Sleep Health 1 (2015) 55–65

Contents lists available at ScienceDirect

Sleep Health

Journal of the National Sleep Foundation

journal homepage: http://www.elsevier.com/locate/sleh

A workplace intervention improves sleep: results from the randomized controlled Work, Family, and Health Study

Ryan Olson, PhD [a,b,c], Tori L. Crain, MS [c], Todd E. Bodner, PhD [c], Rosalind King, PhD [d], Leslie B. Hammer, PhD [c], Laura Cousino Klein, PhD [e], Leslie Erickson, BA [f], Phyllis Moen, PhD [g], Lisa F. Berkman, PhD [h,i], Orfeu M. Buxton, PhD [e,h,i,j,k,*]

[a] Oregon Institute of Occupational Health Sciences, Oregon Health & Science University, 3181 SW Sam Jackson Park Rd, L606, Portland, OR 97239
[b] Department of Public Health & Preventive Medicine, Oregon Health & Science University, 3181 SW Sam Jackson Park Rd, Mail Code CB 669, Portland, OR 97239
[c] Department of Psychology, Portland State University, 1721 SW Broadway, Rm 317, Portland, OR 97201
[d] Population Dynamics Branch, Eunice Kennedy Shriver National Institute of Child Health and Human Development, 6100 Executive Blvd., Bethesda, MD 20892-7510
[e] Department of Biobehavioral Health and Penn State Institute of the Neurosciences, Pennsylvania State University, 221 Biobehavioral Health Bldg, University Park, PA 16802
[f] RTI International, 3040 East Cornwallis Road, Research Triangle Park, NC 27709
[g] Department of Sociology and Minnesota Population Center, University of Minnesota, 50 Willey Hall, 225–19th Ave South, Minneapolis, MN 55455
[h] Harvard Center for Population and Development Studies, Harvard University, 9 Bow Street, Cambridge MA 02138
[i] Department of Social and Behavioral Sciences, Harvard T. H. Chan School of Public Health, 677 Huntington Ave, Kresge Building, Boston, MA 02115
[j] Department of Medicine, Brigham and Women's Hospital, 221 Longwood Ave, Boston, MA 02115
[k] Division of Sleep Medicine, Harvard Medical School, 221 Longwood Ave, Boston, MA 02115

ARTICLE INFO

Article history:
Received 11 November 2014
Accepted 25 November 2014

Keywords:
Intervention
Workplace
Managers
Supportive supervision
Control
Actigraphy

ABSTRACT

Study objectives: The Work, Family, and Health Network Study tested the hypothesis that a workplace intervention designed to increase family-supportive supervision and employee control over work time improves actigraphic measures of sleep quantity and quality.
Design: Cluster-randomized trial.
Setting: A global information technology firm.
Participants: US employees at an information technology firm.
Interventions: Randomly selected clusters of managers and employees participated in a 3-month, social, and organizational change process intended to reduce work-family conflict. The intervention included interactive sessions with facilitated discussions, role playing, and games. Managers completed training in family-supportive supervision.
Measurements and results: Primary outcomes of total sleep time (sleep duration) and wake after sleep onset (sleep quality) were collected from week-long actigraphy recordings at baseline and 12 months. Secondary outcomes included self-reported sleep insufficiency and insomnia symptoms. Twelve-month interviews were completed by 701 (93% retention), of whom 595 (85%) completed actigraphy. Restricting analyses to participants with ≥ 3 valid days of actigraphy yielded a sample of 473-474 for intervention effectiveness analyses. Actigraphy-measured sleep duration was 8 min/d greater among intervention employees relative to controls ($P < .05$). Sleep insufficiency was reduced among intervention employees ($P = .002$). Wake after sleep onset and insomnia symptoms were not different between groups. Path models indicated that increased control over work hours and subsequent reductions in work-family conflict mediated the improvement in sleep sufficiency.
Conclusions: The workplace intervention did not overtly address sleep, yet intervention employees slept 8 min/d more and reported greater sleep sufficiency. Interventions should address environmental and psychosocial causes of sleep deficiency, including workplace factors.

Introduction

Sleep deficiency[1,2] has been linked to increased risk of chronic disease[3,4] and early mortality.[5,6] Prospective studies yield evidence that short sleep duration and/or poor sleep quality is causally related to chronic disease risks of obesity[7,8] and diabetes.[4,9] The recent Institute

* Corresponding author at: Pennsylvania State University, 221 Biobehavioral Health Building, University Park, PA 16802. Tel.: +1 617 507 9177.
E-mail address: Orfeu@PSU.edu (O.M. Buxton).

http://dx.doi.org/10.1016/j.sleh.2014.11.003
2352-7218/

of Medicine report "Sleep disorders and sleep deprivation: an unmet public health problem" highlighted improving sleep health in the United States as a critical public health need.[10] For these reasons and others, increasing the proportion of US adults and adolescents obtaining adequate sleep has become a new federal priority in *Healthy People 2020*[11] and a primary goal for the field of sleep.[12] Clinical sleep medicine focuses primarily on treatment of individual patients' sleep disorders; however, individual-level treatments are limited in reach for meeting this challenge.

The role of workplace factors in sleep loss has been studied for decades.[1,13-15] Most studies focus on the individual level and use stress-based models. Extreme work hours have negative impacts on sleep duration that can be alleviated to some degree by changes in work schedules.[16] Demands of the global recession coupled with mobile technologies have extended work hours and blurred the boundaries between work and nonwork, especially within information technology (IT) industries.[17-19] Time use studies suggest that US employees make the tradeoff of about 2 hours less of sleep for every 1 additional hour of work.[20] Therefore, it is important to understand the impact on sleep of particular workplace factors.[21-23] Most workplace stress interventions focus on individual coping behavior, such as yoga[24] or mindfulness practices.[25,26] Few workplace studies have attempted to reduce employee stress and improve sleep by changing the structure of work.[27,28]

"Impoverished" environments, such as workplaces where employees lack social support and/or have limited control over their time, are associated with a range of negative health outcomes.[29,30] Employees in low support/control work environments are particularly vulnerable to work-family conflict, which occurs when the demands of work are incompatible with the nonwork demands of family and personal life.[31,32] Work-family demands have increased for a growing number of dual-earner families, single mothers, and "sandwich" families who must simultaneously provide care for young and old.[33-38] High work-family conflict increases insomnia and reduces self-reported sleep time and quality.[39-42] In an extended care (nursing home) workplace setting, employees whose managers were less supportive of work-family integration averaged about 30 minutes less daily sleep (measured with actigraphy) than employees with supportive managers.[43] Given the extensive negative health effects of work-family conflict,[27,44] the work-family interface has become a public health priority,[45] including the evaluation of interventions to reduce this occupational health hazard and associated negative impacts on sleep.[27,46,47]

Limited work-family intervention research has shown that improving supervisor support and employee control over work time benefits worker health and/or sleep. A randomized field experiment with grocery workers evaluated the effects of training supervisors on family supportive behaviors. For workers experiencing high work-family conflict, the intervention improved self-reported health and job satisfaction and reduced turnover intentions.[27] A longitudinal study of white-collar employees at the headquarters of a Fortune 500 retail organization found that an intervention promoting greater employee control over time increased self-reported sleep on nights before work by almost an hour[28] and improved perceptions of adequate time for sleep.[48] However, structural workplace interventions to reduce work-family conflict remain scarce, and no prior work-family intervention has measured impacts on objective sleep outcomes within a randomized controlled trial.

The present study evaluated the effects of a theoretically informed workplace intervention on objectively measured employee sleep with a randomized controlled design. The study was implemented at an IT company, and measurements were collected at baseline, 6 months, and 12 months. Our primary hypotheses were that the intervention would improve actigraphically measured total sleep time and wake after sleep onset (WASO; a marker of insomnia symptoms), as well as self-reported measures of sleep insufficiency and insomnia symptoms at the 12-month time point relative to the usual practice (control) condition. Our secondary hypothesis was that intervention effects on sleep at the 12-month time point would be at least partially mediated by increased control over work hours and subsequently reduced work-family conflict at the 6-month time point.

Methods

Study methods were approved by appropriate institutional review boards. Primary study outcomes were actigraphy-based measures of total sleep time per day and WASO (in minutes) and self-reported measures of sleep insufficiency and insomnia symptoms measured at baseline and 12 months. Of interest was the change in these outcomes over the study year in the intervention and usual practice (control) arms of the study.

Design and data collection

The study used a cluster-randomized design with 3 measurement time points reported here (baseline, 6 months, and 12 months). Recruitment spanned from September 2009 to September 2010, and 12-month follow-up was completed on September 2011. Fifty-six "study groups" or clusters of managers and employees were identified with company representatives as eligible for randomization. Adaptive randomization occurred after baseline data collection for each study group, as previously described.[49] All employees within these groups were eligible to participate. Some study groups involved large teams under 1 leader, whereas other study groups involved multiple teams who worked closely together or reported to the same senior leader. We refer to randomization units as study groups to denote that they are aggregations of existing functional work groups that operated in the organization. Baseline demographic descriptive statistics for the sample are provided in Table 1.

Recruitment materials emphasized the value of the research for employees and the organization as well as for scientific knowledge. Trained study site managers introduced the study to employees at

Table 1
Percentage or mean ± SD for demographic characteristics by condition (n = 474).

	Usual practice (n = 240)	Intervention (n = 234)
Female	37.9%	42.7%
Age	46.6 ± 8.4	46.8 ± 8.8
Race/ethnicity		
White, non-Hispanic	72.1%	70.5%
Black or African American, non-Hispanic	1.3%	1.7%
Asian Indian	13.8%	12.4%
Other Asian	4.2%	5.1%
Other Pacific Islander	0.8%	1.3%
Hispanic	6.7%	8.1%
More than 1 race	1.3%	0.9%
Married or living with partner	79.2%	81.2%
No. of children	1.0 ± 1.2	1.0 ± 1.0
Elder care	25.8%	24.4%
Education		
High school graduate	2.5%	3.0%
Some college or technical school	17.9%	22.7%
College graduate	79.6%	74.4%
Hours worked per week	45.5 ± 6.0	45.6 ± 5.5
Shift		
Variable schedule	21.3%	20.9%
Regular daytime	77.9%	78.2%
Rotating	0.4%	0.9%
Split shift	0.4%	0.0%

Note: Descriptives shown for all individuals included in analyses (n = 474).

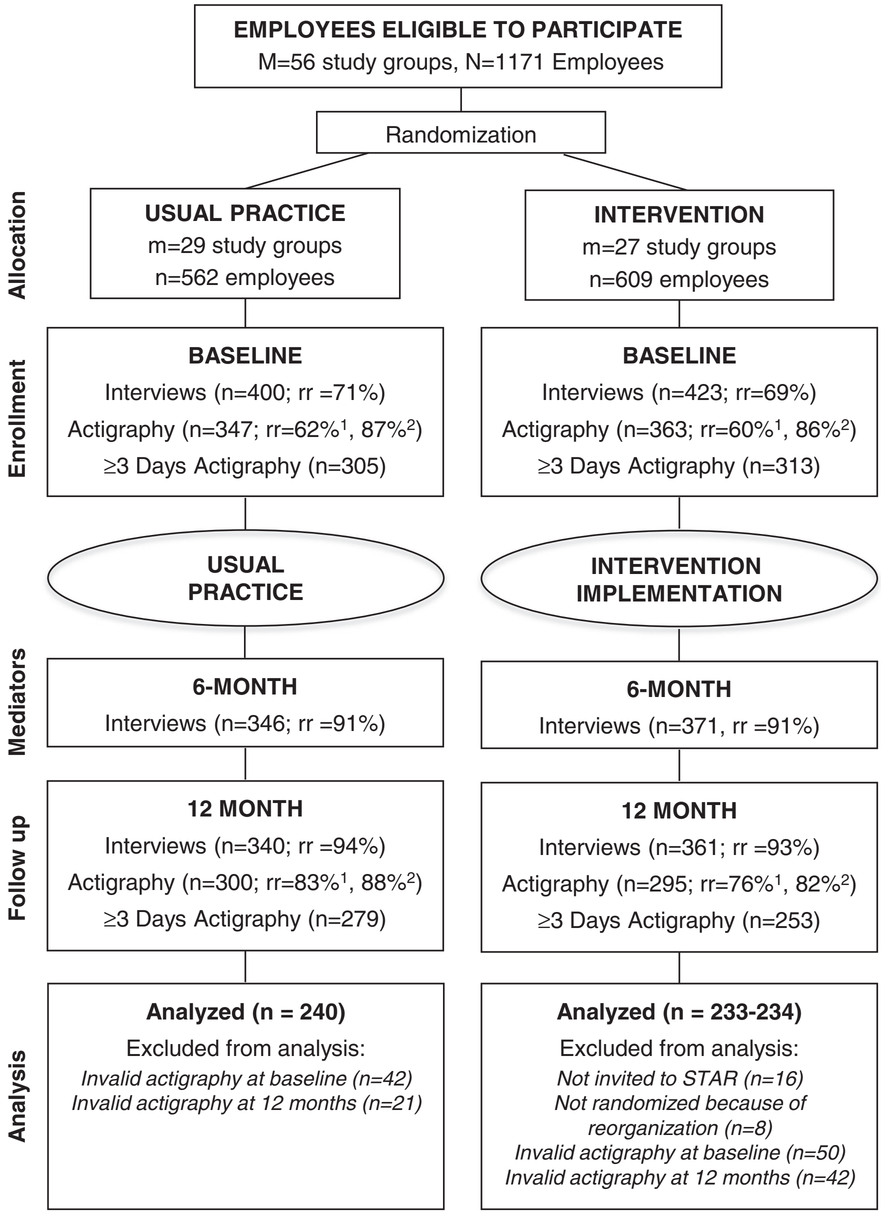

Fig. 1. Flow diagram of study recruitment and retention. A small work group was randomized to intervention (n = 16) but never invited to STAR activities, by error. These individuals were excluded from analyses. rr, retention rate. [1] (No. of actigraphy completed)/(interview eligible employees). [2](No. of actigraphy completes)/(interview completed).

work sites and coordinated project implementation. To minimize bias, separate and blinded study field interviewers obtained written informed consent and collected data from employees within intervention and usual practice study groups at baseline, 6-month, and 12-month time points.[49] Baseline data were collected approximately 1 month before the onset of the 3-month intervention. Self-reported measures were collected as part of a 60-minute interview at each time point. Employees were asked to wear a wrist actigraph for 1 week, as described below. Employees received up to $60 for completing all worksite data collection components at each time point. Figure 1 depicts study recruitment and retention.

Statistical methods

While randomization occurred at the study group level (m = 56), multilevel analyses used coding for the smaller unit of work group level to best account for functional day-to-day work at the organization (m = 107). Given the nonindependence of measures due to the nesting of observations within individuals across time and the nesting of individuals within work groups in the organization, we used a recommended general linear mixed modeling approach for cluster-randomized designs[50-52] in SAS (version 2.2, 2010; SAS Institute, Cary, NC) with restricted maximum likelihood estimation. The key model parameter was the interaction between assessment wave and the intervention indicator that represents the differential change in the sleep outcomes across time and intervention conditions. These models take into account baseline values of the outcome variable. Furthermore, differences between intervention and control groups on demographic variables are irrelevant because multiple waves are included in the models (ie, each person controls for themselves, despite what group they are in). To test our secondary hypothesis of mechanisms underlying intervention effects, we used

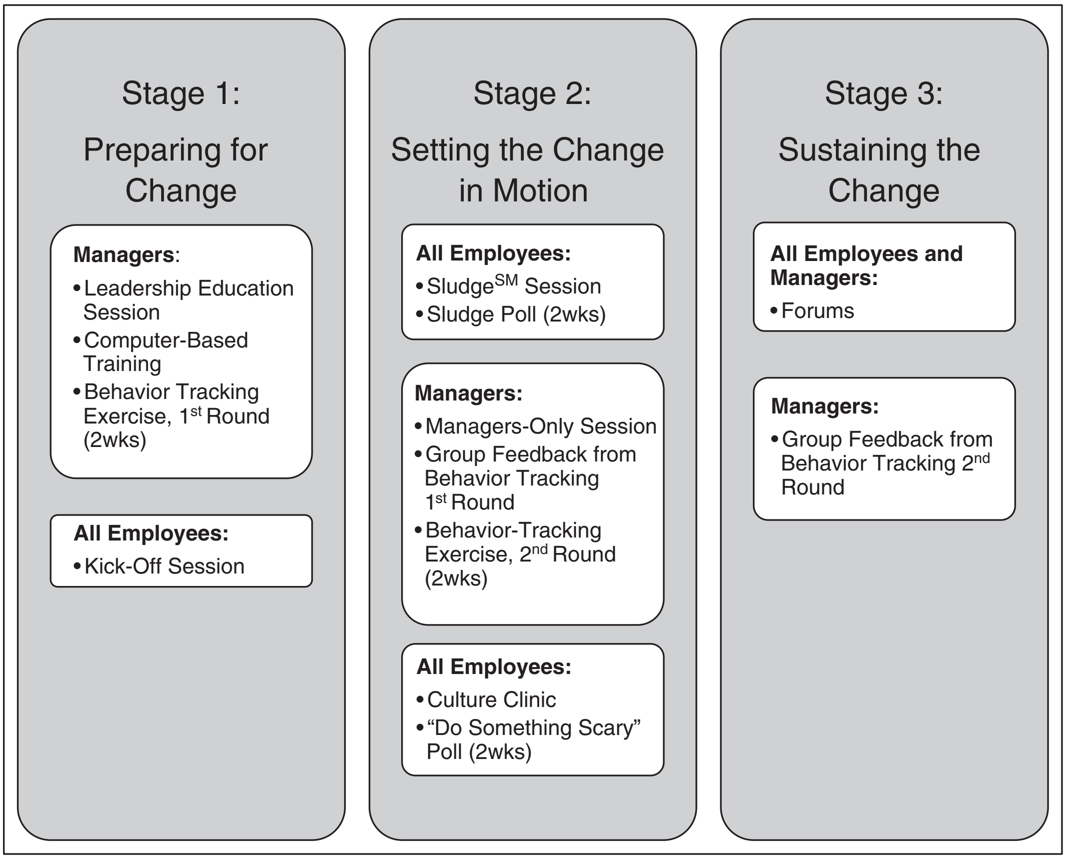

Fig. 2. Overview of the intervention process. The 3-month, workplace-based cultural change process included multiple steps and training sessions for both employees and managers. Adapted from Kossek et al.[55]

multilevel structural equation modeling approaches accounting for longitudinal and nesting features of the data[53] in Mplus (version 4.2, 2006; Muthen & Muthen, Los Angeles, CA). Specifically, we modeled whether the intervention directly increased control over work hours at the 6-month time point, followed by whether these changes, in turn, reduced work-family conflict at the 6-month time point and then whether reductions in work-family conflict were directly related to sleep improvements at 12 months. The product of these direct effects defines the indirect effect (ie, mediation) in our model.[53] Sensitivity analyses using a full information maximum likelihood approach[54] revealed no substantive differences in mediation model results (data not reported).

Intervention

The intervention was a 3-month structural and social change process designed to increase (1) employee control over work time and (2) family supportive supervisory behaviors.[55] The change process was an integration of 2 interventions that, in prior evaluations, had independently addressed family supportive supervisor behaviors and employee control, respectively.[27,56] Behavioral self-monitoring activities were also integrated to support transfer of training.[57,58] For implementation, the new intervention was named STAR (Support. Transform. Achieve. Results.). See Figure 2 for an intervention overview.

During the intervention period, a facilitator led employees and managers through 8 hours of participatory sessions to transition them from a time-based to a result-based work culture. This change was expected to impact employee sleep by enabling greater control over wake time. Participatory sessions included structured presentations about the reasons for workplace changes as well as facilitated discussions, role playing, and games. During this process, leaders and employees were asked to make structural changes and exercise greater freedom to work at whatever time and whatever place they wanted, as long as they produced their expected work results. After being challenged to enact changes, work groups participated in daily Web polls where they self-monitored and viewed feedback about their collective actions.

Managers/supervisors participated in all change activities plus 4 hours of training in family supportive supervisor behaviors and meetings to discuss the change process. Increased supervisor support was expected to impact employee sleep primarily by reducing employee stress, thereby enhancing employee psychological and physical readiness for sleep onset in the evening and quality sleep through the night. The training in supportive supervision, which was named "weSupport for Supervisors" for implementation, began early in the overall intervention process by having managers meet with a facilitator individually to complete a 1-hour self-paced computer-based training, set goals, and start a self-monitoring activity. The individual training was computer based (cTRAIN; NWeta, Lake Oswego, OR) and designed according to behavioral principles (eg, self-paced, mastery required, or frequent quizzes). Goal setting and self-monitoring of supportive behaviors were implemented using an Enterprise application for iPhone/iPod Touch (HabiTrack; Oregon Health & Science University, Portland, OR) that was designed based on best practices in clinical and workplace self-monitoring methods.[58,59] Each supervisor

Table 2
Mean ± SD for work-family conflict and sleep outcomes by condition over time (n = 457-474).

		Usual practice				Intervention			
	Unit	Baseline	6 mo	12 mo	Change	Baseline	6 mo	12 mo	Change
Control over work hours	Rating 1-5	3.7 ± 0.7 (n = 240)	3.7 ± 0.7 (n = 229)		0.0 ± 0.5	3.6 ± 0.7 (n = 234)	3.8 ± 0.7 (n = 228)		0.3 ± 0.6
Work-family conflict	Rating 1-5	3.1 ± 1.0 (n = 240)	3.0 ± 0.9 (n = 229)		−0.1 ± 0.8	3.2 ± 0.9 (n = 234)	2.9 ± 0.9 (n = 228)		−0.3 ± 0.9
Total sleep time	Minutes	440.9 ± 49.8 (n = 240)		436.8 ± 51.5 (n = 240)	−4.2 ± 42.2	433.4 ± 58.7 (n = 234)		437.4 ± 58.6 (n = 234)	4.0 ± 43.8
Sleep insufficiency	Rating 1-5	2.8 ± 0.9 (n = 240)		2.8 ± 0.9 (n = 240)	0.0 ± 0.9	2.9 ± 0.9 (n = 234)		2.6 ± 0.9 (n = 234)	−0.2 ± 0.9
WASO	Minutes	42.7 ± 16.3 (n = 240)		40.4 ± 13.7 (n = 240)	−2.3 ± 12.8	43.6 ± 17.0 (n = 234)		42.5 ± 15.7 (n = 234)	−1.0 ± 11.8
Insomnia symptoms	Rating 1-4	2.8 ± 0.8 (n = 240)		2.7 ± 0.8 (n = 240)	−0.0 ± 0.7	2.7 ± 0.8 (n = 233)		2.6 ± 0.7 (n = 234)	−0.1 ± 0.7

Note: Sample size range reflects the number of individuals included in the analyses at baseline, 6 months, and 12 months.

completed 2 rounds of self-monitoring (each round = 2 weeks); the first occurring immediately after the computer-based training and the second occurring toward the end of the change process.

During intervention implementation, the participating organization announced a pending merger. During mergers, employees are likely to experience heightened job insecurity, which could impact work-family conflict and sleep. Therefore, to control for the possible effect of the merger announcement, multilevel models included an indicator of the timing of employee baseline interviews (premerger or postmerger announcement; Table 3).

Throughout the study, qualitative process evaluation data were collected via observation of training sessions and semistructured interviews with employees and managers. The relevant interviews were conducted with participants in the intervention, including both employees and managers, covering their responses to the intervention activities and descriptions of how the intervention was being implemented in their work group or by them individually. In each study group, trained observers identified employees and managers who seemed engaged during the training sessions and invited them to participate in the interviews. The researchers recruited intervention participants who ranged from being enthusiastic, skeptical (but interested), or resistant to the intervention. More than 90% of invited participants completed these qualitative interviews (n = 128). The interview guide did not ask explicitly about sleep but did ask about health broadly. Selected excerpts from these discussions relevant to sleep and the intervention are included below.

Measures

Actigraphy outcome measures

Wrist actigraphy (Actiwatch Spectrum; Philips/Respironics, Murrysville, PA) data were analyzed using the recently validated manufacturer's standard algorithm at medium sensitivity[60] for 24-hour total sleep time (including naps) and WASO during the main sleep period for all study days with a valid recording, as described below.

Data from each subjects' Actiwatch was uploaded to databases (Respironics Actiware sleep scoring program version 5.61) and analyzed by at least 2 members of the scoring team. All analyses were completed blinded to condition. Scorers first determined the validity of each recording and the validity of each day of the recording and then manually inserted sleep periods (main sleep intervals and naps) based on study-specific standard operating procedures applied similarly to all recordings. Scorers started by finding points of decreased activity levels and also used sudden, decreased light levels (lux) to help suggest, but not confirm, bedtimes. By visually reviewing the entire sleep recording before manually setting intervals, scorers took into consideration the activity intensity of the subject for determining naps and sleep periods to be able to accurately define sleep periods rather than low movement activities such as watching TV or reading in bed. Sleep periods began at the last epoch of high activity (>10 activity counts) preceding at least five 30-second epochs of <10 activity counts, indicating little to no movement. Wake times were determined the same way by finding the first epoch of sustained high activity (>10 activity counts) after at least five 30-second epochs of <10 activity counts. A recording was deemed invalid if there was constant false activity (a device malfunction) or if the data were irretrievable. Reasons for invalid days within a recording include watch error, such as false activity, and subject noncompliance (>4 hours of Actiwatch off-wrist time throughout the day or an off-wrist period >60 minutes within 10 minutes of the determined beginning or end of the main time in bed period for that day). Sleep diaries were not used due to subject burden, recall bias, and low response rates in other studies.[61]

Concordance between at least 2 scorers was measured for the validity of the recording and the number of valid days. All scorers used the same cut time to define 24-hour days. If there were no discrepancies between scorers in any of those variables, the analyses were then checked that all scorers determined that the recording had the same number of sleep periods and that each sleep period as a main sleep or nap was labeled in an identical manner. Any discrepancies were resolved among the scoring team with the final determination by the last author. Finally, each of the sleep periods was checked on an interval-by-interval basis. Any corresponding intervals that exceeded a 15-minute difference in duration or exceeded 15 minutes of either total sleep time or WASO were rescored with all final adjudications by the last author. The Actiware sleep scoring program separates the recording into 30-second epochs and determines sleep or wake using weighted activity counts using the medium sensitivity standard algorithm, as recently validated vs the criterion standard of polysomnography.[60] If the total activity count exceeded the wake threshold level determined by the researchers (medium wake threshold level selection uses a wake threshold value of 40 total activity counts), then the epoch was determined to be wake, and if the total activity count was below the set wake threshold level, the epoch was determined to be sleep. Total sleep time was the total number of epochs determined to be sleep multiplied by the set epoch length, whereas WASO was the total number of epochs determined to be wake multiplied by the set epoch length, with both variables being presented as a value in minutes for both main sleep intervals and nap sleep intervals. Actigraphy measures were screened for outliers using box and whisker plots, but no outliers were present 3 times the interquartile range below or above the 25th and 75th percentile, respectively. More conservative histograms revealed 2 cases <200 minutes for total sleep time and 1 case >125 minutes for WASO. Analyses were then conducted with and without outliers found in these more conservative histograms, but results did not change. Thus, the current analyses are based on the larger sample.

Self-report outcomes

Participants answered questions regarding their sleep for the previous 4 weeks. Sleep insufficiency was assessed with 1 question: "How often during the past 4 weeks did you get enough sleep to feel rested upon waking up?" with response categories of never, rarely, sometimes, often, and very often,[62,63] similar to current Centers for Disease Control and Prevention (CDC) surveillance for state-level sleep insufficiency.[64] Insomnia symptoms were assessed using 2 questions from the Pittsburgh Sleep Quality Index[65]: "During the past four weeks, how often could you not get to sleep within 30 minutes?" and "During the past four weeks, did you wake up in the middle of the night or early morning?" with response categories of never, less than once a week, once or twice a week, and 3 or more times a week ($\alpha = .32$).

Mediation measures

All mediators were assessed with means, computed if participants provided at least 75% of valid responses to the items within a scale. Work-family conflict, a well-validated scale,[66] was assessed using the mean of 5 items; a sample item reads "The demands of your work interfere with your family or personal time." Each item used the following response categories: "strongly agree, agree, neither agree nor disagree, disagree, and strongly disagree" ($\alpha = .91$). Control over work hours[47] was measured with the mean of 8 items; a sample item is "How much choice do you have over when you take vacations or days off?" Response categories included "very little, little, a moderate amount, much, and very much" ($\alpha = .82$).

Results

Baseline interviews were completed by 823 individuals (70% response rate), of whom 710 (86%) also completed wrist actigraphy. Among these individuals, a minimum of 3 valid days of actigraphy, a quality metric for reliable sleep estimates, was available in a final

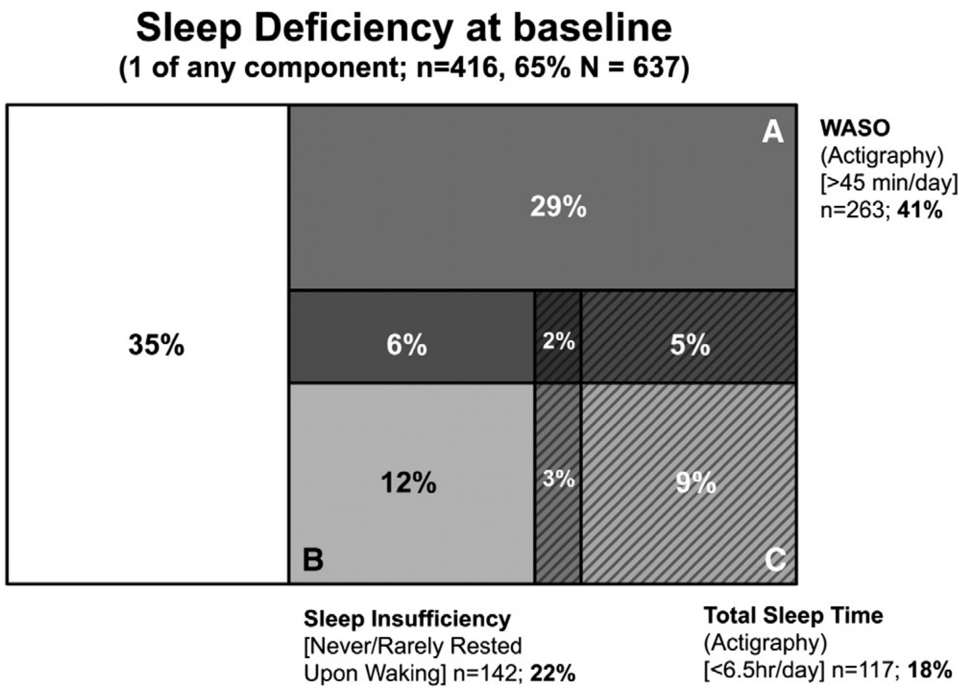

Fig. 3. Venn diagram of the burden of sleep deficiency in the cohort at baseline. Sleep deficiency at baseline (insufficient sleep duration and/or inadequate sleep quality) was defined as having at least 1 of any components: mean Wake After Sleep Onset (WASO) >45 minutes per main sleep period (measured with wrist actigraphy and indicative of insomnia), self-reported sleep insufficiency (never or rarely feeling rested upon waking), and/or mean total sleep time <6.5 h per 24 hours (measured from actigraphy). Due to rounding, totals do not add up to 100%.

Table 3
General linear mixed modeling analysis of intervention effects on sleep outcomes (n = 473-474).

Predictor	Total sleep time (min)		Sleep insufficiency (rating 1-5)		WASO (min)		Insomnia symptoms (rating 1-4)	
	γ	95% CI	γ	95% CI	γ	95% CI	γ	95% CI
Intercept	**441.5*** **	**428.6-454.3**	**2.7*** **	**2.5-2.9**	**44.9*** **	**41.2-48.7**	**2.6*** **	**2.4-2.8**
Intervention	−8.2	−18.6-2.1	0.0	−0.1-0.2	1.3	−1.7-4.3	−0.1	−0.2-0.1
Wave	−4.2	−9.7-1.3	0.0	−0.1-0.1	**−2.3** **	**−3.9-−0.8**	−0.0	−0.1-0.0
Intervention * wave	**8.2** *	**0.3-16.0**	**−0.2** **	**−0.4- −0.1**	1.3	−0.9-3.5	−0.0	−0.1-0.1
Merger	−8.7	−20.0-2.6	−0.1	−0.3-0.0	−0.7	−4.0-2.6	−0.0	−0.2-0.1

Note: Intervention (0, usual practice; 1, intervention). Wave (0, baseline; 1, 12 months). Merger (0, collection before merger announcement; 1, collection after merger announcement). Analyses also controlled for (1) the number of employees for randomization and (2) groups where the most individuals were involved in software development (groups dominated by other IT jobs are the reference group), but neither of the coefficients were significant and are thus not included in this table. Sample size range reflects the number of individuals included in the analyses at baseline at 12 months, with 1 less person providing reports of insomnia symptoms. Significant *P* values are in boldface. Abbreviations: γ, unstandardized regression coefficient; CI, confidence interval.
* $P < .05$.
** $P < .01$.
*** $P < .001$.

baseline sample of 618 individuals (intervention, n = 313; control, n = 305). The 12-month interviews were completed by 701 individuals (93% retention rate), of whom 595 (85%) completed wrist actigraphy. There is no evidence of differential retention/attrition; the wave-1-only sample was not significantly different (at baseline) from those who completed both waves on experimental condition, schedule control, supervisor support, work-family conflict, time adequacy, work hours, or other demographics. A minimum of 3 valid days of actigraphy was available at both baseline and 12-month time points from a sample of 473-474 (intervention, n = 233-234; control, n = 240), which was the functional sample size for the current intervention analyses. On average, individuals had 7.3 ± 2.1 (mean ± SD) valid days of actigraphy, with only 14 individuals having 3 valid days and 23 with 4 valid days. A smaller sample (n = 456-457; intervention, n = 227-228; control, n = 229), due to nonparticipation at 6-month wave, was used in mediation path models. We provide sample size ranges because the sample size varied depending on which sleep outcome was being used in each model. As noted in the statistical analysis section, study groups (m = 56; intervention, 27; control, 29) were the unit of randomization (see Fig. 2 for study flow diagram), but smaller clusters of work groups of employees working together (m = 107; intervention, m = 54; control, m = 53) were used as the appropriate nesting variable in multilevel analyses.

The baseline burden of sleep deficiency using actigraphy and self-reported data is depicted in Figure 3: 65% of the sample exhibited at least 1 of the 3 components of sleep deficiency, including 18% with short actigraphic mean sleep duration, 41% with mean actigraphic WASO >45/min/d, and 22% self-reported sleep insufficiency. In qualitative interviews, common problems that emerged as self-reported reasons for losing sleep included smartphones, staying in bed and thinking about work, not being able to shake a cold because of sleep deprivation, and merger-related sleep deprivation. One participant volunteered the fact that he has trouble sleeping every night because he is constantly on his smartphone, right up until bedtime. He answers his last e-mail for the night, turns it off, and spends hours trying to unwind as he lies there. Then when he gets up in the morning, he's already got e-mails waiting that came in through the night. He said that it started a few years ago, that things have gotten much more hectic and the pace of work has sped up over the past few years, and that his lack of sleep is a result of that.

Unadjusted means and standard deviations of study variables by condition over time are shown in Table 2. Relative to the control condition, the intervention resulted in significant improvements in employees' actigraphy-measured total sleep time (γ = 8.17, $t = 2.07$, $P = .041$) and reported sleep insufficiency (γ = −0.25, $t = -3.11$, $P = .002$) at follow-up. Significant intervention-by-time interactions for respective models are shown in Table 3. Intervention participants demonstrated an average of 8 minutes more total sleep time per night (approximately 1 hour per week increase in sleep) and an average of 0.25 point lower sleep insufficiency ratings (5-point scale) compared to control participants (Fig. 4). Although parameter estimates were in the anticipated direction, the intervention did not have a significant impact on changes in actigraphy-measured WASO (γ = 1.31, $t = 1.15$, $P = .25$) or reported insomnia symptoms (γ = −0.01, $t = -0.20$, $P = .85$) at follow-up.

Path modeling (Fig. 5) examined whether proximal changes in control over work hours led to distal changes in work-family conflict [see Ref [67]] at 6 months, serving as mediating variables for the effects of the intervention on changes in sleep outcomes at 12 months. We observed a significant indirect effect of the intervention on changes

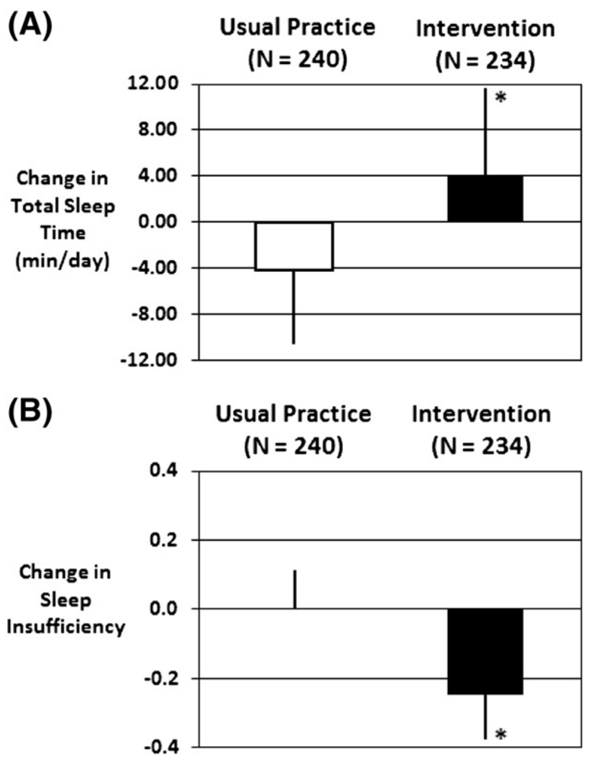

Fig. 4. Effects of the intervention on sleep. Adjusted mean changes in (A) actigraphic measures of sleep duration in minutes per day ± SE of the change and (B) mean changes in self-reported sleep insufficiency ± SE of the change. Sleep insufficiency was a self-report of never or rarely feeling rested upon awakening in the past month.

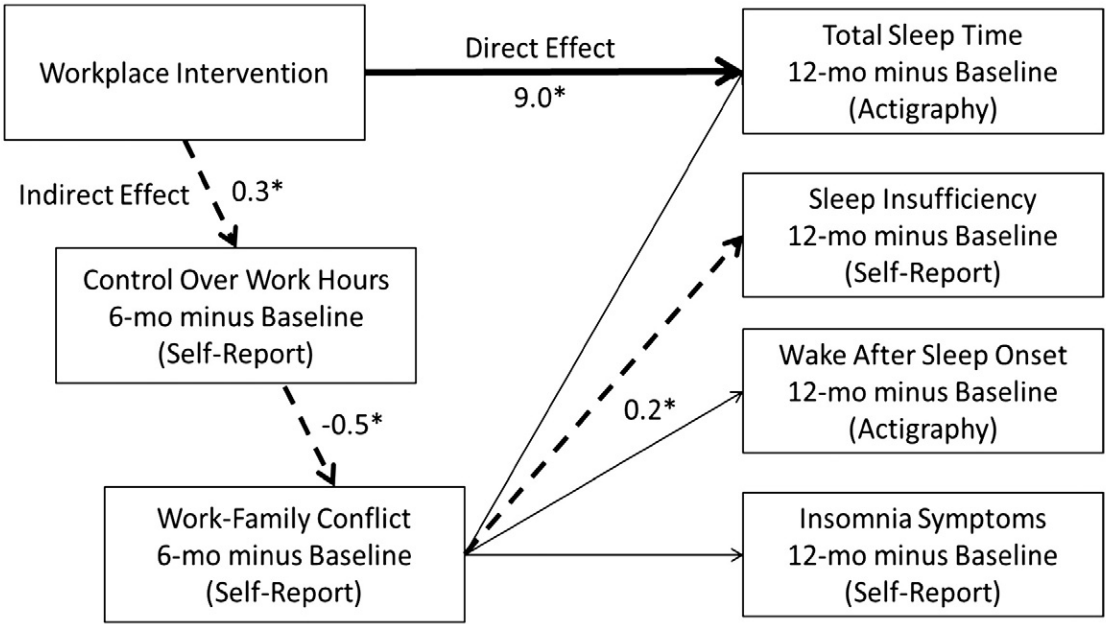

Fig. 5. Intervention path model: reduced sleep insufficiency at 12 months fully mediated by increased control over work hours and reduced work-family conflict at 6 months (n = 456). Significant direct effects of the intervention on actigraphic total sleep time (9 min/d in the path analysis) were not mediated by these intervention targets. Dashed bold arrow depicts significant indirect effects (mediation), whereas solid bold arrow depicts significant direct effects. Black arrows = ns. $^{*}P < .05$.

in self-reported sleep insufficiency through increases in control over work hours and subsequent reductions in work-family conflict (full mediation; indirect effect, −0.03; Z = −2.75; $P = .01$; see Fig. 5). Path modeling confirmed the significant direct effects of the intervention on actigraphy-based total sleep time.

In qualitative interviews, employees also offered examples of how the intervention had helped them improve their sleep. In interviews conducted after the intervention, sleep was mentioned in 27 of 128 interviews (21%, combining 9- and 15-month rounds of interviews). A theme observed in these qualitative data was how control over work time allowed employees to adjust their sleep for a better fit with acute and chronic demands. For example, 1 employee said, "I don't have to get up at 5 o'clock to leave the house at seven, I can get up at a quarter to seven and be online, or sleep until ten till 8 or whatever…" Another employee reported that before the intervention she had to get up at 4:30 to get an early start at work and avoid evening rush hour traffic. After the intervention, she reported that "if I'm working from home I don't get up until 6:00 or 6:30 and I start working at 7:00… I think that's been extremely beneficial to me in that I do get more sleep than I've had in years."

Discussion

The current study was a randomized experimental evaluation of the effects of a workplace intervention on directly measured sleep outcomes 12 months after baseline. Relative to control, intervention employees increased total sleep time by an hour per week, and their perceptions of sleep insufficiency improved. Sleep insufficiency changes were mediated by increases in control over work hours and reductions in work-family conflict, which were intervention change targets. Various interventions with other populations have increased actigraphy-measured total sleep time, including delayed school start times in children,[68] medical resident work hour scheduling,[16] and a variety of pharmacological and behavioral treatments in insomniacs.[69] In contrast, the current study evaluated the effects of an intervention on actigraphy-measured total sleep time among working adults in a stressful occupation. Our findings suggest that there is potential to improve sleep duration in the general US population, a federal priority articulated in *Healthy People 2020*,[11] by addressing environmental and contextual causes of insufficient sleep, particularly within workplace psychosocial environments.

Our Work, Family, and Health Network (WFHN) intervention was informed by the theoretical expectation that increases in (*a*) employee control over work time and (*b*) supervisor support for integrating work and nonwork demands would reduce work-family conflict.[30] Decreases in work-family conflict would, in turn, be expected to improve employee health outcomes, including sleep.[70] The current project used a transdisciplinary research model, as previously described,[49] to test the hypothesis that the WFHN intervention would improve employee sleep quantity and quality and that intervention effects on sleep would be partially mediated by reductions in work-family conflict. We observed full mediation of intervention effects on perceived sleep sufficiency via reductions in control over work hours and work-family conflict. However, the significant direct effect of the intervention on total sleep time was not mediated by these particular work-related resources and stressors, suggesting that factors other than control over work hours and work-family conflict mediated this direct intervention effect. We also observed no direct intervention effects on WASO or insomnia symptoms. A potential explanation for these null results is that the intervention did not create sufficiently large reductions in work-family conflict to impact WASO or insomnia symptoms. It is also possible that work-family conflict is simply unrelated to these metrics of sleep quality; however, a number of prior studies show positive relationships between work-family conflict and sleep problems.[39,40,71,72]

Clinical and health implications of findings

The intervention's main effect of 8 minutes more sleep per day (or ~ 1 hour more sleep per week) relative to the control condition is socially important and may have clinically significant health benefits over time. The clinical health benefits of an extra hour of sleep per week are not clearly known, but an extra hour is important at the population level, especially because work-related factors remain important predictors of sleep even after controlling for home-based factors.[39] CDC analyses of 2010 National Health Interview Survey data revealed that 30.0% of employed US civilian adults report short sleep duration (≤6 hours/day), with significant variation by sector.[73] *Healthy People 2020* articulates a federal goal of increasing the proportion of Americans receiving adequate sleep by 1%,[11] an uphill battle in the face of increasing short sleep among employed US adults.[74] The full mediation of the intervention effect on sleep sufficiency via reductions in control over work hours and work-family conflict suggests that we should also expect other generalized benefits of reduced work stress for employees and employers, such as improved health and reduced absenteeism/turnover. If a collectively administered workplace intervention, such as the group-level WFHN intervention, was enhanced with an individual-level sleep intervention component at work or elsewhere, even larger effects might be anticipated. Indeed, CDC/National Institute for Occupational Safety and Health (NIOSH) has also identified the workplace as a locus of sleep interventions, concluding that "further explorations of the relationship between work and sleep are needed."[73]

Workplace implications

We believe that these findings would generalize to at least other professional, knowledge work environments where employees could be given greater control over work time. As described in detail elsewhere, stressors in the environment included a project-oriented and deadline-driven work culture including coordination with co-workers overseas and job insecurity common in the US workforce with occasional "right-sizing" of the workforce and trends for offshoring of some functions.[75] In terms of work hours, we compared our sample (nonsupervisory employees who participated in the baseline survey) with IT employees as well as other professional employees using the Current Population Survey.[76] Employees put in slightly longer hours on the job (45 hours per week) than the average national average IT workers (43 hours per week) and those in other professional jobs (43 hours per week). Approximately 29% work at least 50 hours per week, whereas the corresponding figure is 16% for IT employees and 19% for other professional employees at the national level. Future studies are needed to replicate and expand upon these findings in other contexts.

Strengths/limitations

Primary strengths of the study include the randomized controlled design, actigraphy-measured sleep outcomes, 1-year follow-up, qualitative and quantitative data, and a focus on working adults as the target population. Additional strengths include mediation analyses involving a target of the intervention collected at a separate, earlier time point from outcomes. Limitations include using only 2 weeks of actigraphy per participant (minimum 3 valid days for each week-long recording) and the IT worker sample not representative of all workforces. Although actigraphy is superior to self-report data, the methodology has limitations and measurement error, including a particular weakness for detecting wakefulness during sleep.[60] Innovative aspects of study included the randomized and controlled design, intervening at the workplace to improve individual health outcomes and intervening at multiple levels (employee and manager) and over time to produce true cultural change. In our zeal to maintain a "pure" work-family focused workplace intervention, we did not also specifically intervene on individual health behaviors that were primary a priori outcomes. Future studies should, of course, take this combined approach and intervene at both organizational and individual levels, and we recognize this as a limitation of the study.

Conclusion

The current study, a randomized experimental evaluation of a work-family intervention, did not overtly address participant sleep as a part of the intervention process. Yet, after organizational and policy changes at the manager and team levels, employees' sleep time increased by an hour per week, as did perceptions of sleep sufficiency. Improvements in sleep sufficiency were fully mediated by reductions in control over work hours and work-family conflict, both targets of the intervention. Increasing family supportive supervision and employee control over work may reduce stress and improve sleep. Workplace interventions may be a particularly effective approach with sufficiently broad reach for achieving the *Healthy People 2020* goal to increase the number of adults who are getting sufficient sleep (US baseline, 69.6%; 2020 goal, 70.9%[11]). Work, although a source of financial security and fulfillment, has modifiable facets that may hinder a healthful lifestyle. In the current study, we modified work and improved measured sleep duration and perceived sleep sufficiency, strongly suggesting workplaces as foci for future sleep interventions.

Support

This research was conducted as part of the WFHN (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, and U01HD051276); National Institute on Aging (U01AG027669); Office of Behavioral and Social Sciences Research and National Institute for Occupational Safety and Health (U01OH008788 and U01HD059773). Grants from the National Heart, Lung and Blood Institute (R01HL107240), William T. Grant Foundation, Alfred P Sloan Foundation, and the Administration for Children and Families have 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.

Acknowledgments

Special acknowledgement goes to Extramural Staff Science Collaborator, Rosalind Berkowitz King, PhD, and Lynne Casper, PhD, for design of the original Workplace, Family, Health and Well-Being Network Initiative (responsible for generating and encompassing the WFHN). We wish to express our gratitude to the worksites, employers, and employees who participated in this research and made this publication possible. The National Institutes of Health, CDC, and other funders did not play a directive role in study design, conduct, reporting, or decision to submit a manuscript. We thank the members of the Biomarker and Actigraphy Data Coordinating Center, James H. Porter, Deirdre T. McLaren, Richard M. Lilienthal, and Chloe M. Beverly for assistance with data collection, scoring, and preparation of this manuscript and Rachel Magennis and Yagmur Karayaka for assistance with qualitative data.

Disclosures

Buxton (last 3 years): OMB reports research grant support from the National Institutes of Health; outside of the submitted work, investigator-initiated research grant support from Sepracor (now Sunovion) and Cephalon (now Teva); personal fees from Takeda Pharmaceuticals North America, Dinsmore LLC (expert witness testimony), Matsutani America (scientific advisory board), Wake

Forest University Medical Center (consulting); travel support and/or honoraria for speaking from American Academy of Craniofacial Pain; National Institute of Heart, Lung and Blood Institute; National Institute of Diabetes and Digestive and Kidney Diseases; National Postdoctoral Association; Oklahoma State University; Oregon Health Sciences University; SUNY Downstate Medical Center; American Diabetes Association; New York University; Academy of Nutrition and Dietetics; and Harvard T.H. Chan School of Public Health. All other authos have no conflicts of interest or disclosures to report.

References

1. Luyster FS, Strollo Jr PJ, Zee PC, Walsh JK. Sleep: a health imperative. *Sleep* 2012;35(6):727–34.
2. National Center on Sleep Disorders Research. National Institutes of Health Sleep Disorders Research Plan. Bethesda, MD: National Institutes of Health; 2011.
3. Buxton OM, Marcelli E. Short and long sleep are positively associated with obesity, diabetes, hypertension, and cardiovascular disease among adults in the United States. *Soc Sci Med* 2010;71(5):1027–36.
4. Cappuccio FP, D'Elia L, Strazzullo P, Miller MA. Quantity and quality of sleep and incidence of type 2 diabetes: a systematic review and meta-analysis. *Diabetes Care* 2010;33(2):414–20.
5. Wingard DL, Berkman LF. Mortality risk associated with sleeping patterns among adults. *Sleep* 1983;6(2):102–7.
6. Grandner MA, Hale L, Moore M, Patel NP. Mortality associated with short sleep duration: the evidence, the possible mechanisms, and the future. *Sleep Med Rev* 2010;14(3):191–203.
7. Cappuccio FP, Taggart FM, Kandala NB, Currie A, Peile E, Stranges S, et al. Meta-analysis of short sleep duration and obesity in children and adults. *Sleep* 2008;31(5):619–26.
8. McAllister EJ, Dhurandhar NV, Keith SW, Aronne LJ, Barger J, Baskin M, et al. Ten putative contributors to the obesity epidemic. *Crit Rev Food Sci Nutr* 2009;49(10):868–913.
9. Knutson KL, Van Cauter E. Associations between sleep loss and increased risk of obesity and diabetes. *Ann N Y Acad Sci* 2008;1129:287–304.
10. Committee on Sleep Medicine Research Board on Health Sciences Policy. Sleep disorders and sleep deprivation: an unmet public health problem. In: Colten HR, Alteveogt BM, editors. Washington, D.C: Institute of Medicine of the National Academies; The National Academies Press; 2006.
11. US Department of Health and Human Services. Healthy People 2020 Objective Topic Areas and Page Numbers. [updated 2011/01/04/; 300-1]. Available from: http://healthypeople.gov/2020/topicsobjectives2020/default.aspx; 2010.
12. Zee PC, Badr MS, Kushida C, Mullington JM, Pack AI, Parthasarathy S, et al. Strategic opportunities in sleep and circadian research: report of the Joint Task Force of the Sleep Research Society and American Academy of Sleep Medicine. *Sleep* 2014;37(2):219–27.
13. Takahashi M. Prioritizing sleep for healthy work schedules. *J Physiol Anthropol* 2012;31:6.
14. Sorensen G, Stoddard AM, Stoffel S, Buxton OM, Sembajwe G, Hashimoto D, et al. The role of the work context in multiple wellness outcomes for hospital patient care workers. *J Occup Environ Med* 2011;53(8):899–910.
15. Theorell T, Åkerstedt T. Day and night work: changes in cholesterol, uric acid, glucose and potassium in serum and in circadian patterns of urinary catecholamine excretion. *Acta Med Scand* 1976;200:47–53.
16. Lockley SW, Cronin JW, Evans EE, Cade BE, Lee CJ, Landrigan CP, et al. Effect of reducing interns' weekly work hours on sleep and attentional failures. *N Engl J Med* 2004;351(18):1829–37.
17. Chesley N. Technology use and employee assessments of work effectiveness, workload, and pace of life. *Inf Commun Soc* 2010;13(4):485–514.
18. Chesley N. Blurring boundaries? Linking technology use, spillover, individual distress, and family satisfaction. *J Marriage Fam* 2005;67:1237–48.
19. Park Y, Fritz C, Jex SM. Relationships between work-home segmentation and psychological detachment from work: the role of communication technology use at home. *J Occup Health Psychol* 2011;16(4):457–67.
20. Basner M, Fomberstein KM, Razavi FM, Banks S, William JH, Rosa RR, et al. American time use survey: sleep time and its relationship to waking activities. *Sleep* 2007;30(9):1085–95.
21. Major VS, Klein KJ, Ehrhart MG. Work time, work interference with family, and psychological distress. *J Appl Psychol* 2002;87(3):427–36.
22. Moen P, Kelly EL, Lam J. Healthy work revisited: do changes in time strain predict well-being? *J Occup Health Psychol* 2013;18(2):157–72.
23. Roxburgh S. "There just aren't enough hours in the day": the mental health consequences of time pressure. *J Health Soc Behav* 2004;45(2):115–31.
24. Hartfiel N, Havenhand J, Khalsa SB, Clarke G, Krayer A. The effectiveness of yoga for the improvement of well-being and resilience to stress in the workplace. *Scand J Work Environ Health* 2010;37(1):70–6.
25. Brand S, Holsboer-Trachsler E, Naranjo JR, Schmidt S. Influence of mindfulness practice on cortisol and sleep in long-term and short-term meditators. *Neuropsychobiology* 2012;65(3):109–18.
26. Kozasa EH, Hachul H, Monson C, Pinto L, Garcia MC, Mello LE, et al. Mind-body interventions for the treatment of insomnia: a review. *Rev Brain Psiquiatr* 2010;32(4):437–43.
27. Hammer LB, Kossek EE, Anger WK, Bodner T, Zimmerman K. Clarifying work-family intervention process: the roles of work-family conflict and family supportive supervisor behaviors. *J Appl Psychol* 2011;96(1):134–50.
28. Moen P, Kelly EL, Tranby E, Huang Q. Changing work, changing health: can real work-time flexibility promote health behaviors and well-being? *J Health Soc Behav* 2011;52(4):404–29.
29. Taylor SE, Repetti RL, Seeman T. Health psychology: what is an unhealthy environment and how does it get under the skin? *Annu Rev Psychol* 1997;48:411–47.
30. King RB, Karuntzos GT, Casper LM, Moen P, Davis KD, Berkman L, et al. Work-family balance issues and work-leave policies. In: Gatchel RJ, Schultz IZ, editors. Handbook of occupational health and wellness. New York: Springer; 2013. p. 323–40.
31. Greenhaus JH, Beutell NJ. Sources of conflict between work and family roles. *Acad Manage Rev* 1985;10(1):76–88.
32. Bogan EC. Economics of the wider family. In: Marciano T, Sussman M, editors. Wider families: new traditional family forms. New York: Harworth Press; 1991. p. 9–27.
33. Bianchi SM, Casper LM, King RB, editors. Work, family, health and well-being. Mahwah, NJ: Lawrence Erlbaum; 2005.
34. Casper LM, Bianchi SM. Continuity and change in the american family: anchoring the future. Thousand Oaks, CA: Sage; 2002.
35. Bianchi S, Milkie MA. Work and family research in the first decade of the 21st century. *J Marriage Fam* 2010;72(3):705–25.
36. Moen P. It's about time: couples and careers. Ithaca, NY: Cornell University Press; 2003.
37. Moen P, Chesley N. Toxic job ecologies, time convoys, and work-family conflict: can families (re)gain control and life-course "fit". In: Korabik K, Lero DS, Whitehead DL, editors. Handbook of work-family integration: research, theory, and best practices. New York, NY: Elsevier; 2008.
38. Neal MB, Hammer LB. Working couples caring for children and aging parents: effects on work and well-being. Mahwah, NJ: Lawrence Erlbaum Associates; 2007.
39. Burgard SA, Ailshire JA. Putting work to bed: stressful experiences on the job and sleep quality. *J Health Soc Behav* 2009;50(4):476–92.
40. Maume DJ, Sebastian RA, Bardo AR. Gender differences in sleep disruption among retail food workers. *Am Sociol Rev* 2009;74:989–1007.
41. Barnes CM, Wagner DT, Ghumann S. Borrowing from sleep to pay work and family: expanding time-based conflict to the broader non-work domain. *Pers Psychol* 2012;65(4):789–819.
42. Barnes CM. Working in our sleep: sleep and self-regulation in organizations. *Organ Psychol Rev* 2012;2:234–57.
43. Berkman LF, Buxton OM, Ertel K, Okechukwu C. Manager's practices related to work-family balance predict employee cardiovascular risk and sleep duration in extended care settings. *J Occup Health Psychol* 2010;115(3):316–29.
44. Grzywacz JG. Work-family spillover and health during midlife: is managing conflict everything? *Am J Health Promot* 2000;14(4):236–43.
45. McSweeny T. Workplace flexibility at the White House. [7/18/2013]; Available from: http://www.whitehouse.gov/blog/2010/04/01/workplace-flexibility-white-house; 2010.
46. Hammer LB, Cullen JC, Neal MB, Sinclair RR, Shafiro MV. The longitudinal effects of work-family conflict and positive spillover on depressive symptoms among dual-earner couples. *J Occup Health Psychol* 2005;10(2):138–54.
47. Thomas L, Ganster D. Impact of family-supportive work variables on work-family conflict and strain: a control perspective. *J Appl Psychol* 1995;80(1):6–15.
48. Moen P, Fan W, Kelly EL. Team-level flexibility, work-home spillover, and health behavior. *Soc Sci Med* 2013;84:69–79.
49. Bray JW, Kelly E, Hammer LB, Almeida DM, Dearing JW, Berkowitz King R, et al. An integrative, multilevel, and transdisciplinary research approach to challenges of work, family, and health. Research Triangle Park, NC 2013. RTI Press publication No. MR-0024-1303.
50. Donner A, Klar N. Pitfalls of and controversies in cluster randomization trials. *Am J Public Health* 2004;94(3):416–22.
51. Murray DM, Varnell SP, Blitstein JL. Design and analysis of group-randomized trials: a review of recent methodological developments. *Am J Public Health* 2004;94(3):423–32.
52. Varnell SP, Murray DM, Janega JB, Blitstein JL. Design and analysis of group-randomized trials: a review of recent practices. *Am J Public Health* 2004;94(3):393–9.
53. MacKinnon DP. An introduction to statistical mediation analysis. New York, NY: Lawrence Erlbaum Associates; 2008.
54. Enders C. Applied missing data analysis. New York: Guilford; 2010.
55. Kossek EE, Hammer LB, Kelly E, Moen P. Designing work, family & health organizational change initiatives. *Organ Dyn* 2014;43:53–63.
56. Kelly EL, Moen P, Tranby E. Changing workplaces to reduce work-family conflict: schedule control in a white-collar organization. *Am Sociol Rev* 2011;76(2):265–90.
57. Gravina N, Olson R. Behavioral self monitoring: a new way to transfer training. *Train Dev* 2009;63(5):18.
58. Olson R, Winchester J. Behavioral self-monitoring of safety and productivity in the workplace: a methodological primer and quantitative literature review. *J Organ Behav Manage* 2008;28(1):9–74.

59. Korotisch WJ, Nelson-Gray RO. An overview of self-monitoring research in assessment and treatment. *Psychol Assess* 1999;11(4):415–25.
60. Marino MM, Li Y, Rueschman MN, Winkelman J, Ellenbogen J, Solet JM, et al. Measuring sleep: accuracy, sensitivity, and specificity of wrist actigraphy compared to polysomnography. *Sleep* 2013;36(11):1747–55.
61. Lauderdale DS, Knutson KL, Yan LL, Rathouz PJ, Hulley SB, Sidney S, et al. Objectively measured sleep characteristics among early-middle-aged adults: the CARDIA study. *Am J Epidemiol* 2006;164(1):5–16.
62. Buxton OM, Hopcia K, Sembajwe G, Porter JH, Dennerlein JT, Kenwood C, et al. Relationship of sleep deficiency to perceived pain and functional limitations in hospital patient care workers. *J Occup Environ Med* 2012;54(7):851–8.
63. Buxton OM, Quintiliani LM, Yang MH, Ebbeling CB, Stoddard AM, Pereira LK, et al. Association of sleep adequacy with more healthful food choices and positive workplace experiences among motor freight workers. *Am J Public Health* 2009;S 99:636–43.
64. Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance System Survey Questionnaire. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention; 2013.
65. Buysse DJ, Reynolds III CF, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh sleep quality index: a new instrument for psychiatric practice and research. *Psychiatry Res* 1989;28:193–213.
66. Netemeyer RG, Boles JS, McMurrian R. Development and validation of work-family conflict and family-work conflict scales. *J Appl Psychol* 1996;81(4):400–10.
67. Kelly EL, Moen P, Oakes M, Fan W. Changing work and work-family conflict in an information technology workplace: evidence from a group-randomized trial. *Am Sociol Rev* 2014;79(3):485–516.
68. Lufi D, Tzischinsky O, Hadar S. Delaying school starting time by one hour: some effects on attention levels in adolescents. *J Clin Sleep Med* 2011;7(2):137–43.
69. Sadeh A. The role and validity of actigraphy in sleep medicine: an update. *Sleep Med Rev* 2011;15(4):259–67.
70. Greenhaus JH, Allen TD, Spector PE. Health consequences of work-family conflict: the dark side of the work-family interface. In: Perrewe PL, Ganster DC, editors. Research in occupational stress and well-being. Amsterdam: JAI Press; 2006. p. 61–98.
71. Barnes CM, Wagner DT, Ghumman S. Borrowing from sleep to pay work and family: expanding time-based conflict to the broader non-work domain. *Pers Psychol* 2012;65:789–819.
72. Barnes CM, Ghumman S, Scott BA. Sleep and organizational citizenship behavior: the mediating role of job satisfaction. *J Occup Health Psychol* 2013;18(1):16–26.
73. Jacobsen HB, Reme SE, Sembajwe G, Hopcia K, Stoddard A, Kenwood C, et al. Work-family conflict, psychological distress, and sleep deficiency among patient care workers. *Workplace Health Saf* 2014;62(7):282–91.
Centers for Disease Control. Short sleep duration among workers—United States, 2010. *Morb Mortal Wkly Rep* 2014;61(16):281–5.
74. Knutson KL, Van Cauter E, Rathouz PJ, DeLeire T, Lauderdale DS. Trends in the prevalence of short sleepers in the USA: 1975-2006. *Sleep* 2010;33(1):37–45.
75. Moen P, Kaduk A, Kossek E, Hammer LB, Buxton OM, O'Donnell E, et al. Is work-family conflict a multi-level stressor linking job conditions to mental health? Evidence from the work, family and health network. In: Ammons SK, Kelly EL, editors. Research in the Sociology of Work: Work and Family in the New Economy. Bradford, U.K.: Emerald Publishing Group; 2015 Forthcoming.
76. IPUMS-CPS. ASEC supplement from IPUMS-CPS. [11/1/2014]; Available from: https://cps.ipums.org/cps/citation.shtml; 2010.