of caring per week, comorbidities and sleep quality) and 2 patient-related factors (dementia severity, neuropsychiatric symptoms of dementia). The independent variables that demonstrated a significant standardised coefficient beta (β) in this single regression, were then included in the final multiple regression model to identify factors affecting carer anxiety.

To address the second research question, a single regression analysis was conducted for cohabitation status and each subscale of the PSQI (subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication and daytime dysfunction) with carer anxiety as a dependent variable. The significant independent variables and the control variable (i.e. cohabitation status) were then included in the final multiple regression model simultaneously to identify different aspects of sleep quality affecting carer anxiety.

Before conducting the regression analyses for the final models, visual examination of the normal probability plot (P-P) of the regression standardised residuals and residuals scatterplots were conducted to test the assumption of normality, linearity and homoscedasticity between predicted dependent variables and errors of prediction. To indicate any problems with multicollinearity within this sample, collinearity statistics with the variance inflation factor (VIF) was used. In the final regression models, the F -test and the model's adjusted R^2 were used to determine the overall model fit.⁴⁴ The standardised coefficients beta (β) was used to assess which of the variables has the strongest predictive value on anxiety symptoms.

The percentage of missing values across the 7 variables varied between 0 and 2.2%. In total the records of 3 participants out of 91 were incomplete. This resulted in missing data for 3 independent variables (i.e. PSQI, MBI-C and cohabitation status). Listwise deletion was used to handle these missing data points. Therefore, in each final regression analysis, a dataset of 89 family carers was used.

Results

Participants

The demographic information and means and standard deviations of measurements are shown in Table 1. Descriptive statistics demonstrated that the majority of participants were female spouses, who lived in the same household as the care recipient. Participants' age ranged from 26 to 95 with 67% of participants being older than 65 years. Nearly half of the care recipients were diagnosed

with Alzheimer's disease (44%) and the majority were in the severe stages of dementia (64%). Seventy-five percent of participants scored 5 or greater on the PSQI, suggesting that most participants presented poor sleep quality. Fifty-seven percent of participants showed minimal symptoms of anxiety, while 21% demonstrated mild symptoms and 10% and 12% of participants demonstrated moderate and severe symptoms, respectively.

Carer- and Patient- Factors Affecting Carer Anxiety

The results of each single regression analysis are shown in Table 2. Among 7 potential independent variables, 6 demonstrated a significant β -value. Thus, carer age, gender, sleep quality, hours of caring per week, dementia severity and neuropsychiatric symptoms were included in the final regression model.

In the final regression model, the VIF was greater than 10 for dementia severity (i.e. FRS), suggesting an issue of multicollinearity due to a high correlation between the FRS and the MBI-C. Therefore, dementia severity was deleted from the model, resulting in 5 independent variables. The results of the normal P-P Plot and the scatterplot of the standard residuals showed that the assumption of normality, linearity and homoscedasticity of residuals was met.

The adjusted R^2 value was .24 ($R^2 = .29$, $\Delta R^2 = .24$, $F(5,83) = 6.64$, $P < .001$), suggesting that the proposed model explains 24% of the variance in anxiety symptoms. The standardised coefficients beta were statistically significant only for hours of caring per week ($\beta = .24$) and sleep quality ($\beta = .28$) (see Table 3). The effect size for this regression model (Cohen's f^2) was 0.40, suggesting a large effect size.

Aspects of Sleep Quality Affecting Carer Anxiety

The results of each single regression analysis are presented in Table 4. Among 7 potential independent variables, 5 demonstrated a significant β -value. Thus, subjective sleep quality, sleep latency, sleep disturbance, daytime dysfunction and cohabitation status were included in the final regression model.

In this final regression model, the VIF value was below 1.59 for all independent variables, suggesting multicollinearity was not present. The results of the normal P-P Plot and the scatterplot of the standard residuals showed that the assumption of normality, linearity and homoscedasticity of residuals was met.

The adjusted R^2 value was .24 ($R^2 = .29$, $\Delta R^2 = .24$, $F(5,83) = 6.68$, $P < .001$), suggesting that the proposed model explains 24% of the variance in anxiety symptoms. The standardised coefficients beta were statistically significant only for subjective sleep quality (i.e. subjective perception of overall sleep quality during the past

Table 1. Demographic Variables (N = 89).

Carer demographic variable	Percentage or M (SD)
Age	69.13 (12.49)
Female	67%
Type of relationship	
Wife	40%
Husband	28%
Daughter	26%
Son	5%
Sister	1%
Cohabitation status	
Living with person with dementia	69%
Living separate from person with dementia	30%
Not specified	1%
Hours of caring per week	
0–2h	4%
3–10h	17%
11–20h	10%
21–40h	17%
41–80h	15%
81+h	37%
Anxiety symptoms (GAD-7), score range 0–21	6.06 (5.66)
No. of participants on antidepressants	14%
No. of participants undergoing psychotherapy	1%
Sleep quality (PSQI), score range 0–21	8.11 (3.85)
Comorbidities (CCI), score range 0–24	1.26 (1.90)
Care recipient demographic variables	Percentage or M (SD)
Dementia Type	
Alzheimer's	44%
Mixed	19%
Vascular	15%
Frontotemporal	8%
Lewy Bodies	6%
Unknown	8%
Dementia Severity (FRS)	
Mild	6%
Moderate	30%
Severe	64%
Neuropsychiatric symptoms (MBI-C), score range 0–102	30.06 (18.01)

Abbreviation: CCI, Charlson Comorbidity Index; FRS, Frontotemporal Dementia Rating Scale; GAD-7, Generalised Anxiety Disorder Scale; MBI-C, Mild Behavioural Impairment Checklist; PSQI, Pittsburgh Sleep Quality Index.

month; $\beta = .33$) and sleep disturbance (i.e. experiences of trouble sleeping due to interruptions, such as difficulty in breathing during the past month; $\beta = .22$) after controlling for cohabitation status (see Table 5). This regression model showed a large effect size of 0.40 (Cohen's f^2).

Table 2. Results of Single Regression Analysis – Carer and Patient Factors.

Potential independent variables	β	P value
Carer age	-.25	.02*
Carer gender	-.32	<.01*
Hours of caring per week	.28	.01*
Sleep quality	.36	<.01*
Comorbidities	-.14	.18
Dementia severity	.27	.01*
Neuropsychiatric symptoms	.26	.02*

Note: * represents significance at the 5% level.

Table 3. Results of Multiple Regression Analysis – Carer and Patient Factors (N = 89).

Independent variables	β	T	P value
Carer age	-.19	-1.77	n.s.
Carer gender	-.19	-1.83	n.s.
Hours of caring per week	.24	2.37	<.05
Sleep quality	.28	2.86	<.01
Neuropsychiatric symptoms	.05	0.47	n.s.

$R^2 = .29$, $F(5, 83) = 6.64$, $p < .001$.

Note: n.s., not significant.

Table 4. Results of Single Regression Analysis – Different Aspects of Sleep Quality.

Potential independent variables	β	P value
Subjective sleep quality	.46	<.01*
Sleep latency	.26	.01*
Sleep duration	.18	.10
Sleep efficiency	.07	.53
Sleep disturbance	.37	<.01*
Sleep medication	.06	.58
Daytime dysfunction	.28	.01*
Cohabitation status	-.24	.02*

Note: * represents significance at the 5% level.

Table 5. Multiple Regression – Different Aspects of Sleep Quality (N = 89).

Independent variables	β	t	P value
Subjective sleep quality	.33	2.82	<.01
Sleep latency	.02	0.19	n.s.
Sleep disturbance	.22	2.21	<.05
Daytime dysfunction	.05	0.43	n.s.
Cohabitation status	-.14	-1.47	n.s.

Discussion

The findings suggested that providing more hours of caring per week and having worse sleep quality may predict higher levels of anxiety symptoms in family carers of people with dementia. Furthermore, the individual's feelings on sleep quality (i.e. subjective sleep quality and sleep disturbances) seem to predict higher levels of anxiety symptoms than the subjective perception of sleep parameters (e.g. sleep latency and sleep duration), after controlling for the cohabitation status of the carer.

It is well known that the increased number of hours of caring leads to higher levels of depression in family carers of people with dementia.¹⁷ This study demonstrated that this common factor was also significantly associated with anxiety symptoms among this population. However, other well-known carer stressors, such as neuropsychiatric symptoms of dementia were not associated with anxiety symptoms, suggesting that more tailored interventions are needed to target carer anxiety. There are community services, which can help reduce caregiving demands, such as respite care.⁴⁵ Current evidence suggests that the use of respite care alone may not be related to improvements in the psychological well-being of family carers of people with dementia,^{46,47} but respite care may support carers to better manage their sleep or maintain hobbies and interests, which in turn may result in improved psychological health.⁴⁸

Moreover, carers often report various barriers to access these community services (e.g. respite care, daycare centres), such as the lack of information about available services and their possible benefits.^{3,49-51} Furthermore, studies suggest that family carers may not use these services due to feelings of guilt and worry even when the services are available to them.^{49,50} It is recommended that future research explores whether the combination of promotion of uptake of respite care and sleep management or the intervention to increase pleasure activities leads to reduced anxiety symptoms in this population.

This study provided evidence on different aspects of sleep quality associated with carer anxiety. Previous studies on sleep quality have used unstandardised measures, such as one single question²⁸ or short instruments with one to 4 questions²⁹ to assess the whole concept of sleep quality in the adult population, including family carers. This study used a comprehensive measure of sleep quality, which has been standardised (i.e. PSQI), and this allowed us to explore the relationships between different aspects of sleep quality and carer anxiety.

The relationship between sleep quality and anxiety symptoms requires further attention as some studies have reported that sleep quality may be bidirectionally related to anxiety.^{20,52,53} Previous studies have shown that family carer of people with dementia experience both greater overall anxiety symptoms⁵ and poorer subjective sleep

quality as well as greater sleep disturbance than non-carers.^{54,55} A previous study conducted with family carers of people with dementia suggested that the nature and duration of caregiving and the progression of dementia of the care recipient may be associated with greater sleep disturbance and hence worse mental health.⁵⁶ Successful treatment of subjective sleep quality and sleep disturbances may thus prevent exacerbation of anxiety symptoms and vice versa. Future research should further investigate the impact of the sleep quality using a longitudinal design.

Currently, nonpharmacological interventions including cognitive behavioural therapy (CBT),^{33,57,58} exercise-based interventions⁵⁹ and mindfulness-based interventions^{60,61} are recommended as the first-line treatments for sleep problems. A recent systematic review of sleep interventions for informal carers of people with dementia³⁵ showed mindfulness-based interventions and prescribed physical exercises have the potential to improve the subjective sleep quality among this population. However, it remains unclear whether these positive effects on subjective sleep quality diminish in the long term.^{60,61} This long-term impact is particularly important given the established relationship between carers' quality of sleep and dementia severity. Carers' quality of sleep is known to diminish as dementia progresses due to the increased care challenges.⁶²⁻⁶⁴ Randomised controlled trials are required to investigate the short-term and long-term effects of these interventions on the subjective sleep quality and anxiety symptoms in family carers of people with dementia.

There are diverse causes of sleep disturbances such as sleep apnoea and physical pain.⁵⁸ Sleep disturbances among dementia carers can involve a complex interaction between disturbances caused by the person with dementia, carer burden and psychological and physical well-being of the carer.^{65,66} Existing interventions such as CBT for Insomnia (CBT-I) are shown to be effective in managing sleep disturbances across multiple populations.^{33,67} CBT is also considered to be effective in improving sleep quality in people with dementia.⁶⁸ Future research is recommended to evaluate the effectiveness of dyadic sleep interventions on sleep disturbances and explore mechanisms of change in anxiety symptoms among family carers of people with dementia.

There are some methodological limitations, which should be considered. The adjusted R^2 value was .24 for both multiple regression models in the current study, which focused on the impact of demographic variables and carer stressors. Therefore, there may be other types of variables that affect carer anxiety. Future studies should investigate the impact of moderating variables, such as individual coping skills and support resources.⁶⁹ Considering the high level of comorbidity between depression and anxiety in family carers of people with dementia,⁷⁰ future studies may benefit from controlling for depression when

examining factors associated with anxiety symptoms in this population.

The sample size required for a regression model in order to achieve a power level of .80, a significance level of .05 and a medium effect size (.15) is 92 when 5 independent variables are included in the model. This study had a sample size of 89 in the multiple regression models, which is slightly smaller than required. However, the effect size for both regression models was large in this study.

Hours of caring per week was measured using categorical data with a relatively wide range of time for each category (e.g. 21–40 h). The highest response option (i.e. 81+ hours) was selected by most of the participants. This may have caused the ceiling effect and decreased the sensibility of the assessment.

Furthermore, this study employed the PSQI to assess the sleep quality of family carers of people with dementia. Since the PSQI relies on self-report and recall of experiences during the past month, the PSQI scores may have been biased. In addition, although the PSQI has been widely used in research as a standardised measure of sleep quality, some studies examining the unidimensionality of the PSQI have however raised concerns over the factor structure of the instrument.^{40,71} Due to the observed poor internal consistency for some of the component scores of the PSQI,^{40,71} using this questionnaire in multivariate statistics might impose a limitation for this study. Therefore, future research is recommended to further investigate the impact of sleep quality using both standardised subjective measurements (e.g. PSQI) as well as objective measures of sleep quality (e.g. actigraphy or polysomnography).

This study did not collect information on the ethnicity of participants. However, participant recruitment took place in counties in the East of England, where more than 90% of the population is White British. The ethnic diversity of the sample was thus limited. In addition, participants were mainly female, and half of the participants experienced minimal to mild anxiety symptoms. Future studies should investigate a wider population, including male family carers, those from different ethnic backgrounds and a clinical population (i.e. participants with more severe anxiety symptoms) to provide further evidence on the generalisability of findings. Finally, given the cross-sectional nature of the study, it is important to note that a conclusion cannot be drawn about causal assumptions.

Despite limitations, this study provided evidence that the hours of caring per week, subjective sleep quality and sleep disturbances are associated with anxiety symptoms in family carers of people with dementia. It is recommended that future research investigates the impact of tailored interventions for managing carer anxiety, such as exploring whether promotion of uptake of respite care combined with evidence-based sleep interventions (e.g. exercise, mindfulness-based interventions, dyadic CBT-I)

improves anxiety symptoms in family carers of people with dementia.

Acknowledgements

The authors also would like to thank Juniper West and Luke Emrich-Mills from Norfolk and Suffolk NHS Foundation Trust for their valuable support in collecting original data.

Declaration of Conflicting Interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: EVH's studentship was supported by Faculty of Medicine and Health Sciences, University of East Anglia. MC's studentship was supported by the National Institute for Health Research (NIHR) Applied Research Collaborations (ARC) East of England, Norfolk and Suffolk Primary and Community Care Research Office and Faculty of Medicine and Health Sciences, University of East Anglia. The views expressed are those of the author(s) and not necessarily those of the NHS, the NIHR or the Department of Health and Social Care.

Data Availability Statement

Data sharing not applicable to this article as no new datasets were generated during the current study.

ORCID iDs

Elien Van Hout  <https://orcid.org/0000-0002-2956-7575>

Naoko Kishita  <https://orcid.org/0000-0001-8453-2714>

References

1. Frias CE, Garcia-Pascual M, Montoro M, Ribas N, Risco E, Zabalegui A. Effectiveness of a psychoeducational intervention for caregivers of people with dementia with regard to burden, anxiety and depression: A systematic review. *J Adv Nurs*. 2020;76(3):787-802.
2. Stall NM, Kim SJ, Hardacre KA, et al. Association of informal caregiver distress with health outcomes of community-dwelling dementia care recipients: A systematic review. *J Am Geriatr Soc*. 2019;67(3):609-617.
3. Qiu D, Hu M, Yu Y, Tang B, Xiao S. Acceptability of psychosocial interventions for dementia caregivers: A systematic review. *BMC Psychiatry*. 2019;19(1):23.
4. Barnes CJ, Markham C. A pilot study to evaluate the effectiveness of an individualized and cognitive behavioural communication intervention for informal carers of people

- with dementia: The talking sense programme. *Int J Lan Commun Disord.* 2018;53(3):615-627.
5. Kaddour L, Kishita N. Anxiety in informal dementia carers: A meta-analysis of prevalence. *J Geriatr Psychiatry Neurol.* 2020;33(3):161-172.
 6. Mahoney R, Regan C, Katona C, Livingston G. Anxiety and depression in family caregivers of people with Alzheimer disease: the LASER-AD study. *Am J Geriatr Psychiatry.* 2005;13(9):795-801.
 7. Somers JM, Goldner EM, Waraich P, Hsu L. Prevalence and incidence studies of anxiety disorders: A systematic review of the literature. *Can J Psychiatry.* 2006;51(2):100-113.
 8. Friðriksdóttir N, Saevarsdóttir T, Halfdánardóttir S, et al. Family members of cancer patients: Needs, quality of life and symptoms of anxiety and depression. *Acta Oncol.* 2011;50(2):252-258.
 9. Loh AZ, Tan JS, Zhang MW, Ho RC. The global prevalence of anxiety and depressive symptoms among caregivers of stroke survivors. *J Am Med Dir Assoc.* 2017;18(2):111-116.
 10. Kishita N, Hammond L, Dietrich CM, Mioshi E. Which interventions work for dementia family carers?: An updated systematic review of randomized controlled trials of carer interventions. *Int Psychogeriatr.* 2018;30(11):1679-1696.
 11. Thompson CA, Spilsbury K, Hall J, Birks Y, Barnes C, Adamson J. Systematic review of information and support interventions for caregivers of people with dementia. *BMC Geriatr.* 2007;7(1):18.
 12. Spencer L, Potterton R, Allen K, Musiat P, Schmidt U. Internet-based interventions for carers of individuals with psychiatric disorders, neurological disorders, or brain injuries: Systematic review. *J Med Int Res.* 2019;21(7):e10876.
 13. Cooper C, Balamurali TBS, Selwood A, Livingston G. A systematic review of intervention studies about anxiety in caregivers of people with dementia. *Int J Geriatr Psychia.* 2007;22(3):181-188.
 14. Cooper C, Balamurali TB, Livingston G. A systematic review of the prevalence and covariates of anxiety in caregivers of people with dementia. *Int psychogeriatr.* 2007;19(2):175-195.
 15. Xiong C, Biscardi M, Astell A, et al. Sex and gender differences in caregiving burden experienced by family caregivers of persons with dementia: A systematic review. *PLoS ONE.* 2020;15(4):1-22.
 16. Brodaty H, Donkin M. Family caregivers of people with dementia. *Dialo Clini Neuros.* 2009;11(2):217-228.
 17. Schoenmakers B, Buntinx F, Delepeleire J. Factors determining the impact of care-giving on caregivers of elderly patients with dementia. A systematic literature review. *Maturitas.* 2010;66(2):191-200.
 18. Williams IC. Emotional health of black and white dementia caregivers: A contextual examination. *J Gerontol Ser B, Psycholo Sci Soc Sci.* 2005;60(6):P287-295.
 19. Kishita N, Contreras ML, West J, Mioshi E. Exploring the impact of carer stressors and psychological inflexibility on depression and anxiety in family carers of people with dementia. *J Contex Behav Sci.* 2020;17:119-125.
 20. Alvaro PK, Roberts RM, Harris JK. A systematic review assessing bidirectionality between sleep disturbances, anxiety, and depression. *Sleep.* 2013;36(7):1059-1068.
 21. Watson B, Tatangelo G, McCabe M. Depression and anxiety among partner and offspring carers of people with dementia: A systematic review. *Gerontol.* 2019;59(5):e597-e610.
 22. Chun M, Knight BG, Youn G. Differences in stress and coping models of emotional distress among Korean, Korean-American and White-American caregivers. *Aging & Ment Heal.* 2007;11(1):20-29.
 23. Chang BL, Brecht ML, Carter PA. Predictors of social support and caregiver outcomes. *Women & heal.* 2001;33(1-2):39-61.
 24. Roth T, Jaeger S, Jin R, Kalsekar A, Stang PE, Kessler RC. Sleep problems, comorbid mental disorders, and role functioning in the national comorbidity survey replication. *Biolo Psychiatry.* 2006;60(12):1364-1371.
 25. Liu S, Li C, Shi Z, et al. Caregiver burden and prevalence of depression, anxiety and sleep disturbances in Alzheimer's disease caregivers in China. *J clini nurs.* 2017;26(9-10):1291-1300.
 26. Beaudreau SA, Spira AP, Gray HL, et al. The relationship between objectively measured sleep disturbance and dementia family caregiver distress and burden. *J Geriatr Psychiatry Neuro.* 2008;21(3):159-165.
 27. Buysse DJ, Reynolds CF 3rd, Monk TH, Berman SR, Kupfer DJ. The pittsburgh sleep quality index: A new instrument for psychiatric practice and research. *Psychiatry Res.* 1989;28(2):193-213.
 28. Li Q, Zhang H, Zhang M, et al. Prevalence and risk factors of anxiety, depression, and sleep problems among caregivers of people living with neurocognitive disorders during the COVID-19 pandemic. *Front Psychiatry* 2021;11:590343.
 29. Ali RM, Zolezzi M, Awaisu A. A systematic review of instruments for the assessment of insomnia in adults. *Nat Sci Sleep* 2020;12:377-409.
 30. Del Rio João KA, de Jesus SN, Carmo C, Pinto P. Sleep quality components and mental health: Study with a non-clinical population. *Psychiatry res.* 2018;269:244-250.
 31. Ramsawh HJ, Stein MB, Belik S-L, Jacobi F, Sareen J. Relationship of anxiety disorders, sleep quality, and functional impairment in a community sample. *J Psychiatric Res.* 2009;43(10):926-933.
 32. Argyriou AA, Karanasios P, Assimakopoulos K, et al. Assessing the quality of sleep in greek primary caregivers of patients with secondary progressive multiple sclerosis: A

- cross-sectional study. *J Pain Symptom Manage.* 2011;42(4): 541-547.
33. Murawski B, Wade L, Plotnikoff RC, Lubans DR, Duncan MJ. A systematic review and meta-analysis of cognitive and behavioral interventions to improve sleep health in adults without sleep disorders. *Sleep Med Rev.* 2018;40: 160-169.
 34. Castro CM, Lee KA, Bliwise DL, Urizar GG, Woodward SH, King AC. Sleep patterns and sleep-related factors between caregiving and non-caregiving women. *Behav Sleep Med.* 2009;7(3):164-179.
 35. Pignatiello GA, Martin R, Kraus N, Gutierrez A, Cusick R, Hickman RL. Sleep interventions for informal caregivers of persons with dementia: A systematic review. *West J Nurs Res* 2021;43(6).
 36. Spitzer RL, Kroenke K, Williams JBW, Löwe B. A brief measure for assessing generalized anxiety disorder. *Arc Int Med.* 2006;166(10):1092-1097.
 37. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: Development and validation. *J Chr Dis.* 1987; 40(5):373-383.
 38. Quan H, Li B, Couris CM, et al. Updating and validating the Charlson comorbidity index and score for risk adjustment in hospital discharge abstracts using data from 6 countries. *Am J Epidemiol.* 2011;173(6):676-682.
 39. Degroot V, Beckerman H, Lankhorst G, Bouter L. How to measure comorbidity: a critical review of available methods. *J Clin Epidemiol.* 2003;56(3):221-229.
 40. Mollayeva T, Thurairajah P, Burton K, Mollayeva S, Shapiro CM, Colantonio A. The pittsburgh sleep quality index as a screening tool for sleep dysfunction in clinical and non-clinical samples: A systematic review and meta-analysis. *Sleep Med Rev* 2016;25:52-73.
 41. Mioshi E, Hsieh S, Savage S, Hornberger M, Hodges JR. Clinical staging and disease progression in frontotemporal dementia. *Neurology.* 2010;74(20):1591-1597.
 42. Ismail Z, Agüera-Ortiz L, Brodaty H, et al. The mild behavioral impairment checklist (MBI-C): A rating scale for neuropsychiatric symptoms in pre-dementia populations. *J Alzheimer's Dis.* 2017;56(3):929-938.
 43. Liew TM. Neuropsychiatric symptoms in cognitively normal older persons, and the association with Alzheimer's and non-Alzheimer's dementia. *Alzheimer's Res Ther.* 2020;12(1):35.
 44. Pallant J. PART FOUR: Statistical techniques to explore relationships among variables. In: Education M-H, eds. *SPSS Survival Manual: A Step by Step Guide to Data Analysis Using SPSS.* ProQuest Ebook Central; 2000:121-202.
 45. Alzheimer's Society. Services, support and housing. In: *Caring for a person with dementia: A practical guide.* London: Alzheimer's Society; 2021:89-106.
 46. Maayan N, Soares-Weiser K, Lee H. Respite care for people with dementia and their carers. *Cochrane database syst rev.* 2014;16(1):CD004396.
 47. Cheng S-T, Zhang F. A comprehensive meta-review of systematic reviews and meta-analyses on nonpharmacological interventions for informal dementia caregivers. *BMC Geriatr.* 2020;20(1):137.
 48. Parkinson M, Carr SM, Rushmer R, Abley C. Investigating what works to support family carers of people with dementia: a rapid realist review. *J pub heal (Oxford, England).* 2016;39(4):e290-e301.
 49. Stephan A, Bieber A, Bieber A, et al. Barriers and facilitators to the access to and use of formal dementia care: Findings of a focus group study with people with dementia, informal carers and health and social care professionals in eight European countries. *BMC Geriatr.* 2018;18(1):131.
 50. Southby K. Barriers to non-residential respite care for adults with moderate to complex needs: A UK perspective. *J Int Disabili.* 2017;21(4):366-386.
 51. Boots LMM, Wolfs CAG, Verhey FRJ, Kempen GIJM, de Vugt ME. Qualitative study on needs and wishes of early-stage dementia caregivers: The paradox between needing and accepting help. *Int Psychoger.* 2015;27(6):927-936.
 52. Neckelmann D, Mykletun A, Dahl AA. Chronic insomnia as a risk factor for developing anxiety and depression. *Sleep.* 2007;30(7):873-880.
 53. Vedaa Ø, Krossbakken E, Grimsrud ID, et al. Prospective study of predictors and consequences of insomnia: Personality, lifestyle, mental health, and work-related stressors. *Sleep Med.* 2016;20:51-58.
 54. Gao C, Chapagain NY, Scullin MK. Sleep duration and sleep quality in caregivers of patients with dementia. *JAMA Net Open* 2019;2(8):e199891.
 55. Cupidi C, Realmuto S, Lo Coco G, et al. Sleep quality in caregivers of patients with Alzheimer's disease and Parkinson's disease and its relationship to quality of life. *Int Psychogeriatr* 2013;25(7):1.
 56. Johnson EO, Roth T, Breslau N. The association of insomnia with anxiety disorders and depression: exploration of the direction of risk. *J Psychiatr Res.* 2006;40(8):700-708.
 57. Passarella S, Duong M-T. Diagnosis and treatment of insomnia. *Am J Heal-Sys Phar.* 2008;65(10):927-934.
 58. Patel D, Steinberg J, Patel P. Insomnia in the elderly: A review. *J clin sleep med.* 2018;14(6):1017-1024.
 59. Miyazaki R, Ayabe M, Kumahara H, Morimura K, and Inukai Y. Effects of light-to-moderate intensity aerobic exercise on objectively measured sleep parameters among community-dwelling older people. *Arc gerontolo geriatr* 2021;94:104336.
 60. Golshani G, Pirnia B. Comparison of mindfulness-based cognitive therapy (MBCT) with acceptance and commitment therapy (ACT) On the severity of fatigue, improvement of sleep quality and resilience in a patient with prostate cancer: A single-case experimental study. *Int J Cancer Manag.* 2019;12(2):e88416.
 61. Salari N., Khazaie H, Hosseinian-Far A, et al. The effect of acceptance and commitment therapy on insomnia and sleep quality: A systematic review. *BMC Neurolo.* 2020;20(1):300.

62. McCurry SM, Gibbons LE, Logsdon RG, Vitiello MV, Teri L. Insomnia in caregivers of persons with dementia: who is at risk and what can be done about it? *Sleep Med Clin.* 2009; 4(4):519-526.
63. Chiu Y-C, Lee Y-N, Wang P-C, et al. Family caregivers' sleep disturbance and its associations with multilevel stressors when caring for patients with dementia. *Aging & Men Heal.* 2014;18(1):92-101.
64. Smyth A, Whitehead L, Quigley E, Vafeas C, Emery L. Disrupted sleep and associated factors in Australian dementia caregivers: A cross-sectional study. *BMC Geriatr.* 2020;20(1):312.
65. Gibson RH, Gander PH, Jones LM. Understanding the sleep problems of people with dementia and their family caregivers. *Dementia.* 2014;13(3):350-365.
66. McCurry SM, Logsdon RG, Teri L, Vitiello MV. Sleep disturbances in caregivers of persons with dementia: Contributing factors and treatment implications. *Sleep Med Rev.* 2007;11(2):143-153.
67. Shaffer KM, Carter P, Garland SN, Applebaum AJ. Cognitive behavioral therapy for insomnia for caregivers. In: Applebaum AJ, ed. *Cancer Caregivers.* Oxford University Press;2019: 201-218.
68. Jin JW, Nowakowski S, Taylor A, Medina LD, Kunik ME. Cognitive behavioral therapy for mood and insomnia in persons with dementia. *Alzheimer Dis Assoc Disord.* 2021; 35(4):366-373.
69. van Ryn M, Sanders S, Kahn K, et al. Objective burden, resources, and other stressors among informal cancer caregivers: A hidden quality issue? *Psycho-Oncolo.* 2011; 20(1):44-52.
70. Mineka S, Anand D, Sumner JA. Important issues in understanding comorbidity between generalized anxiety disorder and major depressive disorder. In: Richards CS, O'Hara MW, eds. *The Oxford Handbook of Depression and Comorbidity.* Oxford University Press; 2014.
71. Grandner MA, Kripke DF, Yoon I-Y, Youngstedt SD. Criterion validity of the pittsburgh sleep quality index: Investigation in a non-clinical sample. *Sleep Biolog Rhy.* 2006; 4(2):129-136.