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Research Article

Tonight's Sleep Predicts Tomorrow's Fatigue: A Daily Diary Study of Long-Term Care Employees With Nonwork Caregiving Roles

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Abstract

Background and Objectives: Long-term care employees and employees with nonwork caregiving roles are at high risk for sleep problems and fatigue. Little is known, however, about relationships between sleep and fatigue among long-term care employees who occupy nonwork caregiving roles. This study examined whether longer sleep duration and better sleep quality reduce fatigue occurrence and severity within and between long-term care employees with nonwork caregiving roles, and investigated nonwork caregiving role occupancy as a moderator of these relationships.

Research Design and Methods: The sample comprised 166 women working in U.S.-based nursing homes. All women had children aged 9–17 years and some also had nonwork caregiving responsibilities for adult relatives. Sleep (duration and quality) and fatigue (occurrence and severity) were assessed via telephone interviews for eight consecutive evenings. Multilevel modeling was used to examine within-person and between-person associations.

Results: At the within-person level, nights characterized by longer-than-usual sleep duration or better-than-usual sleep quality were followed by days with lower odds of reporting fatigue; these same sleep characteristics predicted less severe next-day fatigue. At the between-person level, employees with better average sleep quality, but not longer sleep duration, had lower odds of experiencing fatigue. Relationships between sleep and fatigue were generally similar regardless of nonwork caregiving responsibilities for children or for both children and adults.

Discussion and Implications: Findings suggest that tonight's sleep predicts tomorrow's fatigue. Given the serious and wide-ranging consequences of fatigue, sleep constitutes a worthwhile intervention target with potential benefits for employees, care recipients, and organizations.

Keywords: Double-duty caregivers, Triple-duty caregivers, Sleep duration, Sleep quality, Nursing homes

Long-term care employees with nonwork caregiving roles, or *double-duty and triple-duty caregivers*, report shorter sleep duration, poorer sleep quality, and higher levels of fatigue compared to their counterparts without nonwork caregiving roles (DePasquale, Sliwinski, Zarit, Buxton, & Almeida, 2018; Scott, Hwang, & Rogers, 2006). Inadequate sleep and fatigue can have serious consequences for these caregivers' health and work performance as well as the

welfare and safety of their care recipients across the work and nonwork domains (Magnavita & Garbarino, 2017). Yet, few studies have examined naturally occurring relationships between sleep characteristics and fatigue in the context of double-duty and triple-duty caregivers' day-to-day lives. Given that sleep is a modifiable health behavior, studies are needed to establish how nightly sleep characteristics are related to fatigue. If established, interventions targeting these characteristics may facilitate management of fatigue in the double-duty and triple-duty caregiving workforce. The present study uses daily diary methodology to examine whether longer sleep duration and better sleep quality predict lower odds of and less severe fatigue experiences both within (day-level) and between (person-level) long-term care employees with different nonwork caregiving roles, and to assess nonwork caregiving role occupancy as a potential moderator of these relationships.

Fatigue Among Long-Term Care Employees

Fatigue is a state of energy depletion, reduced physical and mental performance capacity, and whole-body tiredness. Although diagnostically nonspecific, fatigue is a common and central medical symptom of various diseases (Akerstedt, Axelsson, Lekander, Orsini, & Kecklund, 2014). It is related to numerous inflammatory states and predictive of lack of self-care, poor self-rated health, reduced physical activity, impaired activities of daily living, the onset of depression and loneliness, and increased risk of morbidity and mortality (Mueller-Schotte, Bleijenberg, van der Schouw, & Schuurmans, 2016; O'Keefe-McCarthy & Ready, 2016; Wanigatunga et al., 2018).

It is widely assumed (but rarely shown empirically) that fatigue is prevalent among long-term care employees because of the physically and mentally demanding nature of care work. Beyond its likely prevalence and potential impact on employees' health and well-being, fatigue is an especially important issue for long-term care employees since their welfare critically impacts the safety and welfare of those they serve. Fatigue is linked to numerous workplace outcomes with implications for care recipients, including less effective communication, lack of alertness and difficulty concentrating, poorer quality of care, and greater patient safety risk and errors (Sagherian, Clinton, Abu-Saad Huijer, & Geiger-Brown, 2017; Steege et al., 2017). Relatedly, fatigue has ties to workplace outcomes that are problematic for employers, such as sickness absence, turnover intentions, job dissatisfaction, and worse overall job performance (Sagherian et al., 2018; Steege et al., 2017).

The implications of fatigue for long-term care employees, their care recipients, and their employers necessitate identification of modifiable lifestyle factors that can be intervened upon to reduce fatigue. Adequate sleep may constitute such a factor, although few observational studies have examined predictive relationships between sleep and fatigue in nonpatient populations or working adults. Most of these studies use cross-sectional data, with findings generally indicating that short sleep duration and poor sleep quality contribute to fatigue (e.g., Akerstedt et al., 2004; Aritake et al., 2015; Lavidor, Weller, & Babkoff, 2003). Recent microlongitudinal studies have shown, however, that these phenomena are not static. Instead, they covary day to day, with daily fatigue being linked to prior-night sleep adequacy (Akerstedt et al., 2014; Powell, Liossi, Schlotz, & Moss-Morris, 2017). Examining how daily, naturally occurring variations in sleep and fatigue relate to one another in long-term care employees' day-to-day lives may enable us to explain why some days are characterized by higher or lower levels of fatigue than others. Relatedly, examining within-person and between-person relationships will provide insight into differences in daily and average sleep and fatigue processes that can inform change initiatives. That is, findings can provide guidance as to the potential benefits of targeting contextual ("bad sleep days") versus person-based aspects of daily sleep experiences ("bad sleepers").

The Work, Nonwork, and Sleep Framework: A Perspective on Sleep and Fatigue

Conceptually, this study is guided by the Work, Nonwork, and Sleep (WNS) framework (Crain, Brossoit, & Fisher, 2018). The WNS framework expands traditional theoretical perspectives on the work/nonwork interface by incorporating sleep as a major life area connected to the work and nonwork domains via specific resources. Resources have been defined as valued objects, conditions, states, personal traits, and energies considered helpful for goal attainment and the accumulation of more resources (Halbesleben, Neveu, Paustian-Underdahl, & Westman, 2014). A common critique of the resource construct is that its definitions are broad, vague, and resemble taxonomies, thereby allowing "nearly anything good" to constitute a resource (Halbesleben et al., 2014). To address these criticisms, the WNS framework characterizes longer sleep duration and better sleep quality as resources that regenerate physical energy, a separate resource and physiological state related to "the capacity to do work" (Crain et al., 2018). The framework also identifies fatigue as the antithesis of physical energy, proposing that longer sleep duration and better sleep quality inversely affect fatigue intraindividually (i.e., within-people or from day to day) and interindividually (i.e., between-people or on average). These propositions derive from the energy hypothesis of sleep, where energy progressively diminishes during wakefulness and poses an "energetic challenge" to the brain; the physiological processes that occur during sleep enable recovery from this "energy-challenged" state by replenishing expended energy and reestablishing energy equilibrium (Berger & Phillips, 1995; Scharf, Naidoo, Zimmerman, & Pack, 2008). Accordingly, the duration and quality of sleep affect its restorative functions. Short sleep duration directly limits

the amount of restoration that occurs, while poor-quality sleep disrupts restorative processes (Barnes, 2012). Longer sleep duration and better sleep quality are therefore credited with playing central roles in restoring, conserving, and fostering physical energy.

Nonwork Caregiving Roles

Another proposition of the WNS framework is that contextual factors such as nonwork caregiving roles act as moderators of relationships between sleep and fatigue (Crain et al., 2018). The sample used here comprises long-term care employees, all of whom have dependent children and some of whom have simultaneous nonwork caregiving responsibilities for adult relatives. Long-term care employees who informally care for children are *double-duty-child caregivers*, whereas long-term care employees who informally care for children and adults are *triple-duty caregivers* (DePasquale et al., 2016). Accordingly, all employees in the present study were double-duty-child or triple-duty caregivers. Crain and colleagues (2018) identify long-term care employees and employees with nonwork caregiving roles as two "high-risk populations" that should be prioritized when testing WNS propositions, as these occupational groups are particularly likely to experience resource loss through work with increased safety risks and roles typically characterized by high demands and strain. Double-duty and triple-duty caregivers are members of each high-risk group. They also represent an understudied workforce segment, as researchers have traditionally studied paid (work) and unpaid (nonwork) caregiving roles separately rather than considering the consequences of their convergence (Ward-Griffin et al., 2015).

We therefore answer the call to apply the WNS framework to high-risk occupational groups in a novel manner by focusing on double-duty-child and triple-duty caregivers, and test the WNS framework's proposition that nonwork caregiving role occupancy moderates relationships between sleep and fatigue. However, the WNS framework does not address how relationships between sleep and fatigue may differ depending on nonwork caregiving role occupancy. To supplement this proposition, we draw on theoretical perspectives on multiple roles, specifically the role scarcity and competing-demands hypotheses, and past double-duty and triple-duty caregiving research. According to the role scarcity hypothesis, individuals have finite personal resources, such as energy, for distribution among their social roles, each of which involve some level of responsibility (Goode, 1960). Relatedly, the competing-demands hypothesis suggests that each role creates demands, and that these demands contend for the same zero-sum resources (Stephens & Franks, 1999). As individuals occupy more roles, total resource availability decreases and total role demands increase. When total role demands exceed total resource availability, multiple role occupancy can negatively affect psychological and physical well-being. In applying these rationales to the present research, triple-duty caregivers may require additional resources relative to double-duty-child caregivers because of their extra nonwork caregiving role for adults. This assumption is supported by findings from a previous study in which triple-duty caregivers reported significantly higher levels of psychological distress compared to double-duty-child caregivers (DePasquale et al., 2016). Longer sleep duration and better sleep quality (i.e., resource gains), then, may be especially beneficial in promoting physical energy (i.e., reduced fatigue) among triple-duty caregivers.

The Present Study

This microlongitudinal study draws on a sample of long-term care employees with different nonwork caregiving roles to achieve three objectives. The first objective is to analyze the extent of variation in day-to-day reports of sleep characteristics and fatigue experiences. We expect there to be more within-person variation than between-person variation given that recent studies have highlighted the dynamic nature of these constructs (e.g., Akerstedt et al., 2014; Powell et al., 2017; Sin et al., 2017). Additionally, we examine whether these reports exhibit workday-related patterns to elucidate links between the work domain and resources (i.e., longer sleep duration, better sleep quality, and reduced fatigue occurrence and severity). Taking into consideration previous studies that have detected negative workday-related changes in health care employees' sleep (Dorrian et al., 2008; Scott et al., 2006) as well as the strenuous nature of long-term care employment, we anticipate negative changes in sleep on nights preceding workdays and negative changes in fatigue on workdays. The second objective is to test the WNS framework's proposition that sleep duration and quality affect fatigue at the within-person and between-person levels of analysis. Based on assumptions from the framework and past research, we hypothesize that longer sleep duration and better sleep quality will be associated with lower odds of fatigue occurrence and less severe fatigue experiences at each level of analysis. Our final objective is to assess whether nonwork caregiving role occupancy (i.e., double-duty-child vs triple-duty caregiver) moderates relationships between sleep and fatigue. Consistent with the role scarcity and competing-demands hypotheses (Goode, 1960; Stephens & Franks, 1999), we expect that the hypothesized effects of sleep characteristics on fatigue experiences will be most evident among triple-duty caregivers.

Methods

We performed a secondary analysis of existing data from the Work, Family and Health Study (WFHS), an initiative to understand how workplace practices and policies affect employees' work, nonwork, and health outcomes. Detailed information regarding the study's protocol and procedures is published elsewhere (Bray et al., 2013). Study methods

were approved by appropriate institutional review boards at WFHS sites.

The present study focused on U.S.-based long-term care employees recruited from 30 nursing homes located in six states. Each facility was owned by the same company, had at least 30 direct-care employees, and was not recently acquired. Eligible employees worked at least 22.5 hr per week in direct patient care on day or evening shifts. Of 1,783 total eligible employees, 1,524 (85% response rate) were enrolled. The present study used baseline data collected by trained interviewers who administered face-to-face, computer-assisted personal interviews (CAPI) with employees in the workplace. Employees who lived with a child aged 9–17 years were invited to participate in family data collection, which involved a daily diary study. Of 393 employees with age-eligible children, 181 (46%) participated. We restricted this subsample to women (n = 174, 96%); the number of men (n = 7) was too small to enable meaningful statistical comparisons based on gender. Independent sample t tests and chi-square analyses indicated that women who participated did not significantly differ from nonparticipants (n = 199) on basic sociodemographic characteristics.

The daily diary study was initiated within the month following the CAPI and entailed eight consecutive, nightly, computer-assisted telephone interviews lasting about 25 min (M = 7:00PM start time, SD = 2.46 hr). Employees answered questions about *prior-night* sleep characteristics as well as *same-day* fatigue experiences. They received $150 for participating. On average, employees completed over 7 days of calls (M = 7.33, SD = 1.17). We further restricted this subsample to the 166 employees who provided at least 2 days of sleep and fatigue data in order to assess daily variability. Of 1,328 possible days (166 participants × 8 days), participants completed a maximum of 1,221 (92%). Participant and daily characteristics for the final sample are presented in Table 1.

Measures

Outcomes

Two sequential items were adapted from Larsen and Kasimatis (1991) to assess the occurrence and severity of fatigue. Employees first reported whether they experienced fatigue leading up to that day's call (1 = *yes*, 0 = *no*). Among the 166 participants, 111 (67%) endorsed the fatigue occurrence item on at least 1 day. In total, fatigue occurred on 359 of 1,221 days (29%). The 111 participants who reported fatigue were asked to rate its severity, on applicable days, using a 10-point Likert scale (1 = *very*

Table 1. Daily and Participant Characteristics by Nonwork Caregiving Role Occupancy

	Overall (N = 166, N_{days} = 1,221)	Double-duty-child caregiver (N = 113, N_{days} = 835)	Triple-duty caregiver (N = 53, N_{days} = 386)	p
Participant characteristic				
Age (in years)	38.42 (6.40)	37.75 (6.09)	39.83 (6.86)	≤.05
White	63%	65%	60%	.14
Partnered/married	63%	65%	60%	.14
Post-secondary education	64%	69%	53%	≤.05
Certified nursing assistant	65%	61%	72%	.17
Annual household income (range: 1–13)	9.29 (3.38)	9.65 (3.37)	8.51 (3.30)	<.05
Total hours worked per week	39.09 (10.41)	39.55 (11.52)	38.11 (7.55)	.41
Lives with a child who has a developmental disability or health problem	34%	29%	45%	<.001
Time spent doing things with or taking care of all children (hours)	4.03 (2.22)	4.09 (2.24)	3.91 (2.19)	.62
Time spent on household tasks (hours)	2.18 (0.98)	2.04 (0.93)	2.47 (1.05)	<.01
Chronic health condition	34%	33%	38%	.07
Daily characteristic				
Workday, % of days	61%	63%	57%	<.05
Positive affect (range: 1–5)	2.88 (0.66)	2.81 (0.65)	3.04 (0.66)	<.001
Negative affect (range: 1–5)	1.38 (0.33)	1.34 (0.27)	1.45 (0.41)	<.001
Sleep duration (hours)	6.53 (1.02)	6.59 (0.92)	6.41 (1.20)	<.01
Sleep quality (range: 1–4)	2.99 (0.53)	2.99 (0.53)	2.97 (0.52)	.28
Fatigue occurrence, % of days	29%	28%	32%	.25
Fatigue severity (range: 1–10)[a]	5.61 (2.08)	5.60 (2.05)	5.63 (2.16)	.95
Daily interviews completed (range: 2–8)	7.33 (1.17)	7.35 (1.17)	7.26 (1.19)	.20

Note: p values for differences between double-duty-child and triple-duty caregivers were obtained from t tests for continuous variables and chi-square tests for dichotomous variables.

[a]Seventy-five double-duty-child caregivers and 36 triple-duty caregivers provided data on fatigue severity (N = 111, N_{days} = 359).

mild, 10 = *very severe*); the average fatigue severity score was 5.61 (*SD* = 2.08).

Predictors

Prior-night sleep characteristics were assessed each day with questions adapted from the Pittsburgh Sleep Quality Index (PSQI; Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). *Sleep duration* was examined with the question, "How many hours did you sleep last night?" On average, employees slept for 6 hr and 32 min (*M* = 6.53, *SD* = 1.02, N_{days} = 1,218). Sleep quality was assessed with the question, "How would you rate last night's sleep quality overall?" Response options included: 1 = *very badly*, 2 = *badly*, 3 = *well*, and 4 = *very well*. The average sleep quality score of approximately 3 indicated that participants slept "well" (*M* = 2.99, *SD* = 0.53, N_{days} = 1,219).

Moderator

In accordance with previous studies (e.g., DePasquale et al., 2016; Scott et al., 2006), we categorized participants as *double-duty-child* or *triple-duty caregivers* based on their nonwork caregiving roles. Employees who lived with children aged 9–17 years for at least 4 days per week were *double-duty-child caregivers*. Employees who lived with children aged 9–17 years for at least 4 days per week and assisted an adult relative for three or more hours per week in the past 6 months with shopping, medical care, or financial/budget planning, regardless of residential proximity, were *triple-duty caregivers*. Overall, there were 113 (68%) double-duty-child caregivers and 53 (32%) triple-duty caregivers. On average, double-duty-child and triple-duty caregivers lived with children aged 9.37 (*SD* = 4.66) and 11.26 (*SD* = 4.49), respectively. Although women's relationships to adult care recipients were not documented, qualitative data from the WFHS suggest that they typically cared for parents in poor health (DePasquale et al., 2016). Differences in double-duty-child and triple-duty caregivers' background and daily characteristics are shown in Table 1.

Person-Level Covariates

The WNS framework proposes that contextual factors can act as predictors of sleep and fatigue (Crain et al., 2018). We therefore selected the following person-level covariates based on their potential relation to framework constructs: age, race (1 = *White*, 0 = *non-White*), marital status (1 = *partnered/married*, 0 = *single*), annual household income level (1 = *less than $4,999*, 13 = *more than $60,000*), job title (1 = *certified nursing assistant*, 0 = *other*), total hours worked per week, living with a child who is developmentally disabled or has a health problem (1=*yes*, 0=*no*), time spent doing things with or caring for children in the past 8 days, time spent on household tasks in the past 8 days, and chronic health condition (1 = *yes*, 0 = *no*). Continuous variables were centered on the grand mean prior to inclusion in predictive analyses.

Day-Level Covariates

Prior research indicates that mood-dispositional dimensions can influence self-reported responses to questionnaires (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). In particular, positive and negative affect could create systematic variance in relationships between sleep and fatigue that differs from the actual variance between these variables. Although positive and negative affectivity are relatively stable traits, when individuals report their disposition on a day-to-day basis their responses may reflect transient mood states. Transient mood states can produce artifactual covariance when participants respond to questions about predictor and outcome variables while in a particular mood. Moreover, previous studies have linked positive and negative affect to both sleep and fatigue (Russell, Wearden, Fairclough, Emsley, & Kyle, 2016; Sin et al., 2017). Accordingly, we accounted for positive and negative affect at the day- and person levels. Affect was measured with items adapted from the Positive and Negative Affect Schedule (Watson, Clark, & Tellegen, 1988). Participants rated the extent to which they experienced 10 positive emotions (enthusiastic, interested, determined, excited, inspired, alert, active, strong, proud, and attentive) and 10 negative emotions (scared, afraid, upset, distressed, jittery, nervous, ashamed, guilty, irritable, and hostile) on a five-point scale (1 = *none of the time*, 5 = *all of the time*) each day. We computed internal consistency estimates within and between persons based on procedures outlined by Cranford et al. (2006), which can be interpreted similarly to Cronbach's alpha. For the positive affect scale (*M* = 2.88, *SD* = 0.66, N_{days} = 1,220), the daily-level correlation among the items was .89 and the person-mean level correlation was .94. For the negative affect scale (*M* = 1.38, *SD* = 0.33, N_{days} = 1,220), the daily-level correlation was .81 and the person-mean level correlation was .88. Additional day-level covariates included day in study (0 = *Day 1*, 7 = *Day 8*) and type of day (1 = *workday*, 0 = *nonwork day*).

Analytic Plan

We analyzed data using two-level multilevel models (MLMs) in SAS 9.4 to account for the nesting of days within persons. We conducted multilevel logistic models with the Proc Glimmix procedure for the dichotomous outcome of fatigue occurrence and multilevel linear models with the Proc Mixed procedure for the continuous outcome of fatigue severity. The sample sizes for number of participants and number of observation days varied based on the outcome measure being examined. Models predicting the likelihood of fatigue occurrence included all 166 participants (N_{days} = 1,221), whereas models predicting fatigue severity were restricted to a subset of 83 participants (N_{days} = 331) who reported that fatigue occurred on at least 2 days. The number of observation days also differed for daily predictors (i.e., sleep duration, N_{days} = 1,218;

sleep quality, N_{days} = 1,219) and covariates (i.e., positive and negative affect, N_{days} = 1,220).

For Objective 1, we specified unconditional means models to estimate intraclass correlation coefficients (ICCs), or the ratio of interindividual variance to total variance, for sleep and fatigue variables. We then added a fixed effect for type of day to assess workday-related patterns in sleep and fatigue.

For Objective 2, we assessed the within-person (Level 1) and between-person (Level 2) effects of each sleep characteristic on each fatigue outcome, resulting in four models. To obtain within-person estimates of time-varying predictors, we subtracted each participant's person-mean, or average score on a given variable across all study days, from each daily score. We interpreted these estimates as an individual's deviation from her own average levels. For example, negative values for prior-night sleep quality indicate poorer sleep quality than the person's usual sleep quality across the study period. All within-person variables were entered into models as Level 1 predictors. To obtain between-person estimates, we subtracted the person-mean from the grand mean. These estimates reflect how variables covary across people at a given time. For example, positive values of between-person sleep duration indicate sleeping longer than others in the sample. All between-person variables were entered into models as Level 2 predictors.

Prior to predictive analyses, we estimated bivariate associations between potential covariates and fatigue occurrence; we only included covariates significantly correlated with fatigue occurrence in predictive analyses to avoid generating spurious associations (Rovine, von Eye, & Wood, 1988). Day in study, type of day, age, race, total number of hours worked per week, chronic health condition, and within-person and between-person positive and negative affect were significantly correlated with fatigue occurrence. Therefore, all models included day in study, type of day, same-day positive and negative affect, and a prior-night sleep characteristic at Level 1. Age, race, total hours worked per week, chronic health condition, and between-person positive and negative affect, a between-person sleep characteristic, and nonwork caregiving role occupancy (1 = *triple-duty caregiver*, 0 = *double-duty-child caregiver*) were added at Level 2.

For Objective 3, we conducted a moderation analysis. We added a cross-level interaction term between within-person sleep effects and nonwork caregiving role occupancy (e.g., prior-night sleep duration × nonwork caregiving role occupancy) and an interaction term between between-person sleep effects and nonwork caregiving role occupancy (e.g., sleep duration × nonwork caregiving role occupancy). The following is an example equation for Level 1 and 2 models of the moderated analyses (without covariates):

$$\text{Level 1: } \textit{Fatigue severity}_{di} = \beta_{0i} + \beta_{1i}\left(\text{Prior} - \text{night sleep duration}\right)_{d-1i} + e_{di}$$

$$\text{Level 2: } \beta_{0i} = \gamma_{00} + \gamma_{01}\left(\text{Between} - \text{person sleep duration}\right) + \gamma_{02}\left(\text{Nonwork caregiving role occupancy}\right)_i + \gamma_{03}\left(\text{Between} - \text{person sleep duration}\right)_i * \left(\text{Nonwork caregiving role occupancy}\right)_i + u_{0i}$$

$$\beta_{1i} = \gamma_{10} + \gamma_{11}\left(\text{Nonwork caregiving role occupancy}\right)_i$$

Here, person *i*'s amount of fatigue severity on day *d*, Fatigue severity$_{di}$, is a function of the person's own intercept β_{0i}, which represents the person's average amount of fatigue severity when sleep duration is at the person-mean. β_{1i} is the person's own slope, which characterizes the association between sleep duration and fatigue severity for that individual (the day of sleep duration is presented as *d-1* because it refers to the previous night in relation to daily fatigue severity). Residual error e_{di} is the leftover variance in daily fatigue severity that is not explained by prior-night sleep duration.

At Level 2, person *i*'s average fatigue severity score across the study period (β_{0i}) is expressed as a function of the between-person intercept γ_{00}, the effects of the between-person variables sleep duration (γ_{01}) and nonwork caregiving role occupancy (γ_{02}), the between-person interaction between sleep duration and nonwork caregiving role occupancy (γ_{03}), and a between-person error term (u_{0i}). Within-person slopes, β_{1i}, are expressed as a function of the mean slope between persons (γ_{10}) and the effect of nonwork caregiving role occupancy (γ_{11}). This Level 2 equation reflects the aforementioned cross-level interaction.

Results

Descriptive Analyses

Day-to-Day Fluctuations

ICCs ranged from .24 to .32 for sleep characteristics and .36 to .43 for fatigue experiences, indicating that more variance was detected at the within-person level than at the between-person level across measures of interest. Specifically, day-to-day differences within individuals accounted for half or more of the total variation in each measure (sleep duration: 76%, sleep quality: 68%, fatigue occurrence: 52%, fatigue severity: 57%).

Workday-Related Patterns

Sleep duration, sleep quality, and fatigue occurrence, but not fatigue severity, changed significantly as a function of type of day. The average sleep duration on nights preceding nonwork days was 7 hr and 9 min, which decreased by 1 hr on nights preceding workdays (B = –1.00, p < .001). The average sleep quality score was above (3.10) and below (2.92) the threshold for sleeping "well" on nights before nonwork days and workdays, respectively (B = –0.18, p < .001). The odds of reporting fatigue more than doubled

on workdays compared with nonwork days (0.34 vs 0.14, OR = 2.48, $p < .001$).

Main Effects of Sleep Duration and Sleep Quality on Fatigue Occurrence

Tables 2 and 3 present results from MLM analyses of sleep duration and quality predicting fatigue occurrence, respectively. At the within-person level, prior-night sleep duration and quality were both significantly associated with next-day occurrences of fatigue. Specifically, employees had 27% lower odds of experiencing fatigue on days after nights when they slept longer than usual, and 63% lower odds of experiencing fatigue on days following nights characterized by better-than-usual sleep quality. Sleep quality, but not sleep duration, predicted fatigue occurrence at the between-person level. Employees with better average sleep quality had 74% lower odds of reporting that they had experienced fatigue.

Subgroup Analysis for Fatigue Severity

Tables 4 and 5 present results from MLM analyses of sleep duration and quality predicting fatigue severity, respectively, among the subgroup of participants for whom fatigue occurred on at least 2 days. Among employees who reported experiencing fatigue, significant associations between sleep characteristics and fatigue severity were detected at the within-person level. Employees reported less severe fatigue on days following nights of longer-than-usual sleep duration as well as better-than-usual sleep quality.

Moderation Effect of Nonwork Caregiving Role Occupancy

Results from moderation analyses revealed that the aforementioned within-person association between sleep duration and fatigue occurrence differed based on nonwork caregiving role occupancy (Table 2). A simple slopes analysis revealed that, after nights characterized by

Table 2. Within-Person and Between-Person Effects of Sleep Duration on Fatigue Occurrence

	Fatigue occurrence	
	Odds ratio (95% CI)	
	Model 1	Model 2
Fixed Effects		
Level 1 (Within-person effects)		
Mean (Intercept)	0.13 (0.05, 0.29)***	0.12 (0.05, 0.28)***
Day in study	0.76 (0.69, 0.82)***	0.76 (0.70, 0.82)***
Type of day	1.89 (1.27, 2.81)**	1.87 (1.25, 2.79)**
Same-day positive affect	0.46 (0.31, 0.67)***	0.46 (0.32, 0.68)***
Same-day negative affect	2.75 (1.59, 4.77)**	2.81 (1.62, 4.88)**
Prior-night sleep duration	0.73 (0.64, 0.84)***	0.72 (0.62, 0.83)***
Level 2 (Between-person effects)		
Age	1.12 (1.06, 1.18)**	1.12 (1.06, 1.19)**
Race	3.37 (1.52, 7.48)**	3.47 (1.55, 7.76)**
Total hours worked	0.95 (0.92, 0.99)*	0.95 (0.92, 0.99)*
Chronic health condition	1.78 (0.85, 3.73)	1.80 (0.85, 3.78)
Positive affect	0.79 (0.46, 1.37)	0.80 (0.46, 1.38)
Negative affect	3.48 (1.11, 10.93)*	3.53 (1.11, 11.21)*
Nonwork caregiving role occupancy	0.90 (0.41, 1.99)	0.95 (0.43, 2.12)
Sleep duration	0.74 (0.51, 1.06)	0.73 (0.50, 1.07)
Sleep duration × Nonwork caregiving role occupancy	---	1.04 (0.51, 2.14)
Cross-level interaction		
Prior-night sleep duration × Nonwork caregiving role occupancy	---	1.32 (1.01, 1.73)*
Random Effects		
Level 1 Residual		
Level 2 Intercept	3.50 (2.39, 5.59)***	3.57 (2.44, 5.71)***
Fit Statistics		
–2LL	1,067.19	1,063.28
AIC	1,097.19	1,097.28
BIC	1,143.87	1,150.18

Note: $N = 166$, $N_{days} = 1{,}216$. –2LL = log likelihood; AIC = Akaike information criterion; BIC = Bayesian information criterion; CI = Confidence interval. Missing data for prior-night sleep duration ($N_{days} = 3$), same-day positive affect ($N_{days} = 1$), and same-day negative affect ($N_{days} = 1$). Type of day – *workday* (1) versus *nonwork day* (0); race -*White* (1) versus *non-White* (0); chronic health condition – *has a chronic health condition* (1) versus *no chronic health condition* (0); nonwork caregiving role occupancy – *triple-duty caregiver* (1) versus *double-duty-child caregiver* (0). Simple slopes from moderated analyses are not tabled.
$^{*}p \leq .05$, $^{**}p < .01$, $^{***}p < .001$.

Table 3. Within-Person and Between-Person Effects of Sleep Quality on Fatigue Occurrence

	Fatigue occurrence	
	Odds ratio (95% CI)	
	Model 1	Model 2
Fixed Effects		
Level 1 (Within-person effects)		
Mean (Intercept)	0.12 (0.05, 0.28)***	0.12 (0.05, 0.27)***
Day in study	0.75 (0.69, 0.81)***	0.75 (0.69, 0.81)***
Type of day	2.15 (1.44, 3.19)**	2.15 (1.45, 3.20)**
Same-day positive affect	0.54 (0.37, 0.80)**	0.55 (0.37, 0.81)**
Same-day negative affect	2.76 (1.58, 4.82)**	2.76 (1.58, 4.83)**
Prior-night sleep quality	0.37 (0.28, 0.50)***	0.37 (0.27, 0.50)***
Level 2 (Between-person effects)		
Age	1.13 (1.06, 1.20)***	1.13 [1.07, 1.20]***
Race	3.08 (1.34, 7.05)**	3.12 [1.36, 7.13]**
Total hours worked per week	0.96 [0.92, 1.00]†	0.96 [0.93, 1.00]†
Chronic health condition	1.58 [0.74, 3.41]	1.55 [0.72, 3.33]
Positive affect	0.91 [0.51, 1.60]	0.93 [0.53, 1.65]
Negative affect	2.07 [0.60, 7.10]	2.17 [0.64, 7.41]
Nonwork caregiving role occupancy	0.99 [0.44, 2.24]	1.02 [0.45, 2.31]
Sleep quality	0.26 [0.12, 0.59]**	0.25 [0.11, 0.57]**
Sleep quality × Nonwork caregiving role occupancy	---	3.76 [0.83, 17.14]†
Cross-level interaction		
Prior-night sleep quality × Nonwork caregiving role occupancy	---	1.19 (0.65, 2.16)
Random Effects		
Level 1 Residual		
Level 2 Intercept	3.72 (2.53, 5.98)***	3.67 (2.50, 5.92)***
Fit Statistics		
–2LL	1,033.22	1,029.95
AIC	1,063.62	1,063.95
BIC	1,109.90	1,116.86

Note: N = 166, N_{days} = 1,217. –2LL = log likelihood; AIC = Akaike information criterion; BIC = Bayesian information criterion; CI = Confidence interval. Missing data for prior-night sleep quality (N_{days} = 2), same-day positive affect (N_{days} = 1), and same-day negative affect (N_{days} = 1). Type of day – *workday* (1) versus *non-work day* (0); race -*White* (1) versus *non-White* (0); chronic health condition – *has a chronic health condition* (1) versus *no chronic health condition* (0); nonwork caregiving role occupancy – *triple-duty caregiver* (1) versus *double-duty-child caregiver* (0). Simple slopes from moderated analyses are not tabled.
†$p < .10$, **$p < .01$, ***$p < .001$.

longer-than-usual sleep duration, the odds of reporting next-day fatigue decreased when employees were double-duty-child caregivers (OR = 0.66, 95% CI [0.55, 0.78], $p < .001$), but not triple-duty caregivers (OR = 0.87, 95% CI [0.70, 1.07], $p = .19$). Nonwork caregiving role occupancy did not moderate any other associations between sleep characteristics and fatigue experiences.

Discussion

Although sleep is a daily behavior and fatigue can reflect a transient state, researchers rarely account for the dynamic nature of either experience as it naturally occurs in the everyday lives of working adults and long-term care employees in particular. This study used an intensive, microlongitudinal research design to examine whether longer sleep duration and better sleep quality predicted reductions in fatigue occurrence and severity within and between long-term care employees with different nonwork caregiving roles. Guided by the WNS framework (Crain et al., 2018), findings indicated that sleep characteristics mainly affected the occurrence and severity of fatigue intraindividually rather than interindividually. Prior-night sleep characteristics predicted next-day fatigue experiences, such that nights characterized by longer-than-usual sleep duration or better-than-usual sleep quality were followed by days with lower odds of and less severe fatigue. With few exceptions, relationships between sleep and fatigue operated similarly for long-term care employees regardless of whether they were double-duty-child or triple-duty caregivers. Collectively, these results indicate that prior-night sleep characteristics contribute to experiences of next-day fatigue among double-duty and triple-duty caregiving long-term care employees.

This study highlights the importance and value of using designs that permit the assessment of within-subject

Table 4. Within-Person and Between-Person Effects of Sleep Duration on Fatigue Severity in a Subgroup Analysis

	Fatigue severity	
	Coefficient (SE)	
	Model 1	Model 2
Fixed Effects		
Level 1 (Within-person effects)		
Mean (Intercept)	5.67 (0.39)***	5.65 (0.39)***
Same-day positive affect	−0.40 (0.19)*	−0.40 (0.19)*
Same-day negative affect	0.92 (0.27)**	0.93 (0.27)**
Prior-night sleep duration	−0.16 (0.07)*	−0.18 (0.09)*
Level 2 (Between-person effects)		
Age	−0.02 (0.03)	−0.02 (0.03)
Race	−0.42 (0.40)	−0.40 (0.40)
Total hours worked per week	0.01 (0.02)	0.01 (0.02)
Chronic health condition	−0.16 (0.35)	−0.12 (0.36)
Positive affect	−0.65 (0.24)**	−0.63 (0.25)*
Negative affect	0.99 (0.50)*	1.01 (0.50)*
Nonwork caregiving role occupancy	0.50 (0.38)	0.50 (0.38)
Sleep duration	0.08 (0.14)	0.03 (0.17)
Sleep duration × Nonwork caregiving role occupancy	---	0.17 (0.30)
Cross-level interaction		
Prior-night sleep duration × Nonwork caregiving role occupancy	---	0.06 (0.15)
Random Effects		
Level 1 Residual	1.61 (0.36)***	1.63 (0.36)***
Level 2 Intercept	2.15 (0.19)***	2.16 (0.19)***
Fit Statistics		
−2LL	1,309.5	1,311.6
AIC	1,313.5	1,315.6
BIC	1,318.3	1,320.4

Note: N = 83, N_{days} = 330. −2LL = log likelihood; AIC = Akaike information criterion; BIC = Bayesian information criterion. Missing data for same-day positive affect (N_{days} = 1). Type of day – *workday* (1) versus *nonwork day* (0); race -*White* (1) versus *non-White* (0); chronic health condition – *has a chronic health condition* (1) versus *no chronic health condition* (0); nonwork caregiving role occupancy – *triple-duty caregiver* (1) versus *double-duty-child caregiver* (0). Simple slopes from moderated analyses are not tabled.
*p < .05, **p < .01, ***p < .001.

variability in double-duty and triple-duty caregiving research, which has been slow to adopt such methodological approaches. Descriptive analyses revealed that more than 50% of the total variation in each sleep and fatigue measure was attributable to within-person-level daily fluctuations, or day-to-day differences in employees' own usual sleep characteristics and fatigue experiences. These findings suggest that sleep characteristics and fatigue constructs should be used to characterize how days differ from one another as well as how long-term care employees differ from each other. Moreover, these findings are consistent with prior research that depicts sleep as a significant source of variance in everyday life, and fatigue as having state-like properties (Crain et al., 2018).

Descriptive analyses also provided insight regarding the extent to which long-term care employees experience fatigue and pointed to workday-related differences in sleep and fatigue patterns. The assumption that fatigue is a common experience among those who work in nursing homes is widely held but rarely tested. Our findings support this assumption, with 67% of employees reporting that they experienced fatigue during an 8-day period. As for workday-related differences in sleep patterns, sleep duration was 1 hr shorter and sleep quality was poorer on nights before workdays compared with nights before nonwork days. This 1-hr difference in sleep duration is consistent with sleep time deficits documented in previous studies of other types of health care employees (Dorrian et al., 2008; Scott et al., 2006). Similar to conclusions drawn in past studies, we suspect that long-term care employees accrue sleep debt from sleeping significantly less on nights before workdays and sleep longer on nights preceding nonwork days to repay this debt. With respect to poorer sleep quality, more work-related sleep disturbances may occur on nights before workdays (e.g., rumination, Dorrian et al., 2008). Further, the likelihood of experiencing fatigue increased more than twofold on workdays relative to nonwork days. Workday-related changes in fatigue occurrence align with claims that fatigue can be circumstance-based (Ricci, Chee, Lorandeau, & Berger, 2007). They also imply that long-term care

Table 5. Within-Person and Between-Person Effects of Sleep Quality on Fatigue Severity in a Subgroup Analysis

	Fatigue severity	
	Coefficient (SE)	
	Model 1	Model 2
Fixed Effects		
Level 1 (Within-person effects)		
Mean (Intercept)	5.82 (0.38)***	5.83 (0.39)***
Same-day positive affect	−0.38 (0.19)†	−0.38 (0.20)†
Same-day negative affect	0.89 (0.27)**	0.89 (0.27)**
Prior-night sleep quality	−0.36 (0.13)**	−0.35 (0.17)*
Level 2 (Between-person effects)		
Age	−0.01 (0.03)	−0.02 (0.03)
Race	−0.53 (0.39)†	−0.55 (0.40)
Total hours worked per week	0.004 (0.02)	0.004 (0.02)
Chronic health condition	−0.29 (0.35)	−0.29 (0.25)
Positive affect	−0.56 (0.25)*	−0.57 (0.25)*
Negative affect	0.87 (0.50)†	0.87 (0.50)†
Nonwork caregiving role occupancy	0.48 (0.38)	0.48 (0.38)
Sleep quality	−0.39 (0.31)	−0.33 (0.39)
Sleep quality × Nonwork caregiving role occupancy	---	−0.14 (0.62)
Cross-level interaction		
Prior-night sleep quality × Nonwork caregiving role occupancy	---	−.02 (.27)
Random Effects		
Level 1 Residual	1.59 (0.35)***	1.61 (0.36)***
Level 2 Intercept	2.13 (0.19)***	2.14 (0.19)***
Fit Statistics		
−2LL	1,299.8	1,299.7
AIC	1,303.8	1,303.7
BIC	1,308.7	1,308.5

Note: N = 83, N_{days} = 329. −2LL = log likelihood; AIC = Akaike information criterion; BIC = Bayesian information criterion. Missing data for same-day positive affect (N_{days}=1) and prior-night sleep quality (N_{days} = 1). Type of day – *workday* (1) versus *nonwork day* (0); race -*White* (1) versus *non-White* (0); chronic health condition – *has a chronic health condition* (1) versus *no chronic health condition* (0); nonwork caregiving role occupancy – *triple-duty caregiver* (1) versus *double-duty-child caregiver* (0). Simple slopes from moderated analyses are not tabled.
†$p < .10$, *$p < .05$, **$p < .01$, ***$p < .001$.

employees expend a significant amount of physical energy at work, leaving little physical energy resources to fulfill nonwork demands.

Results from predictive analyses aligned with the WNS framework's proposition that longer sleep duration and better sleep quality affect fatigue intraindividually but only provided partial support for its proposition that longer sleep duration and better sleep quality affect fatigue interindividually. Overall, the findings documented here suggest that night-to-night changes in usual sleep characteristics may be a better predictor of fatigue than person-to-person differences in sleep tendencies. Such findings imply that between-person investigations may be inadequate for fully understanding relationships between sleep and fatigue. Additionally, differential findings for sleep duration and quality signify the need to examine these sleep constructs separately; each sleep characteristic was relevant for within-person relationships but only sleep quality was relevant for between-person relationships. These results also corroborate recent findings from the few studies that examine daily associations between sleep and fatigue among healthy adults, and previous between-person studies identifying sleep quality as a consistent predictor of fatigue in samples of healthy and/or employed adults (Akerstedt et al., 2004, 2014; Aritake et al., 2015; Lavidor, Weller, & Babkoff, 2003; Powell, et al., 2017).

Findings provided no support, however, for our hypothesis that relationships between sleep and fatigue would be stronger for triple-duty caregivers than their double-duty-child caregiving counterparts. Contrary to our expectation and arguments from the role scarcity and competing-demands hypotheses (Goode, 1960; Stephens & Franks, 1999), double-duty-child caregivers, but not triple-duty caregivers, had lower odds of reporting that they experienced fatigue on days after nights of longer-than-usual sleep duration. Given that double-duty-child and triple-duty caregivers both engage in nonwork care for children, one potential explanation for this unexpected finding is that the resource of longer-than-usual sleep duration may not suffice in generating next-day physical energy resources when nonwork child care is combined with

nonwork adult care. That is, triple-duty caregivers may require resources beyond longer sleep time to significantly offset physical energy deficits because of the additional demands that likely accompany their extra nonwork caregiving role. Nonetheless, all other associations between sleep and fatigue did not differ on the basis of nonwork caregiving role occupancy. Therefore, longer sleep duration and better sleep quality may similarly contribute to physical energy resources among double-duty-child and triple-duty caregivers.

Limitations and Future Directions

This study has several potential limitations. First, the sample was purposively selected from nursing homes and limited to mothers of children aged 9–17 years, some of whom also informally cared for adults, which may minimize the generalizability of study findings. Future research should replicate this study with other types of health care employees, men, parents of younger children, and health care employees who informally care for adults only. Second, the WFHS was not intended to understand long-term care employees' nonwork care and therefore lacked detailed information about this contextual factor. Other studies should obtain more information about the nonwork caregiving context to clarify whether certain characteristics of these roles are more important than occupancy in relation to fatigue.

Third, each sleep and fatigue construct was measured with a single self-reported item. Although single-item measures have frequently been used to examine these constructs in previous studies (e.g., Aritake et al., 2015; DePasquale et al., 2018; Sin et al., 2017), multiple-item measures may be more reliable, valid, and informative. Moreover, the simultaneous use of self-reported and objective measures (e.g., actigraphy) may provide more accurate or comprehensive evaluations of relationships between sleep and fatigue. Finally, prior-night sleep and same-day fatigue were assessed simultaneously in the evening. The gap in time between waking and evening sleep assessments raises the concern that other daily factors confound perceptions of prior-night sleep. We mitigated this concern by including same-day positive and negative affect in models to account for the potential influence of transient mood effects on relationships between sleep and fatigue (Podsakoff et al., 2003). Nonetheless, future research would be strengthened by incorporating sleep assessments in the morning or collecting ecological momentary assessment data.

Practical Implications

This study has practical implications for long-term care employees, care recipients, and organizations. For employees, our findings indicate that change initiatives targeting "bad sleep days" (i.e., occasions) may be more effective in managing fatigue than helping "bad sleepers" (i.e., individuals). Relatedly, the finding that tonight's sleep characteristics contribute to tomorrow's physical energy resources is important to convey to long-term care employees. Prior research, as well as the descriptive results here, suggests that they may be especially tempted to borrow time from sleep and spend it fulfilling work and nonwork demands. Encouraging double-duty and triple-duty caregivers to identify and capitalize on the conditions or circumstances that help them achieve better-than-usual sleep tendencies could facilitate their fulfillment of next-day role demands via more energy for waking activities, benefit their health, and improve their overall work performance.

Given that a fatigued workforce can adversely affect safe, productive working conditions and jeopardze quality of care, it makes business sense for long-term care organizations to invest in efforts that better position employees to conserve or increase their physical energy resources. One such effort involves creating tailored work schedules. Tailored work schedules would minimize the mismatch between employee chronotypes and working times so that, for example, employees who are early risers are not assigned night shifts. Prior research has shown that this scheduling practice is associated with better sleep characteristics (Vetter, Fischer, Matera, & Roenneberg, 2015). Likewise, energy-conscious work schedules may be helpful. Although some employees may prefer to work consecutive days to have consecutive days off, they may need or benefit from gaps in between workdays and nonwork days to deter workday-related accumulation of sleep debt and reductions in physical energy resources. At the very least, managers should convey support for nonwork demands, a low-cost option that can improve employees' sleep habits (Olson et al., 2015), and monitor employees' fatigue.

These smaller scale efforts should be complemented by larger organizational efforts to establish a workplace culture that values sleep health. To build such a culture, long-term care organizations could organize health communication campaigns that target day-to-day sleep hygiene, incorporate sleep health into extant wellness initiatives, develop policies or practices that ensure employees take allotted breaks to capitalize on opportunities to conserve energy, and provide mindfulness-based training workshops that equip employees with the skills to effectively manage and detach from stress, demands, and other daily hassles capable of disrupting sleep.

Conclusion

The wide-ranging, negative effects of fatigue for long-term care employees, the care recipients they serve in the work and nonwork domains, and the organizations in which they work necessitate a better understanding of modifiable factors contributing to their experiences of fatigue. This diary study demonstrated that longer sleep duration and better sleep quality predict lower odds of fatigue and less severe fatigue among double-duty-child and triple-duty caregiving long-term care employees, with these relationships largely being found at the day level. Additional research

is needed to identify contextual barriers to and facilitators of a fatigue-mitigating lifestyle for this essential workforce.

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Conflict of Interest

None reported.

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