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ARTICLE

Co-resident care-giving and problematic sleep among older people: evidence from the UK Household Longitudinal Study

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Abstract

In light of current pressures within formal social care services, informal carers assume an important role in meeting the care needs of a growing number of older people. Research suggests relationships between care-giving and health are complex and not yet fully understood. Recently, wide-ranging associations between sleep and health have been identified, however, our understanding of the links between care-giving and sleep is limited at present. This study assesses longitudinal patterns in co-resident care-giving and problematic sleep among older people in the United Kingdom. Our sample included 2,470 adults aged 65 years and older from the UK Household Longitudinal Study. Problematic sleep was defined as two or more problems in going to sleep, staying asleep or sleep quality. Using logistic regression models, we assessed how co-resident care-giving status, intensity and transitions influence the likelihood of problematic sleep in the following year, adjusting for potential confounding factors. Adjusted analyses found co-resident care-givers were 1.49 (95% confidence interval = 1.06–2.08) times more likely to report problematic sleep in the following year, relative to those not providing care. Care-giving over 20 hours per week and continuous co-resident care-giving also significantly increased the odds of problematic sleep. This suggests older co-resident care-givers may be at greater risk of incurring sleep problems than non-care-givers. Further longitudinal research is needed to investigate care-giver-specific consequences of poor sleep.

Keywords: sleep; care-giving; co-resident care-giving; carers; longitudinal; quantitative; older adults

Introduction

Informal care by friends and relatives is a central pillar of English social care, critical to meeting the needs of a growing number of older adults at a time of intense financial and systemic pressures (Vlachantoni *et al.*, 2011; Pickard *et al.*, 2016). Defined as 'providing unpaid support for someone with … ill health, disability or needs due to old age' (Vlachantoni, 2010), informal care was provided by over 10 per cent of the population of the United Kingdom (UK) in 2011, 1.3 million of whom were aged 65 and older (Office for National Statistics, 2011).

Supporting individuals to continue to provide care, while maintaining their health and wellbeing, is being given more prominence in legislation (HM Government, 2014). Yet while understanding the implications of care-giving for health is an important research topic, evidence is mixed, with patterns that are not fully understood. One under-explored possible explanation for these diverse results is differential sleep patterns, as sleep has been linked to a wide range of health outcomes (Ferrie *et al.*, 2011). Our study contributes to literatures on care-giver health and care-giver sleep, and provides the first longitudinal assessment of patterns and temporal associations between co-resident care-giving (status, hours and transitions) and sleep in a representative sample of adults aged 65 years and over in the UK. Four waves of data from the UK Household Longitudinal Study (UKHLS) are used, and analysis is set in the context of a modified care-giver stress process framework (Pearlin *et al.*, 1990). The analysis is a preliminary step in investigating care-giver sleep as a potential stressor influencing health outcomes.

Background

Care-giver health

An extensive literature exists exploring the effects of care-giving on health. Relatively consistent findings have identified particular groups of care-givers that are more likely to suffer poorer psycho-social outcomes compared to non-care-givers (Capistrant, 2016). These include care-givers of people with dementia (Brodaty and Donkin, 2009), individuals providing care for 20 hours or more per week (Hirst, 2005), spousal and child care-givers (Rafnsson *et al.*, 2017), and co-resident care-givers (Caputo *et al.*, 2016; Kaschowitz and Brandt, 2017). Care-giver physical health has been studied less frequently but is an area of increasing interest, as a nuanced picture has emerged from studies investigating links to biomarkers, health behaviours, morbidity and mortality (Capistrant, 2016). Certain groups of care-givers are more likely to suffer negative physical health outcomes, for instance, care-givers of people with dementia were found to have significantly higher levels of stress hormones, and lower levels of antibodies compared to non-care-givers (Vitaliano *et al.*, 2003). However, among more general samples of care-givers, physical health outcomes are mixed. For instance, using United Kingdom (UK) census data from 2001 and 2011, the majority of care-givers reported better self-rated health than non-care-givers in all but those ceasing caring after providing heavy care (Vlachantoni *et al.*, 2016). Similarly, care-giving was found to be associated with reduced risk of mortality and lower incidence of chronic disease in five recent population-based studies (Roth *et al.*, 2015). Selection bias out of care-giving among individuals with poorer health and the positive benefits of providing lower levels of care are some of the potential explanations for these findings. However, at present there is an incomplete understanding of care-giver health.

Sleep and health linkages

One possible explanation for variation in care-giver health outcomes that has received little attention is sleep. A burgeoning literature has found associations between poor sleep and a variety of negative physical and mental health outcomes, including among older adults (*e.g.* Jackowska *et al.*, 2013). Associations have been found between poor sleep and increased risk of mortality (Dew *et al.*, 2003) and diabetes (Cappuccio *et al.*, 2010), negative cardiovascular health outcomes (Cappuccio *et al.*, 2011) and, less consistently, poorer cognitive function (Devore *et al.*, 2016). Care-giver health studies have as yet rarely included sleep as a possible explanatory factor. The limited existing evidence suggests sleep may be important for care-giver physical function (Spira *et al.*, 2010) and for older care-givers' quality of life (Cupidi *et al.*, 2012). Poor sleep may also have direct implications for continuation of care-giving: sleep disturbance has been cited as a reason for transitioning care recipients to nursing and residential homes. For instance, in an eight-European country study, approximately one-third of German, Dutch and Swedish carers surveyed cited sleep and night-time behaviour disorders of the person they cared for as a main reason for subsequent institutionalisation (Afram *et al.*, 2014). These few studies suggest potential linkages between poor sleep, care-giver health and continued ability to care that might be explored further, with relevance to understandings of the health implications of providing care, and for social policy aiming to support care-givers and maintain their health (HM Government, 2014). An initial step in exploring such linkages is to understand how care-giving may affect sleep, as there is at present a relatively modest existing literature.

Existing evidence of associations between care-giving and sleep

A relatively small but growing number of cross-sectional studies have explored the relationship between care-giving and sleep. For instance, adult care-givers have been found to have significantly higher odds of reporting sleep disturbance than non-care-givers in a 58-country cross-sectional study using World Health Survey data (Koyanagi *et al.*, 2018). However, this finding is not consistent across all studies. For instance, Gibson *et al.* (2015) found no significant association between care-giving status and sleep in analysis of nationally representative data of older people from New Zealand, though care-givers were significantly more likely to report feeling tired all the time. These two studies compared all care-givers to non-care-givers, however, more often particular characteristics of care-giving or the care-giver have been linked to poor sleep. For instance, a number of cross-sectional studies have found positive associations between care-giving intensity in hours per week and problematic sleep (Happe and Berger, 2002; Arber and Meadows, 2011*a*) among particular vulnerable groups including spousal carers (Kochar *et al.*, 2007; Creese *et al.*, 2008), carers of people with dementia (Cupidi *et al.*, 2012) and co-residential, but not non-residential, care-givers (Arber and Meadows, 2011*a*). Qualitative studies highlight a number of care-giving-related activities and habits that can cause sleep disruption. These include provision of physical night-time care, emotional support to the care recipient, or delaying going to bed and experiencing very light, alert sleep, in anticipation of night-time needs (Biancchera and Arber, 2007; Martin and Bartlett, 2007; Arber and Venn, 2011; Gibson *et al.*, 2014). Of specific research interest is the extent to which care-giving contributes to negative sleep outcomes compared to other possible factors. Previous research has controlled for a wide but inconsistent variety of demographic, health and social factors. Age has been found to have differing relationships depending on the measure of sleep (Arber and Meadows, 2011*b*). Other factors found to be associated with poor sleep have included being female (Arber and Meadows, 2011*a*, 2011*b*) and widowed, divorced or separated (Arber and Meadows, 2011*b*); and having lower household wealth (Kumari *et al.*, 2010), and poor mental (Brummett *et al.*, 2006; Creese *et al.*, 2008; von Kaenel *et al.*, 2014) and physical health (Wilcox and King, 1999; Kumari *et al.*, 2010; Arber and Meadows, 2011*b*).

The collection of sleep data has only relatively recently become a part of prominent longitudinal surveys (Arber and Meadows, 2011*b*). Consequently, only a handful of studies have investigated temporal relationships between care-giving and sleep, one of which, based on a clinical sample from the University of California, San Diego's Alzheimer's Caregiver Study (von Kaenel *et al.*, 2012), found no longitudinal link between care-giving and sleep, but ceasing care-giving following the death of a spouse was associated with a significant increase in sleep disturbance. Most recently, the only longitudinal care-giver sleep study based on nationally representative data sampled Swedish people in employment aged 16–64 years. This study found care-giving for five hours or more per week across two survey waves was associated with greater sleep disturbance compared to continuous non-care-giving; and, counter to von Kaenel *et al.* (2012), ceasing care-giving was associated with a reduction in sleep disturbance (Sacco *et al.*, 2018). The small pool of studies including only one longitudinal study based on nationally representative data of Swedish carers in employment suggests there is scope for further research on longitudinal patterns between informal care-giving and sleep, particularly to widen the evidence base using representative samples in country contexts other than Sweden and among older non-working as well as working care-givers.

The care-giver stress framework

Several reviews of care-giver sleep research have highlighted the limited explicit identification of theoretical frameworks shaping analysis (*e.g.* Peng and Chang, 2013). Therefore, we make explicit the theoretical framework underpinning our analysis: viewing care-giver sleep in the context of the care-giver stress process framework (Pearlin *et al.*, 1990).

The stress process perspective describes the conditions in which stress can arise and which factors may be important in influencing its effect on physical and mental health (Pearlin *et al.*, 1990). Pearlin *et al.* conceptualised care-giving as a type of mutual assistance, a natural part of many close supportive relationships. They suggested that stress is produced when the extent of reciprocity in a relationship declines and care-giving becomes a dominant aspect and upsets the balance of other relationship dimensions (Pearlin *et al.*, 1990). This research analyses care-giver sleep in the context of a modified care-giver stress framework (Pearlin *et al.*, 1990). This framework has been used extensively in the care-giver literature, applying stress theory initially to understand care-giving for people living with Alzheimer's disease, but now used more widely.

Despite sleep disturbance being a common symptom of Alzheimer's disease (Crowley, 2011), sleep was not explicitly included in the original framework.

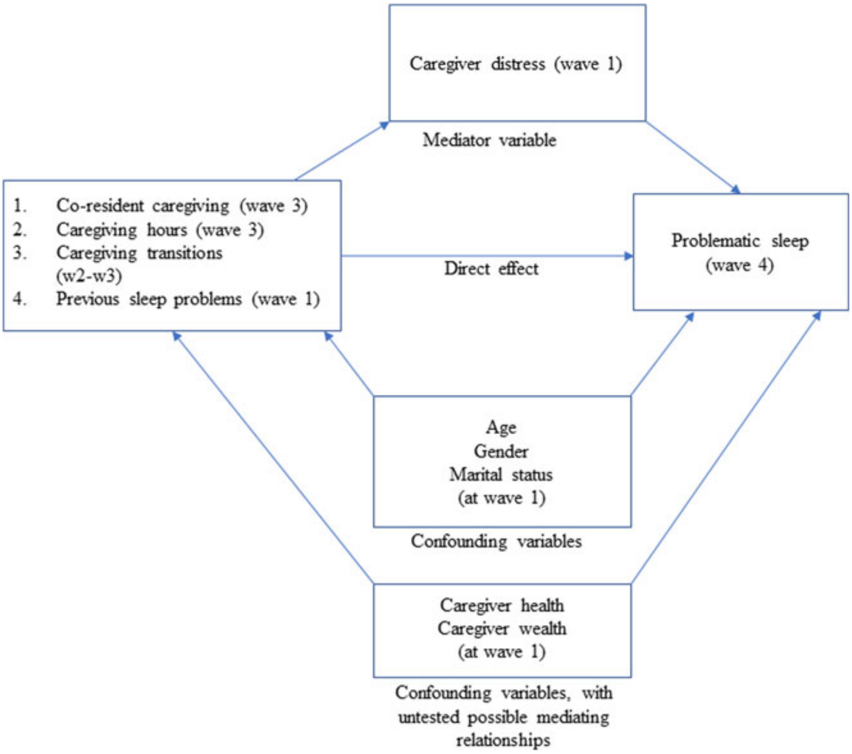

Figure 1. Hypothesised variable relationships.

However, Simpson and Carter (2013) have since modified the original framework, conceptualising sleep as arising indirectly from care-giving, as a secondary stressor. This study modifies the model further to include sleep both as a secondary stressor and previous sleep problems as a background characteristic of the care-giver (Figure 1). The analysis is a preliminary step in investigating care-giver sleep as a potential stressor influencing health outcomes. Background characteristics are defined in the framework as contextual factors such as socio-demographic and financial characteristics. Provision of co-residential care, hours of care-giving and co-residential care-giving transitions between two survey waves are modelled as primary stressors of care-giving.

In the context of co-residential care, disturbed sleep may be a bi-product of care-giving patterns such as night-time monitoring, potentially inducing stress-related health consequences. It may also be a manifestation of stress caused by a changing relationship with the care receiver for instance giving rise to sleeplessness due to worry; or circumstances less directly linked or unrelated to care-giving (Pearlin *et al.*, 1990). The care-giver stress framework accounts for the diversity in care-giver circumstances, enabling the study of combinations of factors that may produce stress. As sleep has both biological, cultural and social aspects (Arber and Meadows, 2011*b*), the framework is particularly appropriate for the identification of variables that may confound or mediate the relationship between care-giving and sleep.

The inclusion of factors in this study's analytical model derive from the care-giver stress framework and existing literature. Potential confounding variables included in the analysis are age, gender, marital status, income, care-giver health and care-giver distress. Potential moderation by income and bidirectional relationships between physical and mental health and sleep are not considered in this study.

Research question and hypotheses

This research addresses the specific research question: how do co-resident care-giving, care-giving hours per week and co-resident care-giving transitions relate to subjectively perceived sleep problems over time in adults aged 65 years and over, adjusting for possible confounding characteristics?

The hypotheses tested are: firstly, provision of co-resident care is temporally associated with an increased likelihood of reporting problematic sleep in the subsequent survey wave, adjusted for confounding variables; secondly, as care-giving intensity (in hours per week) increases, the likelihood of reporting problematic sleep increases in the subsequent wave; finally, transitions into and out of co-resident care-giving, as well as continuous co-resident care-giving, between the two prior survey waves increase the likelihood of problematic sleep compared to non-care-givers.

Methods

Study sample

This study used data from Waves 1–4 of the UKHLS (University of Essex, 2018), an annual, nationally representative household panel survey of over 40,000 households in the UK (Buck and McFall, 2012). The UKHLS collects detailed social, economic and health data (Knies, 2017), and sampling strategy, weighting and response rate details are publicly available (Buck and McFall, 2012). Sleep items were included at Wave 1 (2009–2010) and Wave 4 (2012–2013). Wave 1 sleep data provided a baseline, and Wave 4 sleep data provided the problematic sleep outcome. Co-resident care-giving status and hours of care per week at Wave 3 were used to assess the temporal relationship between care-giving and sleep outcomes one year after. Co-resident care-giving transitions were measured using data from Waves 2 and 3, assessing sleep outcomes in the following year. Cross-sectional analysis of baseline characteristics at Wave 1 included all individuals aged 65 years and over with complete data for all care-giving, sleep and health variables (N = 5,821). After merging data across Waves 2–4, our final longitudinal analytical sample included individuals with full sleep, care and health data for Waves 1–4 (N = 2,470). Analyses including the distress variable have a slightly smaller N due to missing data (*see* Tables 3 and 4). The appropriate weights were applied for each analysis indicated in the table notes (Knies, 2017).

Sample quality

Sleep questions were included in the self-completion questionnaire in Wave 1, resulting in high levels of non-response (31% of individuals in Wave 1 had incomplete sleep data for the three sleep questions used in this study). Sleep items were moved to the main questionnaire in Wave 4 and non-response dropped to 0.1%. Analysis of cases excluded due to sleep item non-response in Wave 1 found they were more likely to be female, older, in poorer health and with lower income than the sample used for this study. The loss of these cases therefore may introduce some bias, in part mitigated using the appropriate longitudinal self-completion weight.

In addition to high levels of missing sleep data, comparison of UKHLS carers for Wave 3, with 2011 census data which collects care-giving status and intensity (Office for National Statistics, 2011), suggests there may be under-representation of care-givers providing longer hours of care in the overall UKHLS sample. The total proportion of carers (both co-residential and non-residential) in UKHLS Wave 3 is slightly higher overall than in the census (21% compared to 14%); but care-givers providing over 20 hours of care per week and over 50 hours of care per week are under-represented (*see* the online supplementary material). This is not a surprising finding given general issues of retention in longitudinal surveys, and the challenges higher-intensity care-giving may present for participation in a survey such as the UKHLS. However, there may be important differences between those higher-intensity care-givers participating in the survey and those who do not participate. These sample quality issues will be considered in interpreting the study results.

Measures

Sleep

Sleep is a complex phenomenon (Arber and Meadows, 2011*b*), and aspects of sleep can be subjectively measured and combined in different forms. Sleep items similar to the well-validated Pittsburgh Sleep Quality Index (PSQI; Buysse *et al.*, 1989) are included in the UKHLS (Arber and Meadows, 2011*b*). Analysis using this validated instrument is not possible, however, as UKHLS does not include the complete set of items in the scale. Instead, researchers have used a variety of different alternative measures of sleep, for instance sleep disturbance: incorporating difficulties falling asleep, staying asleep or waking up feeling tired (Jackowska *et al.*, 2013; Di Gessa *et al.*, 2017), and analysis of individual measures of sleep duration, quality and medication (Tang *et al.*, 2017). This study uses the conceptualisation of sleep problems articulated by Arber and Meadows (2011*a*) that combines difficulty falling asleep, staying asleep and subjective sleep quality. The inclusion of subjective sleep quality is particularly relevant for older people as it incorporates the social expectation of poorer sleep among some older people (Arber and Meadows, 2011*b*), and findings that older people may not be able to achieve the same amount or quality of sleep as younger people (Crowley, 2011). Arber and Meadows' (2011*a*) conceptualisation of problematic sleep is defined as two or more problems with going to sleep, staying asleep and sleep quality. Problems with going to sleep (sleep latency) was measured by the question 'During the past month how often have you had trouble sleeping because you cannot get to sleep within 30 minutes?', while the ability to stay asleep (sleep maintenance) was assessed with 'During the past month how often have you had trouble sleeping because you wake up in the middle of the night or early in the morning'. The five response categories for both these questions ranged from 'Not during the past month' to 'More than once most nights'. A sleep problem was regarded as a response of 'Three or more nights per week' or 'More than once most nights'. Subjective sleep quality was measured by the question 'During the past month, how would you rate your sleep quality overall?', with responses of 'very good', 'fairly good', 'fairly bad' or very bad'. A response of 'fairly bad' or 'very bad' was regarded as a sleep problem. As in the previous study (Arber and Meadows, 2011*a*), a sleep problems variable was constructed with a response range of 0 (no sleep problems) to 3 (three sleep problems), and then dichotomised. The dichotomised variable reference category, no overall sleep problem, includes all respondents reporting none or one sleep problem; those reporting two or more sleep problems were categorised as having problematic sleep.

Care-giving

Co-resident care-giving status and care-giving hours were derived from three questions: 'Is there anyone living with you who is sick, disabled or elderly whom you look after or give special help to?', identifying co-resident care-givers; 'Do you provide some regular service or help for any sick, disabled or elderly person not living with you?', identifying non-resident care-givers; and the linked question 'Now thinking about everyone who you look after or provide help for both those living with you and not living with you – in total, how many hours do you spend each week looking after or helping (him/her/them)?' Co-resident care-givers were coded as anyone providing some co-resident care, this included a small number of individuals who also provided non-resident care (29 individuals in Wave 3). Care-giving status was derived comparing those who provided co-resident care, those who provided non-resident care and those who did not provide care (reference group). While care-giving hours are more usually separated into care under or over 20 hours per week (*e.g.* Hirst, 2005), 50 hours or more per week was considered more relevant to possible problematic sleep, assuming increasing hours of care may lead to sleep disturbance either due to direct night-time caring activities, or due to worry for instance about caring conflicting with other responsibilities. Care-giving hours was categorised into those providing no care (reference category), those providing non-resident care, co-resident carers providing 0–49 hours of care per week and co-resident carers providing 50 or more hours of care per week. However, analysis using this categorisation showed unusual results, thought to be linked to the low sample size of co-resident care-givers providing over 50 hours of care per week. Therefore, a second care-giving hours variable with the more conventional categorisation of under 20 hours and 20 hours or more per week was also used for logistic regression of problematic sleep by care-giving hours (Table 5). A co-resident care-giving transition variable was coded for co-resident care-giving transitions made between Waves 2 and 3. Co-resident care-giving transitions was the focus of interest, therefore care-giving categories were: no care in either wave (reference group), non-resident care-giving in either wave, entry into co-resident care-giving, continuous co-resident care-giving and exit from co-resident care-giving. Individuals moving from non-resident caring to co-resident caring were coded as entering into co-resident care, and individuals moving from co-resident care to non-resident caring were coded as exiting co-resident care-giving. This analytic strategy captures transitions through change in status each year. Mid-year breaks in care-giving or short-term care-giving episodes not collected in the annual questionnaire were not captured.

Socio-economic and demographic variables

Age, gender, marital status and income were considered in the analysis. Respondents between the ages of 65 and 74 were distinguished from those 75 years and over. Women were compared to men; and marital status was recoded into two categories: not married or married/in a civil partnership. Equivalised household net monthly income was chosen as an indicator of socio-economic status at an individual level. This included individual employment income net of taxes, benefits and pension incomes, without housing wealth and equivalised using the Organisation for Economic Co-operation and Development modified scale (Knies, 2017). Income quintiles were used to describe the sample as well as a binary version comparing incomes above the median (reference category) to incomes at or below the median.

Physical and mental health

Subjectively perceived health was assessed using the self-rated health item from the Short Form-12 index. A dichotomous health variable was used for logistic regressions, with categories ‘fair’ or ‘bad’ health, and ‘good’ or ‘better’ health (reference category). A binary distress variable was created from the short form of the General Health Questionnaire, GHQ-12, to assess care-giver mental health following accepted methods (Booker and Sacker, 2011).

Statistical analysis

We first present baseline descriptive and bivariate statistics stratifying the sample by problematic sleep (Table 1) and by co-resident care-giving status (Table 2) at Wave 1. Pearson chi-square was used to test bivariate associations between categorical variables. Tests for continuous variables are provided in the notes for each table. As the problematic sleep outcome variable is binary, a logistic regression model was used in multivariate analyses, investigating the odds of reporting problematic sleep based on co-resident care-giving (and non-resident care-giving) characteristics compared to not care-giving, and adjusting for potential confounding variables. The contribution each variable makes to predicting the outcome variable is reported through odds ratios (OR), significance levels and confidence intervals (CI). −2 Log likelihood and the Cox and Snell statistic are reported, and were used to identify best model fit. Variables were added sequentially, starting with the explanatory variable of interest, the care-giving characteristic. Possible confounding (and untested potential mediating) variables were then added, starting with baseline sleep. Only variables previously found to be statistically significant in predicting the problematic sleep outcome in the prior analyses were added. The final model excluded variables which did not contribute significantly to model fit (Hosmer *et al.*, 2013), indicated in the notes for each table.

Table 1. Baseline characteristics of sample by problematic sleep at Wave 1

	Total sample	No sleep problem at Wave 1	Problematic sleep at Wave 1	χ^2, p[1]
N (%)	5,821[2]	4,431 (76.1)	1,390 (23.9)	
Gender (%):				
Male	45.4	48.8	34.7	84.8, $p < 0.001$
Female	54.6	51.2	65.3	
Mean age (95% confidence interval)	74.6 (74.4–74.7)	74.4 (74.2–74.6)	75.0 (74.6–75.4)	$t = -2.8$, $p = 0.005$[3]
Age (%):				
65–74 years	55.1	55.7	53.3	2.3, $p = 0.13$
75 years and over	44.9	44.3	46.7	
Marital status (%):				
Married/civil partner	57.7	60.1	50.0	43.6, $p < 0.001$
Not married	42.3	39.9	50.0	
Co-resident caring (%):				
Not a carer	82.1	81.9	82.8	9.1, $p = 0.01$
Non-resident carer	8.6	9.2	6.8	
Co-resident carer	9.3	8.9	10.4	
Number of hours per week of co-resident care (%):				
No care	82.1	81.9	82.8	20.6, $p = 0.001$
Non-resident care	8.6	9.2	6.8	
0–49 hours co-resident care	6.5	6.6	6.2	
50+ hours co-resident care	2.8	2.3	4.2	
Subjective health status (%):				

Excellent	10.7	13.1	3.2	508.3, $p < 0.001$
Very good	26.5	29.7	16.6	
Good	27.3	28.5	23.5	
Fair	23.1	20.7	30.4	
Poor	12.3	7.9	26.3	
Distress level, GHQ-12 caseness (%):[2]				
Low distress	85.1	91.4	64.4	585.0, $p < 0.001$
High distress	14.9	8.6	35.6	
Median income (£; interquartile range)	1,118.80 (768.82)	1,133.76 (791.33)	1,064.90 (696.89)	$p < 0.001$[4]
Income quintile (%):				
Highest	20.0	21.2	16.3	23.8, $p < 0.001$
Second highest	20.0	19.8	20.6	
Middle	20.0	20.4	18.7	
Second lowest	20.0	19.2	22.8	
Lowest	20.0	19.5	21.7	

Notes: 1. Cross-sectional weight applied; significance unchanged with the application of design weights. 2. N for analysis including the distress level variable was smaller due to the larger number of missing values, N = 5,673. 3. Independent *t*-test (unequal variance) was used to test for differences in mean age. 4. Mann–Whitney *U* was used to test for differences in median income. GHQ-12: short form of the General Health Questionnaire.

Table 2. Baseline characteristics by hours of care, Wave 1

			Co-resident care-giving (hours per week)		
	Not a carer	Non-resident care	0–49	50+	χ^2, p^1
N (%)	4,779 (82.1)	501 (8.6)	378 (6.5)	163 (2.8)	
Gender (%):					
Male	45.3	43.5	50.7	43.6	5.2, $p = 0.16$
Female	54.7	56.5	49.3	56.4	
Mean age (95% confidence interval)	74.9 (74.7–75.1)	71.7 (71.1–72.3)	74.2 (73.5–74.8)	74.2 (73.3–75.2)	37.5, $p < 0.001^2$
Age (%):					
65–74 years	52.9	73.9	58.6	54.6	82.68, $p < 0.001$
75 years and over	47.1	26.1	41.1	45.4	
Marital status (%):					
Married/civil partner	53.9	58.1	91.2	90.2	273.2, $p < 0.001$
Not married	46.1	41.9	8.8	9.8	
Problematic sleep (%):					
No overall problem	75.9	81.0	77.2	63.8	20.6, $p = 0.001$
Problematic sleep	24.1	19.0	22.8	36.2	
Subjective health status (%):					
Excellent	10.5	16.8	8.5	4.3	80.6, $p < 0.001$
Very good	26.1	32.5	25.1	25.2	
Good	27.1	28.5	25.9	34.4	
Fair	23.2	19.0	25.7	25.8	
Poor	13.1	3.2	14.8	10.4	

Distress level GHQ-12 caseness (%):[3]					
Low distress	85.3	87.8	81.7	76.8	14.7, $p = 0.002$
High distress	14.7	12.2	18.3	23.2	
Monthly net income:					
Median income (£; interquartile range)	1,105.72 (768.42)	1,312.60 (1,026.76)	1,138.00 (677.25)	1,083.32 (570.08)	$p < 0.001$[4]
Income quintile (%):					
Highest	19.3	31.4	16.2	12.9	68.0, $p < 0.001$
Second highest	19.5	21.8	23.1	22.1	
Middle	20.0	15.6	23.1	27.0	
Second lowest	20.4	16.4	20.2	20.2	
Lowest	20.8	14.8	17.5	17.8	

Notes: 1. Cross-sectional weight applied; significance unchanged with the application of design weights. 2. Homogeneity of variance assumption was violated (Levene statistic = 19.6, $p < 0.001$) so the Welch statistic was used to test for differences in mean age. 3. N for analysis including the distress level variable was smaller due to the larger number of missing values, N = 5,673. 4. Kruskal–Wallis was used to test for differences in median income. GHQ-12: short form of the General Health Questionnaire.

In a household panel study design, measures of sleep between individuals of the same household may not be independent. This study did not account for this, for instance through multi-level analysis, and instead referred to the work of Meadows and Arber (2015) who compared multi-level and individual-level analyses of their data and found negligible differences in results in similar sleep research using data from the UKHLS.

All statistical analyses were carried out using IBM SPSS Statistics version 23, and statistical tests were two-tailed and $p < 0.05$ was taken to be statistically significant.

Results

Descriptive findings

The characteristics of the sample at Wave 1 can be found in Table 1, which presents the distribution of explanatory factors and covariates by self-reported problematic sleep. Twenty-four per cent of the sample reported problematic sleep and almost one in ten reported providing co-resident care, of whom 30 per cent provided 50 hours of care or more per week. The majority reported low distress (85%) and good or better self-rated health (65%). Just over half of the sample were women (55%), with a higher proportion aged 65–74 years (55%) compared to those 75 years or older, and 58 per cent of the sample were married.

Table 1 also shows that individuals reporting problematic sleep were significantly more likely to report providing co-resident care for 50 or more hours per week, significantly poorer subjective physical and mental health, and to be female. The same group were less likely to be married or have net incomes in the highest income quintile. There were no significant age differences between those with and without problematic sleep.

Table 2 presents bivariate relationships between co-resident care-giving hours, problematic sleep and relevant covariates.

Co-resident care-givers were significantly more likely to suffer problematic sleep only when providing 50 hours or more of co-resident care. There were also significant differences in the distribution of self-rated health and distress reports among those not providing care, non-resident care-givers, and co-resident care-givers providing under 50 hours and 50 hours or more of care per week. Co-resident care-givers were also significantly more likely to report incomes in the lowest quintile relative to their counterparts providing non-resident care, and they were more likely to be married. There were no significant differences in age between co-resident care-givers and individuals not providing care, but non-resident care-givers were significantly more likely to be younger than both these groups. There were no significant differences in gender.

Multivariate analyses

The results of logistic regression are shown in a series of nested models in Tables 3–6. Each table shows the results of analysis by a different care-giving characteristic, care-giving status, hours or transitions, as shown in the analytical model (Figure 1). Table 3 shows the results of logistic regression analyses using cross-sectional data

Table 3. Cross-sectional analysis: logistic regression of problematic sleep by care-giving, co-resident care-giving hours per week and covariates at Wave 1

	Model 1	Model 2
	Odds ratios (95% confidence intervals)	
Care-giving (Wave 1):		
Not a care-giver	1.00	
Non-resident care-giver	0.86 (0.67–1.11)	
Co-resident care-giver	1.12 (0.88–1.42)	
Co-resident care-giving hours (Wave 1):		
Not a care-giver		1.00
Non-resident care		0.86 (0.67–1.11)
0–49 hours per week		0.92 (0.69–1.22)
50 hours or more per week		1.71** (1.18–2.50)
Baseline covariates (Wave 1):		
Health good	1.00	1.00
Health poor	2.51*** (2.19–2.88)	2.53*** (2.20–2.90)
Income above median	1.00	1.00
Income below median	1.09 (0.95–1.25)	1.09 (0.95–1.24)
Distress (GHQ-12 caseness) low	1.00	1.00
Distress (GHQ-12 caseness) high	4.46*** (3.79–5.25)	4.45*** (3.78–5.24)
Male	1.00	1.00
Female	1.70*** (1.48–1.96)	1.70*** (1.47–1.96)
65–74 years	1.00	1.00
75 years and over	0.77*** (0.66–0.88)	0.76*** (0.66–0.88)
Married	1.00	1.00
Not married	1.18* (1.02–1.37)	1.19* (1.02–1.37)
−2 Log likelihood	5,431	5,423
Cox and Snell	0.13	0.13

Notes: N = 5,673. N is smaller than bivariate analyses in Tables 1 and 2 due to the larger number of missing values for the distress level variable. Weighted by Wave 1 cross-sectional self-completion weight. GHQ-12: short form of the General Health Questionnaire.
Significance levels: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

at baseline (Wave 1). Model 1 shows the results by care-giving status, but this is not a significant predictor of problematic sleep outcomes. On the other hand, care-giving hours is modelled in Model 2, and these results show that individuals providing higher hours of co-resident care (50 hours or more) had significantly greater odds of reporting problematic sleep in the same wave (OR = 1.71, 95% CI = 1.18–2.50) compared to those not providing care. The lower odds of reporting problematic sleep when providing less than 50 hours of co-resident care or when providing non-

Table 4. Logistic regression of problematic sleep at Wave 4 by care-giving at Wave 3

	Model 0	Model 1	Model 2	Model 3 (final)
	Odds ratios (95% confidence intervals)			
Care-giving (Wave 3):				
Not a care-giver	1.00	1.00	1.00	1.00
Non-resident care-giver	1.07 (0.79–1.44)	1.07 (0.77–1.48)	1.24 (0.88–1.73)	1.21 (0.86–1.68)
Co-resident care-giver	1.47* (1.09–1.98)	1.47* (1.05–2.04)	1.56* (1.09–2.23)	1.49* (1.06–2.08)
Baseline sleep (Wave 1):				
No sleep problem		1.00	1.00	1.00
Problematic sleep		8.87*** (7.14–11.02)	7.04*** (5.57–8.91)	7.13*** (5.70–8.91)
Baseline covariates (Wave 1):				
Health good			1.00	1.00
Health poor			2.01*** (1.60–2.54)	2.22*** (1.78–2.77)
Distress (GHQ-12 caseness) low[1]			1.00	
Distress (GHQ-12 caseness) high			1.13 (0.83–1.54)	
Male			1.00	1.00
Female			1.54*** (1.22–1.93)	1.63*** (1.31–2.03)
65–74 years			1.00	
75 years and over			1.01 (0.80–1.28)	
Married			1.00	
Not married			1.13 (0.88–1.28)	
−2 Log likelihood	2,638	2,230	2,114	2,163
Cox and Snell	0.003	0.15	0.17	0.18

Notes: N = 2,470. 1. N for analysis including the distress level variable was smaller due to the larger number of missing values (N = 2,416). Income variable excluded as non-significant in cross-sectional analyses. Longitudinal self-completion weight applied. GHQ-12: short form of the General Health Questionnaire.
Significance levels: * $p < 0.05$, *** $p < 0.001$.

Table 5. Logistic regression of problematic sleep (Wave 4) by care-giving hours at Wave 3

	Model 0	Model 1	Model 2	Model 3
	Odds ratios (95% confidence intervals)			
Co-resident care-giving hours (Wave 3):				
Not a care-giver	1.00	1.00	1.00	1.00
Non-resident care-giver	1.07 (0.79–1.44)	1.07 (0.77–1.44)	1.07 (0.77–1.44)	1.21 (0.86–1.68)
0–49 hours per week	1.43* (1.09–2.04)	1.51* (1.02–2.25)		
50 hours or more per week	1.55 (0.94–2.56)	1.37 (0.78–2.41)		
0–19 hours per week			1.24 (0.72–2.14)	1.20 (0.69–2.09)
20 hours or more per week			1.60* (1.07–2.40)	1.67* (1.11–2.51)
Baseline sleep (Wave 1):				
No sleep problem		1.00	1.00	1.00
Problematic sleep		8.88*** (7.15–11.03)	8.85*** (7.13–11.00)	7.10*** (5.68–8.89)
Baseline covariates (Wave 1):				
Health good				1.00
Health poor				2.28*** (1.78–2.78)
Male				1.00
Female				1.63*** (1.31–2.03)
−2 Log likelihood	2,638	2,230	2,229	2,181
Cox and Snell	0.003	0.15	0.16	0.17

Notes: N = 2,470. Distress, age and marital status variables were excluded as non-significant in longitudinal analyses presented in Table 4.
Longitudinal self-completion weight applied.
Significance levels: * $p < 0.05$, *** $p < 0.001$.

Table 6. Logistic regression of problematic sleep (Wave 4) by co-resident care-giving transition between Waves 2 and 3

	Model 0	Model 1	Model 2
	Odds ratios (95% confidence intervals)		
Care-giving transition (Wave 2 to Wave 3):			
Continued not a care-giver	1.00	1.00	1.00
Non-resident care-giver	0.99 (0.76–1.31)	1.03 (0.77–1.39)	1.14 (0.84–1.54)
Entry into co-resident care-giving	1.27 (0.71–2.25)	1.16 (0.61–2.06)	1.21 (0.64–2.30)
Continued co-resident care-giving	1.59** (1.14–2.24)	1.62* (1.11–2.36)	1.63* (1.11–2.40)
Exit from co-resident care-giving	2.23** (1.38–3.70)	1.62 (0.92–2.85)	1.56 (0.88–2.78)
Baseline sleep (Wave 1):			
No sleep problem		1.00	1.00
Problematic sleep		8.78*** (7.06–10.91)	7.08*** (5.66–8.86)
Baseline covariates (Wave 1):			
Health good			1.00
Health poor			2.19*** (1.75–2.74)
Male			1.00
Female			1.65*** (1.32–2.05)
−2 Log likelihood	2,628	2,226	2,161
Cox and Snell	0.007	0.16	0.18

Notes: N = 2,446. Longitudinal self-completion weight applied.
Significance levels: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

resident care were not significant. These preliminary results showing no significant cross-sectional association between co-resident care-giving status and sleep, but a significant association between higher hours of care and problematic sleep, are consistent with studies finding particular characteristics of care-giving associated with sleep (*e.g.* Arber and Meadows, 2011*a*).

Hypothesis 1: Co-resident care-givers are more likely to suffer problematic sleep the following year than non-care-givers, independent of other covariates

Table 4 shows the results of logistic regression of problematic sleep at Wave 4 by co-resident care-giving status (at Wave 3). Unlike the cross-sectional analysis, Model 0 shows that compared to non-care-givers, those who provided co-resident care at Wave 3 were nearly 1.5 times more likely to report problematic sleep at Wave 4. This effect was not attenuated following adjustment for baseline sleep in Model 1. Unsurprisingly, those who reported sleep problems at Wave 1 were nearly nine times more likely to report problematic sleep at Wave 4. The effect of co-resident care-giving on problematic sleep was not attenuated in subsequent models when health, distress, marital status and gender were added; health and gender were both independently associated with problematic sleep. No significant association was found for non-residential care-givers. Null hypothesis 1 can therefore be rejected as co-resident care-givers had significantly higher odds of reporting problematic sleep after one year than those not providing care, independent of potential confounding variables.

Studies using repeated measurements have found similar significant associations between care-giving and sleep over a period of seven days (Rowe *et al.*, 2008) and two years (Sacco *et al.*, 2018), though not among all studies (von Kaenel *et al.*, 2012; Song *et al.*, 2017). The present study found 27 per cent of co-resident care-givers suffered problematic sleep, in comparison to 24 per cent of non-care-givers (Table 2). These differences are similar to those found by Kumari *et al.* (2010) in a sample of adults aged over 50 from the English Longitudinal Study of Ageing.

Hypothesis 2: As hours of co-resident care-giving increase, the likelihood of reporting problematic sleep in the following year increases

Table 5 shows the odds ratio of having problematic sleep for non-residential care-giving and two different categorisations of co-resident care-giver hours: under 50 hours, and 50 hours or more of care per week (Models 0 and 1); and under 20 hours, and 20 hours or more of care per week (Models 2 and 3), compared to non-care-giving. Care-giving for less than 50 hours per week was a significant predictor of problematic sleep after the addition of baseline sleep problems to the model (Model 1), however, care-giving for 50 hours or more per week did not show significantly greater odds of reporting problematic sleep. A handful of studies have analysed care-giving intensity and sleep (Wilcox and King, 1999; Happe and Berger, 2002; Arber and Meadows, 2011*a*; Song *et al.*, 2017). Unlike any previous study, these initial results indicated a significant association between lower-intensity care-giving (under 50 hours per week), but not higher-intensity care-giving (50 hours and over), and problematic sleep. This finding is counter-intuitive, particularly for those care-givers providing very long hours of care per week (100+ hours), and cross-sectional analysis of Wave 1 data in Table 3 found the opposite result. The small longitudinal sample size is likely to have reduced statistical power in this analysis, with a small group of care-givers providing 50 hours of care or more (64 respondents). For this reason, we ran a further set of logistic regressions using the more conventional categorisation, under 20 hours and 20 or more hours of care per week. Using this variable, lower-intensity care-giving (0–19 hours) was not associated with greater odds of problematic sleep; but higher-intensity care-giving (20 or more hours per week) showed greater odds of problematic sleep compared to non-care-givers. This effect was not attenuated in subsequent models with the addition of baseline sleep, health or gender, and the final model indicated that those care-givers providing 20 hours or more care per week were 1.67 times (95% CI = 1.11–2.51) more likely to report problematic sleep than non-care-givers. This suggests the null hypothesis can be rejected partially as higher-intensity hours of care provided per week, measured at 20 hours or more per week, significantly increased the odds of problematic sleep.

Hypothesis 3: Transitions in co-resident care-giving, and continuous co-resident care-giving between the previous two waves increase the likelihood of reporting problematic sleep in the following year, compared to those who continue to be non-care-givers

Table 6 presents the results from adjusted and unadjusted logistic regression models assessing the association between care-giving transitions between Waves 2 and 3, and problematic sleep at Wave 4.

Model 0 shows that continuous co-resident care-giving between Waves 2 and 3 was associated with a significant increase in the odds of reporting problematic sleep (OR = 1.59, 95% CI = 1.14–2.24) compared to individuals not providing care. This suggests those providing continuous co-resident care-giving for one year have almost 1.6 times the likelihood of reporting problematic sleep in the following year, compared to those not care-giving. The odds of reporting problematic sleep were not significantly higher for individuals entering into care-giving between Waves 2 and 3, or for individuals providing only non-resident care. However, there was a significant increase in the odds of reporting problematic sleep for individuals ceasing care-giving between Waves 2 and 3 compared to individuals providing no care (OR = 2.23, 95% CI = 1.38–3.70).

When baseline sleep at Wave 1 was added (Model 1), the association between continuous care-giving and problematic sleep at Wave 4 was not attenuated, suggesting co-resident care-givers providing care over a one-year period were more likely to report problematic sleep, independent of previous sleep patterns, than non-care-givers. The odds of reporting problematic sleep decreased for those ceasing care-giving when previous sleep problems at baseline was added, and the odds ratio became non-significant. Model 2 added health and gender; and the significantly increased odds of reporting problematic sleep among continuous care-givers remained, while baseline sleep, health and gender were all independently associated with the Wave 4 sleep outcome. Based on these results, null hypothesis 3 cannot be rejected, as only continued care-giving, rather than either entry into or exit from care-giving, were found to increase the likelihood of problematic sleep.

In summary, providing co-resident care-giving was found to increase significantly the odds of reporting problematic sleep in the following year, compared to non-care-givers, net of baseline sleep, gender and health. Similarly, continuous co-resident care-giving over a one-year period was associated with increased odds of problematic sleep in the following year, compared to those not providing care, controlling for the same covariates. Small sample size, resulting in reduced statistical power, hampered analyses by care-giving hours and care-giving transitions, and may be important contributing factors to unexpected results. Individuals reporting higher intensity care-giving, measured at 20 or more hours per week, but not 50 or more hours per week, had greater odds of reporting problematic sleep in the following year. Finally, no significant associations with problematic sleep were found among non-resident care-givers, and individuals entering into and exiting from co-resident care-giving.

Discussion

Recent research into differences in care-giver health outcomes has questioned the long-held view that provision of care contributes to poor mental and physical health (Capistrant, 2016). Underlying mechanisms are not yet fully understood, and a possible explanatory variable, sleep, has rarely been investigated among care-givers. To date, four studies have investigated care-giving and sleep over time, only one using nationally representative data sampling working carers; and none sampling the full range of older carers and using data from the UK (von Kaenel *et al.*, 2012, 2014; Song *et al.*, 2017; Sacco *et al.*, 2018). The present study, therefore, makes an important contribution to care-giver sleep research with its use of longitudinal data and a representative UK sample to explore the relationship between co-resident care-giving and problematic sleep among older people over time. It also addresses a preliminary step in investigating whether care-giver sleep may contribute to care-giver health outcomes. Results showed that co-resident care-givers experience an increased likelihood of problematic sleep in the following year, compared to those not providing care, after accounting for baseline sleep and other covariates. Being female and having poorer health both independently contributed to an increased likelihood of problematic sleep, in addition to having previously reported problematic sleep. Continuous care-giving in the two years prior was also a significant predictor of problematic sleep in the subsequent year. Higher-intensity care-giving (20 or more hours of care per week) was associated with significantly greater odds of reporting problematic sleep in the following year compared to non-care-givers, though this result was not found when analysing individuals providing care for 50 or more hours per week. Non-resident care-giving and transitions into and exits from co-resident care-giving between Waves 2 and 3 did not significantly increase the odds of having problematic sleep compared to non-care-givers.

Qualitative research has consistently documented a range of care-giving-specific sources of poor sleep, such as care recipient night-time wandering and care-giver monitoring activities that might contribute to this increased risk of problematic sleep (*e.g.* Gibson *et al.*, 2014). Our findings are consistent with these accounts and with the conceptualisation of problematic sleep arising as a secondary stressor as a result of being a care-giver within our theoretical model, the modified care-giver stress framework (Figure 1). The results suggest co-resident caring in a previous wave, and continuous co-resident care-giving between the two previous waves, was associated with higher odds of reporting problematic sleep the following year. Care-giving has been characterised as a form of unforeseen career, with different stages experienced by the individuals involved (Pearlin, 2010). These results suggest care-givers continue to be more likely to experience problematic sleep as they move through their care-giving 'career' (Pearlin and Aneshensel, 1994), at least over a period of several years. Our research did not test the relationship between problematic sleep among care-givers and the negative mental and physical health outcomes that Pearlin *et al.* (1990) assert are the result of the stress process. However, existing research among the general older population suggests that individuals experiencing poor sleep are more likely to suffer such negative outcomes (*e.g.* Jackowska and Poole, 2017).

Unexpectedly, analysis by care-giving hours gave differing results when hours per week were categorised by 20 or more hours or 50 or more hours per week. Individuals providing care for 20 hours or more per week, and less than 50 hours per week had higher odds of reporting problematic sleep in the following year compared to non-care-givers. However, providing less than 20 hours per week, or 50 hours or more per week were not significantly associated with problematic sleep. This contrasts with the cross-sectional analysis of Wave 1 data which found 50 hours of care or more associated with problematic sleep. The finding is surprising given high prevalence of 'round the clock' care-giving among older care-givers (Vlachantoni, 2010) and qualitative findings highlighting the night-time activities that disrupt care-giver sleep. However, it accords with wider evidence pointing to greater difficulties experienced among care-givers providing over 20 hours of care per week (*e.g.* Hirst, 2005). Explanations include the possibility that individuals providing between 20 and 50 hours of care per week may be subject to additional pressures that affect sleep. These may include the need to balance care-giving with employment (Sacco *et al.*, 2018) or grandchild care, which may disrupt sleep through worry. Alternatively, individuals providing 50 or more hours of care may receive state-funded or other support that allows them to provide long hours of care without experiencing problematic sleep. Indeed, Pickard *et al.* (2016) highlight the high proportion of older care-givers providing long hours of care among those receiving state support. However, analysis by care-giving hours is also likely to have been limited by the small sample size and lower statistical power available to identify significant associations. In addition to the small available sample, the sample may include underlying bias, as carers providing longer hours of care are under-represented in the UKHLS sample, and these individuals, along with individuals with missing sleep data in Wave 1, may be more likely to suffer sleep disruption.

Small sample size and resulting reduced statistical power may also have affected analyses of care-giving transitions. Transitions, and their influence on stress outcomes, is an important concept at the heart of the stress process (Pearlin, 2010). Previous research has found ceasing care-giving was associated with reduced sleep problems (Sacco *et al.*, 2018), but von Kaenel *et al.* (2012) found increased sleep disturbance after three months, where ceasing care-giving was as a result of spousal death. Our analyses found neither entering into care-giving nor ceasing care-giving had significantly different odds of reporting problematic sleep in the following year compared to non-care-givers. The finding was less surprising for entering into care-giving, as the care-giver stress process framework suggests care-giving is a natural part of normal relationships, not inherently stressful and potentially initially less arduous (Pearlin *et al.*, 1990). Researchers are indeed increasingly interested in the benefits providing care can bring (Brown and Brown, 2014). Explanations accounting for the lack of associations between ceasing care-giving and problematic sleep may be more wide-ranging. Although ceasing care-giving has been associated with increased levels of distress (Hirst, 2005), evidence is mixed among care-givers who institutionalised the person they care for, with studies finding decreased levels of burden (Bleijlevens, 2014) yet also significant levels of anxiety and poor sleep (Washington *et al.*, 2018). The analysis of von Kaenel *et al.* (2012) of the impact of ceasing care-giving due to institutionalisation or death of the spouse, and the contrasting results of Sacco *et al.* (2018) among younger working carers indicates a need for close attention to be paid to the characteristics of the care-giver and the circumstances of ceasing care. No significantly differing odds compared to non-care-givers may suggest ceasing care-giving alleviates any problems of physical night-time care or may indicate differing effects dependent on circumstance. Methodologically, however, measuring sleep outcomes one year after measuring the care transition may also be too long to pick up any shorter-term problems with sleep.

Limitations

The findings presented here must be considered in the context of a number of limitations. There is no one accepted conceptualisation or measure of poor sleep in the current care-giver sleep literature. Here, we used a binary indicator of the presence or absence of problematic sleep, following Arber and Meadows (2011*a*). This measure was used because the full validated sleep scale, PSQI, was not available in the dataset, and the combination of questions included in the measure used is particularly relevant to older care-givers, as described in the Methods section. Future studies of care-giver sleep might usefully carry out more extensive comparisons of different measures to evaluate the most appropriate for purpose, for instance disturbed sleep (Jackowska *et al.*, 2013), or individual measures of sleep (Tang *et al.*, 2017).

While the care-giver stress process framework has provided a useful theoretical structure for analysis, and most results seem consistent with its assumptions and assertions, further research might develop more sophisticated analyses with a wider range of factors, to deepen understanding of care-giver sleep, and crucially its links to health.

Most importantly, the sample on which this study is based under-represents care-givers providing 20 hours and particularly 50 hours and over per week and lost a high proportion of potential cases due to missing sleep data at Wave 1. These groups may differ significantly from the study sample, for instance, being more likely to be higher-intensity care-givers, and in the case of missing sleep data, more likely to be female, having less than median income and older age as discussed in the Methods section. As a result, the study findings may underestimate the association between care-giving and problematic sleep. Future studies would benefit from identifying larger samples of care-givers to conduct analyses on care-giving hours and transitions.

Policy implications

In investigating the patterns and possible contributory factors to problematic sleep among older co-resident care-givers, this research contributes findings that may be useful to policy makers and practitioners to protect and improve the health of older care-givers. The results point to the greater risk of problematic sleep among older co-resident care-givers, but not non-resident care-givers. Poorer sleep has been linked to a variety of poor health outcomes (Ferrie *et al.*, 2011) and may be a factor in moves from informal care to institutionalisation (Pollak and Perlick, 1991; Afram *et al.*, 2014). This research therefore adds to evidence of the significant challenges to well-being experienced by many older care-givers (*e.g.* Rafnsson *et al.*, 2017). The findings have policy and practical implications for the UK where access to formal state-funded home care and institutional care settings has been decreasing, and informal family care represents an essential pillar of social care (Vlachantoni *et al.*, 2011).

In a recent review of interventions for care-givers of people with dementia, sleep was identified as an important contributor to care-giver resilience through physical health, and coping strategies (Parkinson *et al.*, 2016). Carer needs assessments can include questions on sleep problems, however Carers UK found only 38 per cent of older carers were offered an assessment in 2016 (Carers UK, 2016). In addition to the limited coverage of carer assessments, reviews of interventions to improve care-giver sleep have identified only mixed success (Lee and Thomas, 2011). Indeed, some research suggests respite away from the home can be counter-productive in disrupting care recipient sleep patterns following the respite period (Lee and Thomas, 2011). These findings suggest further piloting and evaluation of promising sleep interventions, in addition to increasing opportunities to identify care-giver sleep problems, may be useful developments.

Considering potential research directions, with an increasing body of evidence pointing to the negative health consequences of poor sleep for the wider adult population, the study's findings raise questions of what care-giving-specific consequences an increased likelihood of problematic sleep may have; and what can be done to mitigate the factors leading to problematic sleep in care-givers.

Conclusion

Exploration of the impact of care-giving on health has yet to understand fully the underlying mechanisms for a range of diverse outcomes. One potential factor may be differences in care-giver sleep patterns, as current research is uncovering consistent patterns in the influence of sleep on many aspects of health. Circumstances in which care-givers may find themselves may include physical night-time care, monitoring activities, worry and stress that could lead to sleep disturbance (Arber and Venn, 2011). While a cross-sectional relationship between care-giving and sleep has been relatively consistently established, only a handful of studies have sought to investigate whether this relationship persists over time, and only one study has used a representative sample, using data from the Swedish Longitudinal Occupational Survey of Health (Sacco *et al.*, 2018). This research provides evidence for a longitudinal association between co-resident care-giving and problematic sleep, using a large-scale UK data-set with a probability sample. The results suggest co-resident care-giving is temporally associated with problematic sleep, as older co-resident care-givers are more likely to report problematic sleep in the subsequent year than non-care-givers even when other covariates are taken into account. It finds care-giving over 20 hours per week, and continuous co-resident care-giving over a period of one year, increases the likelihood of problematic sleep in the subsequent year compared to non-care-givers. Entries into and exits from co-resident care-giving, as well as non-resident care-giving, were not found to be significant, though smaller sample sizes may have masked any underlying association. These findings suggest increasing opportunities to identify care-giver sleep problems, and test potentially supportive interventions would be appropriate. Finally, the research findings support assertions that further longitudinal research into the factors associated with problematic sleep and potential care-giver-specific outcomes of poor sleep are required.

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