SLEEP DURATION/SLEEP QUALITY

Work-Family Conflict and Employee Sleep: Evidence from IT Workers in the Work, Family and Health Study

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Study Objectives: Work-family conflict is a threat to healthy sleep behaviors among employees. This study aimed to examine how Work-to-Family Conflict (demands from work that interfere with one's family/personal life; WTFC) and Family-to-Work Conflict (demands from family/personal life that interfere with work; FTWC) are associated with several dimensions of sleep among information technology workers.

Methods: Employees at a U.S. IT firm (n = 799) provided self-reports of sleep sufficiency (feeling rested upon waking), sleep quality, and sleep maintenance insomnia symptoms (waking up in the middle of the night or early morning) in the last month. They also provided a week of actigraphy for nighttime sleep duration, napping, sleep timing, and a novel sleep inconsistency measure. Analyses adjusted for work conditions (job demands, decision authority, schedule control, and family-supportive supervisor behavior), and household and sociodemographic characteristics.

Results: Employees who experienced higher WTFC reported less sleep sufficiency, poorer sleep quality, and more insomnia symptoms. Higher WTFC also predicted shorter nighttime sleep duration, greater likelihood of napping, and longer nap duration. Furthermore, higher WTFC was linked to greater inconsistency of nighttime sleep duration and sleep clock times, whereas higher FTWC was associated with more rigidity of sleep timing mostly driven by wake time.

Conclusions: Results highlight the unique associations of WTFC/FTWC with employee sleep independent of other work conditions and household and sociodemographic characteristics. Our novel methodological approach demonstrates differential associations of WTFC and FTWC with inconsistency of sleep timing. Given the strong associations between WTFC and poor sleep, future research should focus on reducing WTFC.

Keywords: work-to-family conflict, family-to-work conflict, sleep duration, nap, inconsistency of sleep clock time

Citation: Buxton OM, Lee S, Beverly C, Berkman LF, Moen P, Kelly EL, Hammer LB, Almeida DM. Work-family conflict and employee sleep: evidence from IT workers in the Work, Family and Health Study. *SLEEP* 2016;39(10):1871–1882.

Significance

This paper shows that experiencing interference from work domain to family/personal domain (i.e., work-to-family conflict) is detrimental to employee sleep. Information technology workers' reports of higher work-to-family conflict were linked to shorter nighttime sleep and more and longer napping measured by objective assessment (via actigraphy), as well as to their reports of less sufficient and lower quality sleep and more insomnia symptoms. Higher work-to-family conflict was also linked to greater day-to-day variability of bed- and wake-times that relate to inconsistent amount of nighttime sleep. These associations were not found with the conflict in the other direction (i.e., family-to-work conflict). The results highlight the importance of decreasing work-to-family conflict to improve employees' sleep, which may in turn increase workplace productivity.

INTRODUCTION

Employees in professional occupations experience the shortest sleep duration.[1] Employees in information technology (IT) industry have particularly demanding jobs that may inhibit their ability to maintain healthy sleep habits.[2,3] Stress embedded in the interconnection between work and family life, called work-family conflict, may impact employee sleep as a result.[4] Because one's time, energy and other resources may be limited, participation in the two incompatible roles creates unavoidable conflict and stress.[5,6] Work-Family Conflict (WFC) is bidirectional; Work-to-Family Conflict (WTFC) occurs when demands from work interfere with one's family and personal life, whereas Family-to-Work Conflict (FTWC) arises when demands experienced in the family and personal domain leads to interference with work.[6–8]

The goal of this study is to investigate the associations of WTFC and FTWC with employee sleep in a sample of IT industry workers. In accomplishing this, this study makes a contribution in three distinct ways. First, this study examines the *unique* associations of WTFC and FTWC with employee sleep above and beyond work conditions. Previous studies have examined WTFC and/or FTWC as predictors of employee sleep[2]; however, the independent effects of these predictors are not well understood (but see[9,10]). For example, it is not clear whether WTFC explains additional variance in employees' sleep deficiency that is not explained by working in poorer conditions (e.g., having greater job demands and less resources). Understanding the unique effects of WTFC and FTWC is increasingly important, given that there is a growing trend of conflict between work and non-work domains with increased competition and 24/7 operations in a range of occupations.[11] Scholars have called for research to investigate how work-family conflict influences employee sleep.[12] To respond to this call, this study focuses on examining the unique and additive associations of WTFC and FTWC with employee sleep, above and beyond typical occupational characteristics (i.e., work hours, job tasks). We also control for the psychosocial effects of job demands, decision authority, schedule control, and family-supportive supervisor behavior, which have been found to be important for employee sleep in prior research.[2,9,10]

Second, this study incorporates a variety of sleep indicators, including self-reported sleep and actigraphically assessed sleep, in order to fully understand how WTFC and FTWC are associated with multiple dimensions of employee sleep. Numerous studies have documented the associations between work-family conflict—primarily WTFC—and self-reported sleep deficiency[10,13] and sleep quality.[2,14] Relatively few studies have examined the links between work-family conflict and insomnia symptoms, although it is plausible that inter-role strain can increase insomnia symptoms.[15] This study includes sleep sufficiency, sleep quality, and sleep maintenance insomnia symptoms for self-reported sleep indicators. Exploring the relationship of WFC to napping behavior is also unique. In addition, actigraphic sleep has not been as widely used as self-reports, but has started to receive much attention from researchers due to its potential to reduce common-method bias between WTFC/FTWC and self-reported sleep.[16] Taking advantage of our actigraphy data that include detailed information on activity intensity and the beginning and end time of each sleep episode, this study examines nighttime sleep duration, the likelihood of napping, and nap duration.

Third, in addition to incorporating these several dimensions of sleep, this study makes a methodological innovation to examine the associations of WTFC and FTWC with *inconsistency* of sleep. The American Academy of Sleep Medicine and the Sleep Research Society recommend including variations of sleep circadian rhythms and timing to understand the phenomenon of sleep deficiency.[17] Inconsistency of sleep refers to irregular circadian rhythm of sleep and can be measured by day-to-day variability in nighttime sleep duration and sleep clock times (i.e., bed time, midpoint, and wake time). Given that the primary source of WTFC and FTWC is *time-based* conflict,[5,18] employees who frequently experience WTFC and/or FTWC may borrow time from sleep to handle the conflict,[12] and thus may exhibit greater inconsistency in their sleep duration and sleep clock times. Previous research using daily sleep data often operationalized inconsistency of sleep by individual standard deviation (iSD),[19–21] but this study adapts multilevel modeling with heterogeneous variance[23–25] that provides a more parsimonious and powerful within-person approach to modeling daily sleep fluctuation, while simultaneously accounting for individuals' mean level of sleep across days. This approach allows us to examine how WTFC and FTWC are simultaneously and independently linked to both mean levels and day-to-day inconsistency in nighttime sleep duration and sleep timing.

In sum, using a sample of IT workers, the present study sought to examine the associations of WTFC and FTWC with a variety of sleep behaviors, independent of work conditions (i.e., job demands, decision authority, schedule control, and family-supportive supervisor behavior), individual and family characteristics (i.e., age, gender, marital status, providing care for children, and/or for adult relatives) and sociodemographic factors (i.e., race, household income). Our first aim was to examine the unique associations of WTFC and FTWC with self-reported sleep measures. We hypothesized that higher WTFC and FTWC would be negatively associated with sleep sufficiency and sleep quality, and positively associated with insomnia symptoms. The second aim was to examine the unique associations of WTFC and FTWC with actigraphically assessed sleep phenotypes. We expected that higher WTFC and FTWC would be negatively associated with nighttime sleep duration, and positively associated with the likelihood of napping and nap duration per day on average. Lastly, adapting a new approach of assessing inconsistency of sleep, we hypothesized that higher WTFC and FTWC would be positively associated with day-to-day inconsistency of nighttime sleep duration and sleep clock times (bedtime, midpoint, and wake time).

METHODS

Participants and Procedure

Data came from the Work, Family, and Health Study (WFHS).[25,26] The current study used baseline data from a sample of employees located in teams within the IT division of a large Fortune 500 firm. IT employees working in the metropolitan areas with the two largest worksites were invited to participate in the study. The worksites were selected in collaboration with corporate leadership's endorsement to facilitate the study, as previously described.[25] We then identified a total of 56 study groups (operational clusters of workgroups within the organization) and randomly assigned these to either the intervention or the control condition. Trained field interviewers administered face-to-face Computer-Assisted Personal Interviews (CAPI) to employees beginning in September 2009 and ending in September 2010. Employees completed a 60-min interview at the worksite and received a $20 incentive. All procedures were conducted in accordance with the principles in the Declaration of Helsinki, and approved by appropriate institutional review boards.

Considering that statistical power in group randomized trials depends on the relative magnitude of the variance across levels,[27] we invited total 1,171 employees from 56 study groups (approximately 20 employees per group). Of those, 823 employees completed the CAPI interview at baseline (70% response rate). The employees were nested within 123 workgroups who reported to the same senior leadership or worked closely together on the same application. To have a consistent sample with other studies that examined this IT employee cohort,[3] we excluded 24 employees across 5 workgroups who had different experiences from other employees during the study period, such as changing their manager-employee reporting structures or not following the WFHS protocol due to research staff error. Therefore, 799 employees from 118 workgroups who completed the CAPI were the baseline cohort of IT employees. Because the larger study from which this study was based was powered to detect longitudinal effects of a workplace intervention, our study that examined cross-sectional associations between WTFC and FTWC on employee sleep should have sufficient power to detect the associations.[28]

Immediately following the CAPI, interviewers introduced the actigraphy data collection process and requested participation for an additional $20 incentive. If the participant agreed, the interviewer instructed them to wear the sleep monitor actigraph (Spectrum, Respironics/Philips, Murrysville, PA) on

their non-dominant wrist at all times for the next week except in situations in which the watch could be damaged (e.g., excessive impact, extreme temperatures). Out of 799 employees, 635 employees completed the actigraphy data collection, and a total of 618 employees had valid actigraphy data for 3 or more days, the minimum criterion deemed reliable and valid for participant data.[29] On average, participants had 6.85 days of valid actigraphy.

Measures

Work-Family Conflict

Work-to-family conflict: Employee WTFC was measured using the 5-item subscale developed by Netemeyer and colleagues.[6] A sample item from the WTFC scale reads, "The demands of your work interfere with your family or personal time." Items were rated on a scale ranging from 1 (strongly disagree) to 5 (strongly agree). We used the mean of the 5 items such that higher scores indicated greater WTFC. The reliability estimate for the WTFC subscale was $\alpha = 0.91$.

Family-to-work conflict: The extent of FTWC was measured by the 5-item subscale developed by Netemeyer and colleagues validated on a diverse (regional) US employee population including elementary and high-school teachers, administrators, small business owners, and real estate salespeople.[6] Items address perceived time-based and strain-based conflict from family/personal life to work. A sample item from the FTWC scale reads, "The demands of your family or personal relationships interfere with work-related activities." Items were rated on a scale ranging from 1 (strongly disagree) to 5 (strongly agree). We used the mean of the 5 items, and higher scores indicated greater FTWC. The reliability estimate for the FTWC subscale was $\alpha = 0.84$.

Actigraphic Sleep

Actigraphy data came from each participant's actiwatch using the Actiware Sleep Scoring Program (v5.71, Philips-Respironics). We used a standard algorithm recently validated,[29] and at least two members of the scoring team determined the validity of each recording based on study-specific standard sleep criteria applied similarly to all recordings.[30] In short, a recording was determined to be invalid if there was a device malfunction indicated by constant false activity on the recording or if the data were unable to be retrieved. Certain days within the recording were determined to be invalid if a watch error occurred, such as false activity patterns characteristic of a failing battery, or if the participant did not comply with the study's actigraphic procedures (i.e., > 4 h of actiwatch off-wrist time throughout the day, or an off-wrist period > 60 min within 10 min of the determined beginning or end of the main time in bed period for that day). The scoring team members visually scored naps by determining points of decreased activity levels. Rapidly decreased light levels (lux) were considered confirmatory but not necessary. Scorers took into consideration the decrease in activity intensity within the context of the entire subject profile. Sleep episodes were defined as beginning at the last epoch of high activity (> 10 activity counts) preceding at least five 30-s epochs of < 10 activity counts, indicating little to no movement. Any intervals identified that exceeded a 15 min difference in duration or timing between the scorers were reviewed by the senior author and scorers until agreement.

Nighttime sleep duration, nap episodes, and nap duration: Among sleep periods each day, the longest sleep period of the day was defined as the main, nighttime sleep. All other sleep periods of the day were defined as nap episodes. Accordingly, each sleep period was coded as 0 (main nighttime sleep episode, no nap) or 1 (nap episode), with mean nighttime sleep duration expressed in per day in minutes/day for valid actigraphy recording days only. The average nap duration (where nap episode = 0) for those who had any naps during the study period was expressed in minutes/day.

Wake after sleep onset (WASO): WASO was computed as the average amount of time spent "waking" after sleep onset and before sleep offset during nighttime sleep, in minutes, as previously validated versus polysomnography (PSG).[29]

Sleep clock times: Bedtimes were determined by points of decreased activity levels and sudden, decreased light levels (lux). Wake times were determined the same way by finding the first epoch of sustained high activity (> 10 activity counts) after ≥ 5 30-second epochs of < 10 activity counts. Midpoint times were calculated based on the bed time and wake time variables of each nighttime sleep. Midpoint times were centered at midnight (00:00 = 0), such that midpoint time of 2 indicated that a person's midpoint of sleep is 02:00.

Self-Reported Sleep

Sleep sufficiency was measured by one item asking, "How often during the past four weeks did you get enough sleep to feel rested upon waking up?" This item, used in prior research,[2,13,30,31] is similar to current Centers for Disease Control and Prevention (CDC) surveillance for state-level sleep sufficiency.[32] Responses were rated on a scale ranging from 1 (never) to 5 (very often), such that higher scores indicated greater sleep sufficiency.

Sleep quality was measured by one item derived from the Pittsburgh Sleep Quality Index (PSQI),[33] asking, "Over the past four weeks, how would you rate your sleep quality overall?" Responses were rated on a scale ranging from 1 (very bad) to 4 (very good), such that higher scores indicated better sleep quality.

Sleep maintenance insomnia symptoms were measured by one item derived from the PSQI.[33] Participants were asked, "During the past four weeks, how often did you wake up in the middle of the night or early morning?" Items were rated on a scale ranging from 1 (never) to 4 (three or more times a week), with higher scores indicating more frequent insomnia symptoms.

Other Work Conditions

Job demands and decision authority were based on the work of Karasek and colleagues.[34,35] The extent of psychological job

demands was assessed by 3 items, asking about having enough time to get work done and working very fast and hard. Decision authority was measured by 3 items, whether employees are allowed to make a lot of decisions on their own, have freedom to decide how to do work, and have a say about what happens on the job. Responses ranged from 1 (strongly disagree) to 5 (strongly agree). We used the mean of the items for each scale such that higher scores reflected higher job demands or higher decision authority. The reliability estimates were $\alpha = 0.59$ and 0.71 for the job demands and decision authority, respectively.

Schedule control was used to measure employees' control over the hours that they work. We utilized a shortened, 8-item version of Thomas & Ganster's scale.[36] Items included how much choice employees have over: when they take vacation or days off, when they take off a few hours, when they begin and end work days, total number of hours worked/week. Responses were coded 1–5 (very little to very much) and averaged with higher scores reflecting greater schedule control ($\alpha = 0.79$).

Family-supportive supervisor behaviors (FSSB) assessed employee appraisals of supervisor's supportive behavior related to integrating work and family.[37,38] Employees were asked about family-related supervisory support in 4 domains: emotional support, instrumental support, role modeling, and creative management. We used a short form of FSSB derived from 4 items,[39] categorized 1–5 (strongly disagree to strongly agree) and averaged to generate an overall score, with higher scores reflecting greater FSSB ($\alpha = 0.88$).

Covariates

Individual and Family Characteristics

Given that employees' personal and family characteristics may denote family demands and responsibilities as well as their sleep behavior,[40,41] we controlled for employee age (in one-year intervals, centered at the sample mean), gender (0 = female, 1 = male), marital/partner status (0 = unmarried, 1 = married or living with a partner), living with children under the age of 18 in household (0 = no, 1 = yes), and providing care to adult relatives (0 = no, 1 = yes) in all models.

Sociodemographic and Background Characteristics

Employee race (0 = White, 1 = Asian or Pacific Islander or other; two dummy variables were created) and range of current annual household income (1 = less than 49,999 to 12 = more than 150,000) were included in all models. Moreover, to consider possible differences from background work characteristics, total work hours were assessed from items asking "About how many hours do you work in a typical week in this job?" and "On average, how many hours per week do you work at this other job(s)?" and summed if the respondent indicated he/she has an additional job to obtain total hours worked/week across all jobs. Additionally, occupation was assessed by asking official job titles, and coded as core software developer (1) versus other support (0). Furthermore, in the IT firm, there was an organizational level merger and about half of employees (54%) were pre-informed about it while others were not. To take into account potential differences from this, we included the merger announcement indicator (0 = NOT pre-informed, 1 = pre-informed) in our analysis. All continuous variables were centered at the sample mean.

Analytic Strategy

First, to examine whether WTFC and FTWC predict self-reported sleep and actigraphic sleep, we conducted multilevel modeling using Proc Mixed in SAS 9.4. This technique allowed us to account for the hierarchical structure of the data with Level 1 as individuals (denoted by $_i$) nested within Level 2 units (i.e. workgroups, denoted by $_w$).[24] Note that our data were screened for potential violations of the distributional assumptions of two-level multilevel modeling, including (1) residual normality, (2) linearity, (3) homogeneity of variance, and (4) influential outliers (detailed results available upon request), following the criteria suggested by Raudenbush and Bryk.[24] The abbreviated version (only includes WTFC and FTWC as predictors) of the Level 1 equation for nighttime sleep duration is:

$$Y_{iw} = \beta_{0w} + \beta_{1w} (WTFC_{iw}) + \beta_{2w} (FTWC_{iw}) + e_{iw}$$

where Y_{iw} denotes nighttime sleep duration of the i^{th} employee in the w^{th} workgroup, β_{0w} denotes the workgroup mean of nighttime sleep duration, β_{1w} denotes changes in nighttime sleep duration with one-unit increase in WTFC, β_{2w} denotes changes in nighttime sleep duration with one-unit increase in FTWC, and e_{iw} denotes the random variation of the employee from the workgroup mean. The Level 2 equation with workgroup-level measures that were created by aggregating individual-level responses includes:

$$\beta_{0w} = \gamma_{00} + \gamma_{01} (WTFC_w) + \gamma_{02} (FTWC_w) + u_{0w}$$

$$\beta_{1w} = \gamma_{10} + u_{1w}$$

$$\beta_{2w} = \gamma_{20} + u_{2w}$$

with γ_{00} being the grand mean, γ_{01}, γ_{02} means the workgroup-level effects of WTFC and FTWC, and u_{0w}, u_{1w} and u_{2w} denote random deviations of the w^{th} workgroup from those grand means. Our primary interests were γ_{10} and γ_{20}, which indicate individual-level effects of WTFC and FTWC, respectively, after adjusting for possible workgroup-level differences. We estimated the fixed effects of the parameters, because we did not assume that each employee had their own random slope. Individual-level predictors were centered at the workgroup mean, such that higher scores of WTFC/FTWC indicated higher conflict than the other employees in the workgroup.

Second, to examine whether WTFC and FTWC predict employee naps, we used multilevel Zero-Inflated Poisson model. Given that there were excessive zeros in nap episodes (38%), the use of the multilevel Zero-Inflated Poisson model that can simultaneously predict (1) the likelihood of no napping and (2) nap duration for those who had any naps was appropriate. We estimated the parameters with two-step approaches suggested by Lee and colleagues.[42] In step 1, we obtained start values for the two types of outcomes using Proc Glimmix. Start values for the likelihood of no napping were from binary logit function and those for nap duration were from Poisson function. In

step 2, we simultaneously predicted the two outcomes using Proc Nlmixed.

Third, to examine whether WTFC and FTWC are linked to day-to-day inconsistency in actigraphic nighttime sleep duration and sleep clock times, we used multilevel models with heterogeneous within-person variance. For example, day-to-day inconsistency in nighttime sleep duration was modeled in random effects as:

$$\sigma^2_{ei} = \alpha_0 \, Exp \, (\alpha_1(WTFC_i) + \alpha_2(FTWC_i))$$

The exponential function (*Exp*) was used to normalize the variance, such that a linear prediction model could be used, as well as to eliminate the dependence of the variance on the mean level of nighttime sleep duration.[23] This approach can estimate more robust variability than the iSD approach because it is model-based and takes into account temporal dependence of data (day effect) as well as the effects of covariates on the mean level.[43] Positive coefficients of α_1 and α_2 indicate greater inconsistency in nighttime sleep duration.

To examine the unique associations of WTFC and FTWC with employee sleep above and beyond covariates (i.e., individual, family, sociodemographic, and background characteristics) and work conditions, we first entered covariates in Model 0. In Model 1, we added both WTFC and FTWC along with work condition variables (i.e., job demands, decision authority, schedule control, and FSSB) in addition to all covariates in the prior model. In examining inconsistency of sleep, we also controlled for covariates, work conditions, and WTFC and FTWC in the fixed effects of the multilevel models.

RESULTS

Descriptive Results

Table 1 presents gender-stratified, unadjusted means, standard deviations, and frequencies (%) for sociodemographic and background characteristics, work conditions, and sleep indicators. Participants had a mean age of 46 ± 9.1 (standard deviation [SD]) years. Slightly more than half (61%) of the employees were men. The majority (80%) was married or living with permanent romantic partner; 67% were white and 23% were Asian or Pacific Islander; 24% were providing care to their adult parents or relatives; 78% were college graduates. The mean annual household income was in the range of $110,000 to $119,999. About half (48%) had children under the age of 18 living in the home. Mean work hours per week was 46 h (SD = 7.2). Forty-three percent were software developers. In terms of work conditions, employees reported relatively high levels of job demands, decision authority, schedule control, and supervisor support (mean ≥ 3.6, on a 5-point scale). They reported a moderate level of WTFC and a low level of FTWC. With regards to self-reported sleep indicators, employees perceived moderately sufficient amount of sleep, high sleep quality, and frequent insomnia symptoms. With respect to actigraphic sleep, the average nighttime sleep duration was 7 h/day. Seventy percent of employees had naps for 24 min per episode on average. The means of nocturnal bed time, sleep midpoint, and wake time were 23:00, 02:30, and 06:36, respectively.

Links between Work-Family Conflict and Self-Reported Sleep

Table 2 shows results from multilevel models separately predicting self-reported sleep sufficiency, sleep quality, and insomnia symptoms. Beginning with sleep sufficiency, having children under the age of 18 and greater job demands were negatively associated with sleep sufficiency. After adjusting for these effects, higher WTFC significantly predicted less perceived sleep sufficiency, and higher FTWC marginally predicted less perceived sleep sufficiency. The practical significance of the effect of WTFC can be compared to the effect of age, known to be an important factor for sleep. A one-unit increase in WTFC was associated with 0.17-unit decrease in sleep sufficiency, which corresponds to 17 years of difference in age due to the independent contribution of increasing age on sleep. The combined set of predictors explained 13% of variance in sleep sufficiency. Turning to sleep quality, greater job demands were significantly linked to poorer sleep quality. On top of this, higher WTFC predicted poorer sleep quality. The model explained 7% of variance in sleep quality. For insomnia symptoms, older and White employees tended to have more frequent insomnia symptoms than younger non-whites. Moreover, higher WTFC predicted more frequent insomnia symptoms after controlling for possible differences in work conditions and family factors as well as other covariates. All the variables accounted for 16% of the variance in insomnia symptoms.

Links between Work-Family Conflict and Actigraphic Sleep

Table 3 presents results from multilevel models predicting actigraphic nighttime sleep and WASO assessed in minutes on average per day. The first column shows results for nighttime sleep duration. Women/white employees slept longer than males/non-whites during nighttime. After taking into account the effects of covariates, there was a significant association of WTFC with nighttime sleep duration, beyond the associations with work conditions (none of them were significant). Employees who had higher WTFC had shorter nighttime sleep per day, on average. With a one-unit increase in WTFC, nighttime sleep duration was shorter by 8 min, resulting in a total of 32 min difference between the lowest and highest levels of WTFC. The effect of a one-unit change in WTFC was 1.6 times larger than the effect of 10 years of aging. FTWC was not significantly linked to nighttime sleep duration. The combined set of variables explained 14% of variance in nighttime sleep duration. The second column shows results for WASO. White employees had shorter WASO than non-whites, and employees who had children under the age 18 in their household had shorter WASO than those who did not. However, none of the work condition variables and WTFC and FTWC significantly predicted WASO.

Table 4 shows results of the multilevel Zero-Inflated Poisson model simultaneously predicting the two nap-related outcomes. The first column shows results for the likelihood of no napping versus any napping, and thus the reversed sign of the estimates indicates the likelihood of napping. The second column presents results for nap duration for those who had any naps. The estimates indicate % change in nap duration with one-unit increase in each predictor. For the likelihood of napping, there was a significant effect of marital status, such that being single

Table 1—Family, sociodemographic, work, and health characteristics by gender, IT employees baseline cohort.

	Total (n = 799)	Men (n = 486)	Women (n = 313)	Diff Tests
Individual, family, sociodemographic, and background factors				
Age	45.7 (9.1)	44.9 (9.4)	46.9 (8.4)	3.2**
Married/Partnered (%)	79.5	85.2	70.6	24.8***
Race, White (%)	66.7	66.4	67.1	35.2***
Race, Asian or Pacific Islander (%)	22.9	27.6	15.7	
Race, Others (%)	10.4	6.0	17.2	
Adult caregiver (%)	23.7	20.4	28.8	7.4**
Education, College graduates (%)	77.6	84.2	67.4	39.5***
Household income range [a]	8.3 (3.1)	8.1 (3.0)	8.5 (3.1)	1.4
Living with children age ≤ 18 in household (%)	47.6	49.4	44.7	1.7
Total work hours (per week)	46.3 (7.2)	46.5 (7.1)	46.0 (7.3)	−0.9
Job task, Software developer (%)	43.2	48.2	35.5	12.5***
Merger, Pre-informed (%)	53.7	54.3	52.7	0.2
Work conditions				
Job demands (1–5 scale)	3.6 (0.7)	3.5 (0.7)	3.7 (0.7)	4.2***
Decision authority (1–5 scale)	3.8 (0.7)	3.9 (0.6)	3.8 (0.8)	−1.1
Schedule control (1–5 scale)	3.6 (0.7)	3.6 (0.7)	3.6 (0.7)	1.6
Family supportive supervisor behavior (1–5 scale)	3.8 (0.8)	3.9 (0.8)	3.8 (0.9)	−1.3
Work-to-family-conflict (1–5 scale)	3.1 (0.9)	3.0 (0.9)	3.2 (1.0)	2.3*
Family-to-work conflict (1–5 scale)	2.1 (0.6)	2.1 (0.6)	2.1 (0.7)	−1.0
Self-reported Sleep indicators				
Sleep sufficiency (1–5 scale)	3.2 (0.9)	3.2 (0.9)	3.1 (0.9)	−1.6
Sleep quality (1–4 scale)	2.9 (0.7)	2.9 (0.7)	2.8 (0.7)	−1.1
Sleep maintenance insomnia symptoms (1–4 scale)	3.1 (1.0)	3.1 (1.0)	3.3 (1.0)	2.7**
Actigraphic Sleep indicators				
Nighttime sleep duration (h/day)	7.0 (0.9)	6.8 (0.9)	7.3 (0.9)	6.1***
% of having naps	61.9	62.2	61.4	0.1
Nap duration for people who had naps (min/day)	69.9 (38.8)	68.5 (38.1)	72.1 (39.9)	0.9
Sleep bed time (decimal h/day)	−1.0 (1.3)	−0.8 (1.3)	−1.3 (1.2)	−4.1***
Sleep midpoint clock time (decimal h/day)	2.5 (1.1)	2.6 (1.2)	2.4 (1.1)	−2.2*
Sleep wake time (decimal h/day)	6.6 (1.2)	6.6 (1.3)	6.6 (1.1)	0.3

Values presented as mean (standard deviation) or percent. Age: n = 312 for women; Race: n = 485 for men; Household income range: n = 432 for men and 286 for women, [a] Household income range 8 means 110,000–119,999; Job demands: n = 118 for males and 1,405 for women; Decision authority: n = 483 for men and 312 for women; Family Supportive Supervisor Behavior: 482 for men and 312 for women; Actigraphic nighttime sleep, having naps, sleep clock times: n = 384 for men and 251 for women; Nap duration for people who had naps: n = 239 for men and 154 for women. *P < 0.05, **P < 0.01, ***P < 0.001.

predicted greater likelihood of napping than being married/partnered. Moreover, higher WTFC was linked (albeit marginally) to greater likelihood of napping (P = 0.0586). A one unit increase in WTFC predicted 32% greater odds of having a nap (*Exp*(0.28) = 1.32). For those who had naps, being single, Asian or Pacific Islander, and having no adult caregiving responsibilities and higher household income were associated with longer nap duration. Among work condition variables, higher decision authority and lower supervisor support were linked to longer nap duration. Beyond these effects, higher WTFC increased nap duration by 8%. The intercept indicates expected actigraphically measured nap duration, when all other predictors were at the average values, and it is estimated as 25.47 min (*Exp*(3.24) = 25.47). With each one-unit increase in WTFC, the expected mean nap duration increased by 8%, which corresponds to 2.04 min increase. FTWC, however, was only marginally associated with employee naps.

Links between Work-Family Conflict and Day-to-Day Inconsistency of Sleep

We then examined whether WTFC and FTWC are linked to day-to-day inconsistency of nighttime sleep duration and sleep clock times. Table 5 shows results from multilevel models with heterogeneous within-person variance. The first column shows results for inconsistency of nighttime sleep duration. There was a significant effect of WTFC predicting inconsistency of nighttime sleep duration (α_1 = 0.12, P < 0.001). Figure 1 depicts that with increases in WTFC daily variance of nighttime sleep duration increased, such that employees who experienced higher WTFC exhibited greater inconsistency in their

Table 2—Results of multilevel models predicting self-reported sleep sufficiency, sleep quality, and insomnia symptoms.

IT Employees (n = 799)	Sleep Sufficiency (1 = never to 5 = very often feeling rested upon waking up)	Sleep Quality (1 = very bad to 4 = very good)	Insomnia Symptoms 1 = never to 4 = three or more times a week)
Fixed effects			
Intercept, adjusted mean	**3.20 (0.10)*** **	**2.85 (0.08)*** **	**3.23 (0.11)*** **
Age	0.01 (0.00)	0.00 (0.00)	**0.02 (0.00)*** **
Gender, Men (vs. Women)	0.02 (0.07)	0.02 (0.06)	−0.04 (0.08)
Marital status, Married (vs. Unmarried)	0.07 (0.10)	0.01 (0.08)	0.12 (0.10)
Race, Asian/Pacific Islander (vs. White)	0.11 (0.09)	−0.10 (0.07)	**−0.44 (0.10)*** **
Race, Other (vs. White)	−0.13 (0.11)	−0.08 (0.09)	−0.04 (0.12)
Adult caregiving, Caregiver (vs. Not)	−0.05 (0.07)	−0.06 (0.06)	0.06 (0.08)
Household income range	0.01 (0.01)	0.01 (0.01)	−0.01 (0.01)
Living with children age ≤ 18 (vs. Not)	**−0.16 (0.07)***	−0.01 (0.06)	−0.08 (0.08)
Total work hours	−0.01 (0.00)†	−0.01 (0.00)†	−0.00 (0.01)
Job task, Software developer (vs. Support)	−0.01 (0.08)	−0.02 (0.07)	0.02 (0.09)
Merger, Pre-informed (vs. Not)	−0.02 (0.08)	0.04 (0.06)	−0.07 (0.08)
Job demands	**−0.14 (0.06)***	**−0.10 (0.05)***	0.11 (0.06)†
Decision authority	0.07 (0.06)	0.04 (0.05)	0.02 (0.06)
Schedule control	0.05 (0.06)	−0.08 (0.05)	0.12 (0.07)†
Family supportive supervisor behavior	0.03 (0.05)	0.06 (0.04)	−0.09 (0.05)
WORK-TO-FAMILY CONFLICT	**−0.17 (0.05)*** **	**−0.09 (0.04)***	**0.15 (0.06)** **
FAMILY-TO-WORK CONFLICT	−0.10 (0.06)†	−0.04 (0.05)	−0.01 (0.06)
Random effects			
Workgroup-level variance	0.02 (0.02)	0.01 (0.01)	0.02 (0.02)
Individual-level variance	0.68 (0.04)***	0.48 (0.03)***	0.81 (0.05)***
−2 Res Log Likelihood	1832.50	1579.90	1944.10
Pseudo R-square (%)	12.91	6.97	15.97

Values presented as beta (SE). 709 observations were used in the analyses because of missing values in covariates; Model 2 adjusted for workgroup-level work-family conflict and other work conditions; For categorical predictors, reference group is in parenthesis; Significant effects are bolded. Main variables are capitalized. †P ≤ 0.10, *P < 0.05, **P < 0.01, ***P < 0.001.

nighttime sleep duration across days. Moreover, higher WTFC was also associated with greater inconsistency of sleep clock times, across the 3 variables: bedtime, midpoint, and wake time (see the second to fourth columns of Table 5). FTWC was not significantly linked to inconsistency of nighttime sleep duration, however, it was negatively associated with inconsistency of midpoint clock time ($\alpha_2 = -0.17$, $P < 0.001$) and wake time ($\alpha_2 = -0.41$, $P < 0.001$). Figure 2 illustrates that with increases in FTWC daily variance of wake time *decreased*, meaning that employees who experienced higher FTWC exhibited more consistency in their wake time, in effect a more temporally "rigid" wake time routine. These effects were present even after taking into account the effects of covariates (i.e., individual and family characteristics, sociodemographic and background factors), work conditions, and WTFC and FTWC on the mean of nighttime sleep duration or sleep clock times.

DISCUSSION

This study examined the associations of the particular work-related stressors of WTFC and FTWC with a variety of sleep indicators, independent of family and sociodemographic variables. We expected that higher levels of both WTFC and FTWC would be associated with poorer sleep of employees in this IT-worker sample, and that these effects would be demonstrated over and above the effects of work conditions. Results from this study, however, revealed a more complex picture. Higher WTFC was associated with poorer sleep across all of the dimensions we examined (less sleep sufficiency, poorer sleep quality, more insomnia symptoms, shorter nighttime sleep duration, greater likelihood of napping and longer nap duration), whereas FTWC was not. Furthermore, higher WTFC was associated with greater inconsistency of nighttime sleep duration and sleep clock times. Higher FTWC was linked to *greater* consistency of sleep midpoint, driven by an increased rigidity of the morning wake time. Given these starkly different associations of WTFC and FTWC and every aspect of sleep examined, the mechanisms of how WTFC and FTWC are linked to employee sleep clearly differ. Based on these results, we discuss two important implications of this study and future research directions.

Our results highlight the significance of perceived stress from work in the form of WTFC for employee sleep at home. Consistent with suggestions from Hammer and Sauter,[4] stress and the corresponding draining of physical and psychological resources are likely critical mechanisms linking WTFC with sleep. WTFC predicted self-reported sleep as well as

Table 3—Results of multilevel models predicting actigraphic nighttime sleep duration and wake after sleep onset.

IT Employees (n = 618)	Nighttime Sleep Duration (in minutes per day)	Wake after Sleep Onset (in minutes per day)
Fixed effects		
Intercept, adjusted mean	**443.49 (6.74)*** **	**43.34 (2.15)*** **
Age	−0.51 (0.30)†	0.04 (0.10)
Gender, Men (vs. Women)	**−25.90 (4.88)*** **	−0.63 (1.55)
Marital status, Married (vs. Unmarried)	−3.77 (6.69)	−1.57 (2.12)
Race, Asian/Pacific Islander (vs. White)	**−27.82 (6.50)*** **	**11.48 (2.06)*** **
Race, Other (vs. White)	**−27.75 (7.58)*** **	**4.73 (2.40)***
Adult caregiving, Caregiver (vs. Not)	**10.38 (5.21)***	−0.90 (1.65)
Household income range	1.26 (0.86)	0.02 (0.27)
Living with children age ≤ 18 (vs. Not)	−3.90 (5.10)	**−3.63 (1.61)***
Total work hours	−0.25 (0.33)	−0.08 (0.10)
Job task, Software developer (vs. Support)	4.06 (5.15)	−2.11 (1.70)
Merger, Pre-informed (vs. Not)	2.94 (5.02)	1.37 (1.64)
Job demands	−3.21 (4.12)	−0.32 (1.30)
Decision authority	−5.68 (3.93)	0.14 (1.24)
Schedule control	−1.13 (4.34)	0.50 (1.37)
Family supportive supervisor behavior	2.61 (3.43)	0.30 (1.08)
WORK-TO-FAMILY CONFLICT	**−7.92 (3.49)***	0.64 (1.10)
FAMILY-TO-WORK CONFLICT	−2.19 (4.21)	−1.86 (1.33)
Random effects		
Work group level variance	0.00 (0.00)	3.36 (6.30)
Individual level variance	2633.33 (162.07)***	260.62 (16.89)***
−2 Res Log Likelihood	5783. 60	4568.30
Pseudo R-square (%)	14.05	9.00

Values presented as beta (SE). n = 618; people who provided more than 3 valid days of actigraphic sleep reports; 552 observations were used in the analyses because of missing values in covariates; Model 2 adjusted for workgroup-level work-family conflict and other work conditions. †P < 0.10, *P < 0.05, **P < 0.01, ***P < 0.001.

actigraphically assessed sleep, after controlling for sociodemographic factors and work conditions. Prior research has suggested that the experience of WTFC is strongly related to time pressures.[18] Given that work time is less flexible than non-work times, employees who experienced high WTFC might have unavoidably reduced their sleep time. This kind of employee sleep loss is expected to increase, with the increasing trend of WTFC.[11] To intervene in the process, researchers and practitioners could continue to make efforts to decrease WTFC. For example, an intervention educating supervisors about reasons and tools to provide more support for work-family issues[25] may be able to reduce tensions between work and family roles, which in turn, may give employees opportunities for maintaining healthy sleep behavior.[30]

Moreover, this study demonstrates the importance of examining inconsistency of sleep clock times as well as incorporating more traditionally measured sleep dimensions. The different associations of WTFC and FTWC with the inconsistency (variability) of sleep timing suggest that the two forms of inter-role conflict can impact employee sleep in different ways. This study demonstrates that WTFC interferes with employees' ability to maintain consistent sleep timing, a central tenet of healthy sleep habits. The experience of higher WTFC was linked to greater inconsistency in when employees go to bed and wake up, which relates to inconsistency in their nighttime sleep duration. FTWC, on the other hand, was related to more rigidity of sleep, primarily rigidity of wake time. Having specific family demands (e.g., childcare responsibilities) might have contributed to this. For example, in our study sample, the presence of children under the age 18 was positively correlated with the level of FTWC (r = 0.16, P < 0.001), but it was not significantly correlated with WTFC. A supplementary analysis examined whether living with children under the age 18 makes a difference in the association between FTWC and rigidity of wake time (Table S1 in the supplemental material). Consistent with our expectation, living with children under the age 18 was associated with more rigidity of wake time; but the association was not found for employees who did not live with children under the age 18. Taken together, employees who were living with children under the age 18 tended to report higher FTWC; their childcare responsibilities might have afforded less flexibility for adjusting their wake time. This interpretation, however, may not be free from the auxiliary hypothesis bias,[44] in that our subjective judgment introduced the new factor of childcare responsibilities to explain the unexpected effect of FTWC on wake time. In general, FTWC may be expected to have limited and specific impacts on non-work activities, including sleep, given the meaning of the construct

Table 4—Results of zero-inflated Poisson model simultaneously predicting the likelihood of not having a nap and nap duration for those who had any naps.

IT Employees (n = 618)	Likelihood of No Napping	Nap Duration (% change)
Intercept, adjusted mean	**−0.82 (0.28)****	**3.24 (0.03)*****
Age	−0.02 (0.01)	0.01 (0.00)***
Gender, Men (vs. Women)	−0.24 (0.20)	−0.05 (0.03)†
Marital status, Married (vs. Unmarried)	**0.58 (0.28)***	**−0.16 (0.03)*****
Race, Asian/Pacific Islander (vs. White)	−0.50 (0.27)†	**0.27 (0.03)*****
Race, Other (vs. White)	−0.27 (0.31)	−0.01 (0.04)
Adult caregiving, Caregiver (vs. Not)	−0.02 (0.21)	**−0.28 (0.03)*****
Household income range	−0.04 (0.04)	**0.04 (0.00)*****
Living with children age ≤ 18 (vs. Not)	0.13 (0.21)	0.02 (0.03)
Total work hours	0.02 (0.01)	0.00 (0.00)
Job task, Software developer (vs. Support)	0.11 (0.21)	0.05 (0.03)†
Merger, Pre-informed (vs. Not)	0.06 (0.21)	−0.02 (0.03)
Job demands	−0.01 (0.17)	0.00 (0.02)
Decision authority	−0.22 (0.16)	**0.09 (0.02)*****
Schedule control	0.05 (0.18)	0.03 (0.02)
Family supportive supervisor behavior	0.05 (0.14)	**−0.07 (0.02)*****
WORK-TO-FAMILY CONFLICT	−0.28 (0.15)†	**0.08 (0.02)*****
FAMILY-TO-WORK CONFLICT	0.09 (0.17)	0.04 (0.02)†
Fit Statistics		
−2 Res Log Likelihood	7354.4	
AIC	7450.4	
BIC	7657.4	

Values presented as beta (SE). n = 618; people who provided more than 3 valid days of actigraphic sleep reports; 552 observations were used in the analyses because of missing values in covariates. †P < 0.10, *P < 0.05, **P < 0.01, ***P < 0.001.

Table 5—Results of multilevel models with heterogeneous within-person variance examining associations between work-to-family conflict and family-to-work conflict and day-to-day inconsistency in actigraphic nighttime sleep duration and clock times.

IT Employees (n = 618)	Inconsistency of Nighttime Sleep Duration (Variance in minutes)	Inconsistency of Sleep Bed Time (Variance in decimal hours; 00:00 = 0)	Inconsistency of Sleep Midpoint Time (Variance in decimal hours; 00:00 = 0)	Inconsistency of Sleep Wake Time (Variance in decimal hours; 00:00 = 0)
Random effects				
Individual level variance, σ^2_{u0}	1908.39 (160.95)***	1.13 (0.08)***	0.85 (0.06)***	0.68 (0.07)***
Residual variance, α_0	4553.35 (113.69)***	1.27 (0.03)***	0.92 (0.02)***	2.65 (0.07)***
−2 Res Log Likelihood	43106.20	12735.2	11544.2	14978.3
Effects of Work-family conflict				
Exp (**WORK-TO-FAMILY CONFLICT**), α_1	**0.12 (0.03)*****	**0.12 (0.03)*****	**0.15 (0.03)*****	**0.16 (0.03)*****
Exp (**FAMILY-TO-WORK CONFLICT**), α_2	−0.03 (0.04)	−0.05 (0.04)	**−0.17 (0.04)*****	**−0.41 (0.04)*****

Values presented as α (SE). n = 618; people who provided more than 3 valid days of actigraphic sleep reports; 552 people's data were used in the analyses because of missing values in covariates; 3,769 daily observations were analyzed; All covariates from the previous models, such as employee age, gender, marital/partner status, race/ethnicity, adult caregiver status, range of current annual household income, presence of children under the age of 18 in household, total work hours, occupation, and merger indicator, as well as other work condition variables (job demands, decision authority, schedule control, and FSSB) were included in the fixed effects to control for the effects on the mean of nighttime sleep duration and sleep clock times; Day and total number of days were also additionally controlled in the fixed effects; There were no fixed effects of work-to-family and family-to-work conflict on each sleep clock time. ***P < 0.001.

that family demands interfere with work.[6–8] Furthermore, it should be noted that our sample of employees reported a relatively low level of FTWC (mean = 2.1, on a 5-point scale), and thus FTWC may not be a concern for most of them. In short, the interesting and differential associations of WTFC and FTWC with sleep clock times call for more research on this topic, especially in other populations with greater levels of FTWC. Alternatively, outcomes focused on the impact of

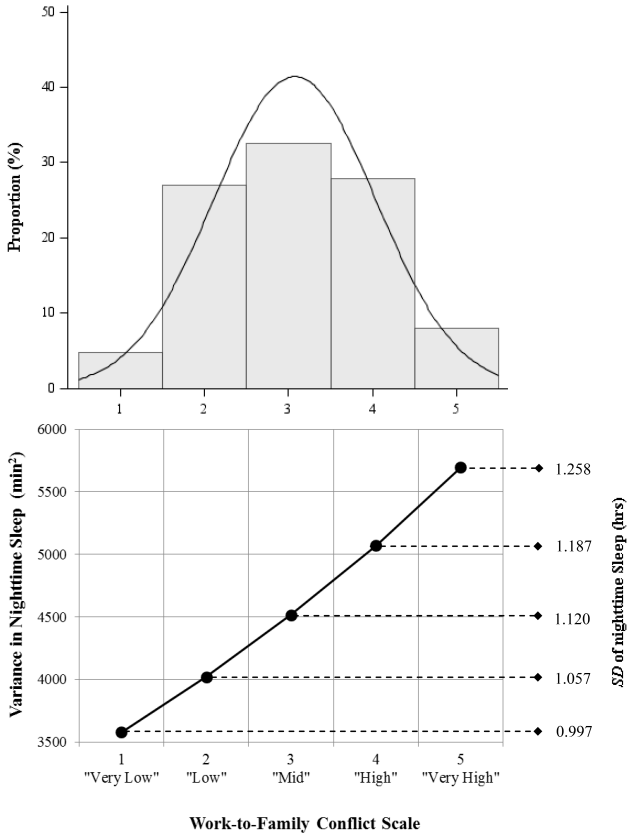

Figure 1—Association between work-to-family conflict and inconsistency of nighttime sleep duration.

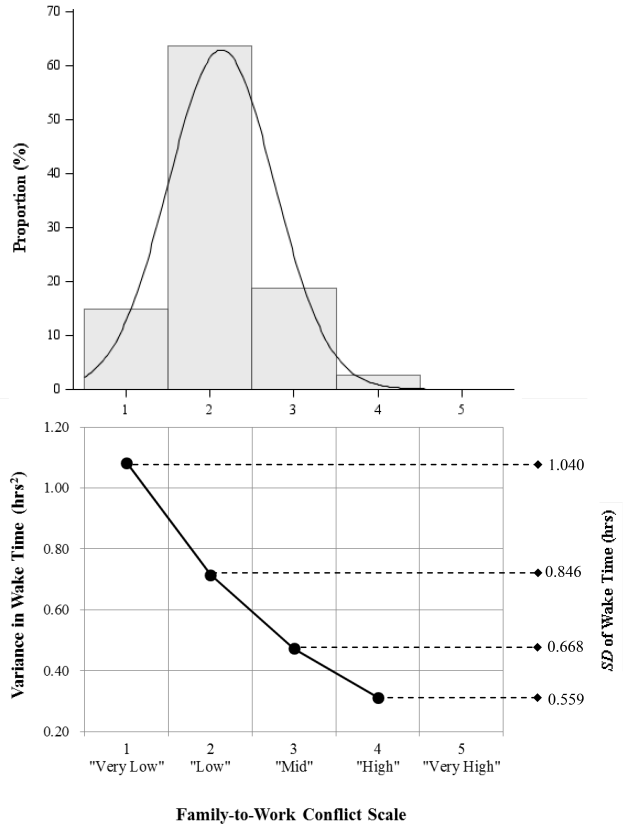

Figure 2—Association between family-to-work conflict and inconsistency of sleep wake time.

FTWC may need to focus on work-related outcomes, either individual or organizational.

In addition, the findings on the associations of higher WTFC with a greater likelihood of napping and longer nap duration add new knowledge to the research field. Employees with high WTFC were likely to be compensating during the day for their perceived insufficient nighttime sleep and actigraphically measured shorter nighttime sleep durations. Note that our study sample may have more temporal flexibility to take naps during their work hours than employees in other contexts, given that they work in professional occupations. This implies that workplace preventions/interventions could allow employees to recover from insufficient sleep and restore energy during daytime work hours. Such efforts could help increase work productivity by decreasing the cost of poor sleep.[45]

Limitations and Future Directions

The current study has limitations. First, the cross-sectional data constrain our ability to identify any causality. Although our statistical models imply that WTFC and FTWC predict employee sleep, our design does not rule out reverse causality. Thus, future research should include multiple time points and adopt experimental designs to attempt to identify causality. Second, work-family conflict, sleep sufficiency, sleep quality, and insomnia symptoms were measured via self-reports, which poses a potential risk for a common-method bias that may arise when both predictors and outcomes are measured by the same method.[16] Although the results were consistent with the findings based on actigraphy data, the effects might still be inflated by common-method bias. Moreover, the fact that we used one item each to measure sleep sufficiency, quality, and insomnia symptoms limits our ability to examine the reliability of the measures. Lastly, the sample of this study was purposely selected from the IT industry, and thus the findings may not be generalized to employees in other work contexts. Future research may need to see whether the inferences from this study are applicable to other industry samples. In addition, non-probability sampling of worksites from the IT industry also limits generalizability of the results to the population of employees in the IT industry. In addition, this study treated inconsistency of sleep as outcomes, but future work could treat inconsistency of sleep as a predictor of long-term health risks utilizing, for example, an intra-individual variability predictor using a Bayesian Variability Model recently developed by Wiley and colleagues.[43]

We demonstrate that the two dimensions of the work-related stress of Work-Family Conflict (WFC), Work-to-Family Conflict (WTFC) and Family-to-Work Conflict (FTWC), impact sleep in many but very different ways. Associations controlling for sociodemographic, family, workplace psychosocial factors and workplace conditions reveal an independent and deleterious relationship of WTFC with every aspect of sleep examined, including lower perceived sleep sufficiency and sleep quality, greater insomnia symptoms, reduced actigraphically

measured nighttime sleep duration, greater likelihood of napping and longer naps, and greater inconsistency of sleep duration, and greater inconsistency of sleep timing including bed time, midpoint (a circadian phase marker of social jet lag), and wake time. In contrast, FTWC was associated with lower perceived sleep sufficiency, and greater *consistency* of sleep timing driven by a more rigid morning wake time. These findings starkly contrast the two dimensions of WFC, and suggest that close attention to WTFC may continue to be a fruitful avenue for future interventions designed to improve employee sleep.

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SUBMISSION & CORRESPONDENCE INFORMATION

Submitted for publication September, 2015
Submitted in final revised form May, 2016
Accepted for publication May, 2016
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DISCLOSURE STATEMENT

This was not an industry supported study. This research was conducted as part of the Work, Family, and Health Network (www.WorkFamilyHealthNetwork.org), which is funded by a cooperative agreement through the National Institutes of Health and the Centers for Disease Control and Prevention: *Eunice Kennedy Shriver* National Institute of Child Health and Human Development (U01HD051217, U01HD051218, U01HD051256, U01HD051276), National Institute on Aging (U01AG027669), Office of Behavioral and Social Sciences Research, and National Institute for Occupational Safety and Health (U01OH008788, U01HD059773). Grants from the National Heart, Lung and Blood Institute (R01HL107240), the William T. Grant Foundation, Alfred P Sloan Foundation, and the Administration for Children and Families provided additional funding. The contents of this publication are solely the responsibility of the authors and do not necessarily represent the official views of these institutes and offices. No off-label or investigational use is indicated. The authors have indicated no financial conflicts of interest.