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Associations between poor sleep quality and stages of change of multiple health behaviors among participants of employee wellness program

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ABSTRACT

Objective. Using the Transtheoretical Model of behavioral change, this study evaluates the relationship between sleep quality and the motivation and maintenance processes of healthy behavior change.

Methods. The current study is an analysis of data collected in 2008 from an online health risk assessment (HRA) survey completed by participants of the Kansas State employee wellness program (N = 13,322). Using multinomial logistic regression, associations between self-reported sleep quality and stages of change (i.e. precontemplation, contemplation, preparation, action, maintenance) in five health behaviors (stress management, weight management, physical activities, alcohol use, and smoking) were analyzed.

Results. Adjusted for covariates, poor sleep quality was associated with an increased likelihood of contemplation, preparation, and in some cases action stage when engaging in the health behavior change process, but generally a lower likelihood of maintenance of the healthy behavior.

Conclusions. The present study demonstrated that poor sleep quality was associated with an elevated likelihood of contemplating or initiating behavior change, but a decreased likelihood of maintaining healthy behavior change. It is important to include sleep improvement as one of the lifestyle management interventions offered in EWP to comprehensively reduce health risks and promote the health of a large employee population.

Introduction

Chronic diseases, including heart diseases, cancer, and stroke, are the leading causes of death in the US (Heron, 2012). These diseases are prevalent and costly. The four major individual behavioral risk factors contributing to a significant proportion of deaths from these diseases are tobacco use, poor diet, lack of physical activities and alcohol overuse (Mokdad et al., 2004; Pronk et al., 2010). The worksite setting and the large, diverse, aging employee population (U.S. Bureau of Labor Statistics, 2014) provide opportunities to implement health promotion and disease prevention programs to reduce multiple individual risk factors and worksite environment-related risk factors (e.g. hazardous job exposures, high job demands) of these diseases (Sorensen et al., 2011). In addition, employers are interested in reducing the economic burden of unhealthy employees caused by high health care costs and illness-related loss of productivity due to absenteeism and presenteeism (i.e., decreased performance at work) (World Economic Forum, 2010).

Employee wellness programs (EWPs) are defined as organized, employer-sponsored programs that strive to promote a healthy lifestyle for employees, maintain or improve health and well-being, and prevent or delay the disease onset (Schoenman and Chockley, 2011). At their core, these programs offer assessment of participants' health risks (health risk assessment or HRA) and deliver tailored educational and lifestyle management interventions designed to lower the identified risk factors and improve health outcomes (Schoenman and Chockley, 2011). A recent report shows that in the U.S., 92% of employers with ≥200 employees offered EWPs in 2009 (Mattke et al., 2013). Larger employers offer more sophisticated EWPs, but mid-size and even smaller employers are quickly adopting them as well, because of accumulating evidence attesting to their effectiveness (Schoenman and Chockley, 2011). Research has shown that well-implemented EWPs can change employees' behaviors (e.g., smoking, exercise), improve their biometric risk profile and work productivity, reduce use of and spending for health care services, and achieve a positive return on investment of up to $4–6 per dollar spent (Berry et al., 2010; Mattke et al., 2013).

Among the employers offering a lifestyle management program in their EWP, the most frequently targeted behaviors are nutrition/weight-control activities (79%), smoking (77%), and fitness (72%) (Mattke et al., 2013). Almost no employers with an EWP offer an intervention to promote healthy sleep, despite strong evidence that

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sufficient sleep duration and adequate sleep quality are important health behavior domains (Colten and Altevogt, 2006; Zee et al., 2014). Poor sleep quality has been associated with obesity (Grandner et al., 2012), hypertension (Meng et al., 2013), diabetes (Byberg et al., 2012; Kita et al., 2012; Lou et al., 2012), and a host of other adverse health outcomes (Grandner, 2014). In particular, poor sleep quality (especially in the context of insomnia) has been identified as a major risk factor for poor mental health (Baglioni et al., 2011; Baglioni and Riemann, 2012; Baglioni et al., 2010; Spiegelhalder et al., 2013). Thus, sleep quality appears to represent a neglected domain of health behavior in the context of EWP.

Because sleep quality impacts such a broad range of health outcomes, poor sleep quality may have indirect effects on other aspects of health, such as health behaviors. Some of the adverse health effects of poor sleep quality may involve direct biological mechanisms, such as dysregulation of insulin/glucose (Knutson et al., 2007; Pyykkonen et al., 2012; Yamamoto et al., 2010), metabolic hormones (Kjeldsen et al., 2014; Motivala et al., 2009; Zimberg et al., 2012), neuroendocrine stress systems (Meerlo et al., 2008), and neurocognitive functions (Banks and Dinges, 2007; Drummond et al., 2004), but other effects on health may be indirect through health behaviors. There is evidence to suggest that poor sleep quality may impair an individual's ability to initiate and/or maintain healthy behaviors, including healthy patterns of eating (Knutson et al., 2007; St-Onge, 2013), physical activity (Baron et al., 2013), alcohol intake (Chakravorty et al., 2013), smoking (Cohrs et al., 2014; Jaehne et al., 2012), and stress management (Kashani et al., 2012; Soderstrom et al., 2012).

However, no studies have been conducted to examine these relations from the view of health behavior change process. Therefore, the present study evaluates the relationship between sleep quality and the motivation and maintenance stages of healthy behavioral changes, according to the Transtheoretical Model of Behavior Change (TTM). We chose the TTM to examine these relationships because it seeks to include and integrate key constructs from other health behavior change theories into a comprehensive theory of change that can be applied to a variety of behaviors and populations (Prochaska and DiClemente, 1982; Prochaska et al., 1992). One major concept of the TTM is that behavior change is a process, not an event. As an individual attempts to change a behavior, he/she moves through the five stages of change: precontemplation, contemplation, preparation, action, and maintenance (see Table 1 for their definitions) (Prochaska and DiClemente, 1983). These stages of change in TTM and their measures have been well-researched and validated in health behavior change process literature (Prochaska et al., 2008).

Adopting the TTM framework and based on some evidence from previous studies that poor sleep quality is significantly related to healthcare seeking in primary care setting (Baran and Chervin, 2009; Mold et al., 2011; Senthilvel et al., 2011), which may indicate a higher motivation to get well, we hypothesized that poor sleep quality would be associated with increased likelihood of being motivated to engage in healthy behavior change (i.e. in contemplation, preparation, or action stages) to improve one's own health. This may be because sleep disturbances are unpleasant and lead to a broad spectrum of impairments in many aspects of daytime function, but they are typically not so debilitating that they limit the ability of individuals to engage in healthy behavioral change. Thus, they may be a consistent reminder of poor health, which may motivate change. Individuals with poor sleep quality may be motivated to compensate for their unhealthy behavior by engaging in a healthy behavior (Knäuper et al., 2004).

In contrast, based on the preliminary evidence that poor sleep quality is associated with other unhealthy lifestyle behaviors (Baron et al., 2013; Chakravorty et al., 2013; Cohrs et al., 2014; Jaehne et al., 2012; Kashani et al., 2012; Knutson et al., 2007; Soderstrom et al., 2012; St-Onge, 2013), we hypothesized poor sleep quality would be associated with decreased likelihood of maintaining the healthy behavior change (i.e. the maintenance stage of change). This may be because although sleep disturbances may be more mildly uncomfortable and do not drastically limit daytime function (mentioned above), the cumulative effects on energy level, emotion regulation, decision making, and other processes may inhibit an individual's ability to maintain healthy behaviors in the face of normal challenges (Matteson-Rusby et al., 2010). Thus, like mild chronic pain, the effects of poor sleep quality may be uncomfortable and pervasive enough to motivate an individual to alleviate the discomfort but may also serve to limit an individual's ability to maintain healthy behaviors (Rabbitts et al., 2014). Using a large EWP dataset to explore this research question, the current study addresses the knowledge gap of how sleep quality may relate to stage of change progression in the health behaviors change process among EWP participants.

Table 1
Stages of change and their definitions from the Transtheoretical Model of behavioral change.

Stage	Definition
Precontemplation	Has no intention of taking action within the next 6 months
Contemplation	Intends to take action in the next 6 months
Preparation	Intends to take action within the next 30 days and has taken some behavioral steps in this direction
Action	Has changed behavior for less than 6 months
Maintenance	Has changed behavior for more than 6 months

Materials and methods

The current study is an analysis of data collected in 2008 from an online HRA survey conducted as part of the EWP used by Kansas state employees. The data were obtained through a data use agreement between the University of Kansas Medical Center and the Kansas Health Policy Authority in 2010. Data included the basic personnel data of all eligible participants and complete responses of all HRA participants. Eligible participants of the Kansas State EWP were the employees enrolled in the state health plans. Each individual in these files had a unique alpha-numerical identifier. Because the coding of the numerical identifier was unknown to the authors, these data were not considered as personally identifiable, and it was deemed exempt by the Human Subjects Committee at the University of Kansas Medical Center.

Participants

The participants of this study were Kansas state employees and their dependents who completed a standard online HRA in 2008. Among the eligible 60,594 employees and their dependents, 13,322 (22%) of them completed the HRA and their responses were analyzed. This HRA participation rate is typical among EWPs (Mattke et al., 2013) and since the participation rate in the present study is in line with that of most other studies, the data are likely to be at least as representative as is the standard in the literature. Furthermore, since the Kansas state EWP is a large program that encompasses many industries (e.g., education, transportation, healthcare, administration), the data from the present study is likely to generalize to multiple industries. Previous studies reported that when participation rates are lower than 30%, female workers are more likely to participate in worksite health promotion programs, though no other systematic demographic differences (e.g. age, race/ethnicity, marital status, education, income level) between participants and non-participants were consistently found (Lewis et al., 1996; Robroek et al., 2009) using Chi-square, *t*-tests or meta-analysis techniques (e.g. Cohen's d). This was also the case in our study population.

Measures

Sleep quality was assessed with the question, “During the past 4 weeks, how often have you been bothered by any of the following

Table 2
Characteristics of the sample (N = 13,322).

Variable	Category	Complete Sample	Stratified by sleep quality (measured by frequency of trouble sleeping)					
			Never	Seldom	Sometimes	Often	Always	*p*
Stage of change: stress	Precontemplation	14.07%	15.75%	14.41%	12.40%	12.02%	9.56%	<.0001
	Contemplation	10.63%	7.83%	8.89%	12.52%	18.67%	18.87%	
	Preparation	18.37%	14.66%	17.61%	21.68%	25.32%	24.51%	
	Action	19.61%	16.87%	19.32%	22.80%	21.81%	25.74%	
	Maintenance	37.32%	44.89%	39.77%	30.60%	22.18%	21.32%	
Stage of change: weight	Precontemplation	4.94%	5.45%	4.84%	4.75%	4.44%	1.74%	<.0001
	Contemplation	15.21%	13.32%	14.43%	16.86%	19.26%	22.33%	
	Preparation	32.99%	31.36%	33.70%	34.21%	36.07%	32.75%	
	Action	29.82%	29.73%	29.26%	30.49%	29.75%	30.27%	
	Maintenance	17.04%	20.14%	17.77%	13.71%	10.48%	12.90%	
Stage of change: physical Activity	Precontemplation	4.68%	4.88%	4.19%	4.81%	4.06%	6.03%	<.0001
	Contemplation	12.21%	11.12%	11.28%	12.83%	15.90%	18.56%	
	Preparation	35.93%	34.05%	37.06%	37.96%	37.42%	35.96%	
	Action	27.58%	27.15%	27.62%	27.67%	29.13%	28.31%	
	Maintenance	19.59%	22.81%	19.85%	16.75%	13.48%	11.14%	
Stage of change: alcohol use	Precontemplation	30.75%	30.92%	30.75%	30.43%	31.78%	27.50%	<.0001
	Contemplation	3.75%	3.54%	3.31%	4.51%	3.33%	5.63%	
	Preparation	6.74%	5.35%	6.76%	8.25%	10.22%	7.50%	
	Action	10.91%	9.80%	10.07%	13.23%	11.56%	15.63%	
	Maintenance	47.86%	50.38%	49.12%	43.58%	43.11%	43.75%	
Stage of change: smoking	Precontemplation	19.07%	19.30%	19.18%	19.41%	17.43%	18.18%	<.0001
	Contemplation	17.46%	14.32%	15.57%	18.62%	26.65%	33.64%	
	Preparation	11.85%	9.27%	11.48%	15.49%	16.78%	10.00%	
	Action	13.12%	11.41%	13.37%	14.24%	16.12%	17.27%	
	Maintenance	38.50%	45.71%	40.41%	32.24%	23.03%	20.91%	
Age	Mean ± SD	44.46 ± 11.89	42.65 ± 12.36	45.47 ± 11.47	46.62 ± 11.15	45.10 ± 11.39	46.096 ± 10.484	<.0001
Sex	Female	63.46%	58.72%	62.95%	67.71%	73.61%	75.52%	<.0001
Race	Non-Hispanic White	86.33%	86.70%	86.02%	86.65%	86.30%	81.42%	<.0001
	Black/African-American	4.40%	3.80%	4.14%	4.47%	6.60%	7.57%	
	Hispanic/Latino	3.41%	3.27%	3.85%	3.27%	3.47%	3.21%	
	Native American	2.58%	1.97%	2.87%	3.20%	2.39%	5.28%	
	Asian/Other	3.28%	4.27%	3.12%	2.410%	1.24%	2.52%	
Education	Post-graduate	25.06%	27.87%	26.54%	21.77%	17.82%	19.22%	<.0001
	College graduate	32.65%	33.85%	33.54%	31.74%	29.46%	25.63%	
	Some college	27.74%	25.32%	26.65%	29.09%	36.22%	35.24%	
	High school	13.67%	12.00%	12.75%	16.61%	15.18%	18.54%	
	Less than high school	0.88%	0.97%	0.53%	0.79%	1.32%	1.37%	
Income	$100,000+	2.13%	2.57%	2.37%	1.66%	0.99%	0.79%	<.0001
	$85,001–$100,000	1.89%	2.54%	1.48%	1.43%	1.19%	0.79%	
	$55,001–$85,000	14.16%	15.25%	15.87%	13.14%	9.04%	8.42%	
	$35,001–$55,000	39.57%	39.94%	41.52%	38.79%	35.85%	36.58%	
	$20,001–$35,000	34.85%	32.18%	32.87%	36.82%	44.09%	46.58%	
	$0–$20,000	7.40%	7.53%	5.90%	8.15%	8.84%	6.84%	

problems?" with "Trouble Sleeping" as one item. The response choices were "Never," "Seldom," "Sometimes," "Often," and "Always".

The stage of change for health behaviors was measured by a standard question on the HRA based on the TTM (Prochaska et al., 2009; Prochaska et al., 2008). The general question was: "Right now, are you planning to make any of the following changes to keep yourself healthy or improve your health?" Immediately following the general question, a more specific sub-question indicated the particular health behavior that was assessed. The behaviors of interest included: "Limiting the amount of alcohol," "Increase physical activity or exercise," "Quit or cut down smoking," "Cope or deal with stress better," and "Lose weight."

According to the TTM, stage of change for each of the health behavior domains presented was measured by different responses (DiClemente et al., 1991). Respondents indicated "No, I don't plan to make a change" (coded as precontemplation); "Yes, in the next 6 months" (coded as contemplation); "Yes, in the next 30 days" (coded as preparation); "I have recently made a healthy change in this area" (coded as action); or "I am already maintaining healthy activities in this area" (coded as maintenance). Some respondents indicated "not needed" on these questions, either because they had no history with the target health behavior problem or other unclear meaning about their stage of change. To avoid confusion, and because it is unclear which stage of change this response category can be attributed to, these respondents were excluded from the analysis. In this paper, the focus was on the major health behaviors that contribute to most preventable chronic diseases and which are associated with leading causes of death (Mokdad et al., 2004).

Covariates included age, sex, race/ethnicity (Non-Hispanic White, Black/African-American, Hispanic/Latino, Native American, and Asian/Other), education, and income category. These covariates were chosen because previous studies have shown that they are associated with sleep (Grandner et al., 2013b; Whinnery et al., 2014) in the context of health behavior.

Procedure

An internet-based portal for the Kansas State EWP was open during the months of March to September in 2008 for eligible participants to log on and complete their HRA. Because some questions on the HRA asked for clinical data, it was recommended that participants obtain these data from their worksite biometric screening first and then enter into the HRA questionnaire. However, participants could also obtain the clinical data from their primary care doctor's visit. Participants received an incentive of $50 gift card if they completed both the HRA and the worksite biometric screening. Immediately after completing the online HRA, participants received their electronic personalized disease risk feedback and preventive care recommendations, that is, the HRA feedback. Lifestyle risk factors and recommendations on changing them are usually on the HRA feedback.

Table 3
Multinomial logistic regression analyses between sleep quality categories and stages of change.

Variable	Sleep quality	Unadjusted		Adjusted	
		RRR (95% CI)	p	RRR (95% CI)	p
Stage of change: stress management					
Contemplation	Never	Reference		Reference	
	Seldom	1.24 (1.00, 1.53)	0.0453	1.30 (1.04, 1.63)	0.0222
	Sometimes	**2.03 (1.66, 2.48)**	**<.0001**	**2.10 (1.69, 2.62)**	**<.0001**
	Often	**3.13 (2.42, 4.03)**	**<.0001**	**2.55 (1.92, 3.37)**	**<.0001**
	Always	**3.97 (2.65, 5.96)**	**<.0001**	**3.32 (2.14, 5.13)**	**<.0001**
	*Linear trend**	*1.46 (1.37, 1.56)*	*<.0001*	*1.40 (1.30, 1.50)*	*<.0001*
Preparation	Never	Reference		Reference	
	Seldom	**1.31 (1.10, 1.57)**	**0.0024**	**1.36 (1.13, 1.64)**	**0.0013**
	Sometimes	**1.88 (1.58, 2.23)**	**<.0001**	**1.98 (1.64, 2.38)**	**<.0001**
	Often	**2.26 (1.79, 2.86)**	**<.0001**	**2.08 (1.62, 2.68)**	**<.0001**
	Always	**2.75 (1.87, 4.05)**	**<.0001**	**2.47 (1.64, 3.71)**	**<.0001**
	*Linear trend**	*1.32 (1.25, 1.40)*	*<.0001*	*1.31 (1.23, 1.39)*	*<.0001*
Action	Never	Reference		Reference	
	Seldom	1.25 (1.05, 1.48)	0.0103	1.25 (1.04, 1.50)	0.0192
	Sometimes	**1.72 (1.45, 2.03)**	**<.0001**	**1.68 (1.39, 2.02)**	**<.0001**
	Often	**1.69 (1.34, 2.15)**	**<.0001**	**1.49 (1.15, 1.92)**	**0.0024**
	Always	**2.51 (1.72, 3.68)**	**<.0001**	**2.04 (1.36, 3.07)**	**0.0006**
	*Linear trend**	*1.25 (1.18, 1.32)*	*<.0001*	*1.20 (1.13, 1.28)*	*<.0001*
Maintenance	Never	Reference		Reference	
	Seldom	0.97 (0.83, 1.12)	0.6699	0.94 (0.80, 1.10)	0.4336
	Sometimes	0.87 (0.74, 1.01)	0.0680	0.83 (0.70, 0.98)	0.0304
	Often	**0.65 (0.51, 0.81)**	**0.0002**	**0.58 (0.45, 0.74)**	**<.0001**
	Always	0.78 (0.53, 1.15)	0.2143	0.64 (0.43, 0.98)	0.0375
	*Linear trend**	*0.91 (0.86, 0.96)*	*0.0004*	*0.88 (0.83, 0.93)*	*<.0001*
Stage of change: weight management					
Contemplation	Never	Reference		Reference	
	Seldom	1.22 (0.95, 1.57)	0.1143	1.13 (0.87, 1.47)	0.3690
	Sometimes	**1.45 (1.14, 1.85)**	**0.0026**	1.26 (0.97, 1.65)	0.0834
	Often	**1.78 (1.26, 2.51)**	**0.0012**	1.57 (1.07, 2.30)	0.0218
	Always	**5.26 (2.41, 11.50)**	**<.0001**	**4.99 (1.99, 12.52)**	**0.0006**
	*Linear trend**	*1.27 (1.17, 1.38)*	*<.0001*	*1.21 (1.10, 1.32)*	*0.0001*
Preparation	Never	Reference		Reference	
	Seldom	1.21 (0.96, 1.52)	0.1010	1.14 (0.89, 1.46)	0.3031
	Sometimes	1.25 (1.00, 1.57)	0.0518	1.13 (0.89, 1.45)	0.3202
	Often	1.41 (1.02, 1.96)	0.0398	1.27 (0.88, 1.83)	0.2048
	Always	**3.28 (1.52, 7.08)**	**0.0026**	**3.45 (1.39, 8.57)**	**0.0076**
	*Linear trend**	*1.16 (1.07, 1.25)*	*0.0004*	*1.12 (1.02, 1.22)*	*0.0142*
Action	Never	Reference		Reference	
	Seldom	1.11 (0.88, 1.40)	0.3786	1.00 (0.78, 1.28)	0.9905
	Sometimes	1.18 (0.94, 1.48)	0.1602	1.02 (0.80, 1.31)	0.8676
	Often	1.23 (0.88, 1.71)	0.2246	0.93 (0.64, 1.34)	0.6861
	Always	**3.20 (1.48, 6.92)**	**0.0032**	2.94 (1.18, 7.32)	0.0204
	*Linear trend**	*1.12 (1.04, 1.22)*	*0.0044*	*1.04 (0.96, 1.14)*	*0.3367*
Maintenance	Never	Reference		Reference	
	Seldom	0.99 (0.78, 1.26)	0.9626	0.94 (0.72, 1.22)	0.6338
	Sometimes	0.78 (0.61, 1.00)	0.0470	0.72 (0.55, 0.94)	0.0157
	Often	0.64 (0.44, 0.92)	0.0166	0.61 (0.41, 0.92)	0.0174
	Always	2.01 (0.90, 4.47)	0.0873	1.95 (0.76, 5.00)	0.1673
	*Linear trend**	*0.93 (0.86, 1.02)*	*0.1182*	*0.91 (0.82, 1.00)*	*0.0434*
Stage of change: physical activity					
Contemplation	Never	Reference		Reference	
	Seldom	1.18 (0.91, 1.52)	0.2073	1.17 (0.89, 1.55)	0.2544
	Sometimes	1.17 (0.92, 1.49)	0.2048	1.15 (0.88, 1.50)	0.2984
	Often	**1.72 (1.21, 2.44)**	**0.0025**	1.57 (1.06, 2.31)	0.0233
	Always	1.35 (0.85, 2.15)	0.2068	1.26 (0.74, 2.17)	0.3990
	*Linear trend**	*1.13 (1.04, 1.22)*	*0.0039*	*1.11 (1.01, 1.21)*	*0.0305*
Preparation	Never	Reference		Reference	
	Seldom	1.26 (1.01, 1.59)	0.0452	1.23 (0.96, 1.57)	0.1064
	Sometimes	1.13 (0.91, 1.41)	0.2717	1.12 (0.88, 1.43)	0.3613
	Often	1.32 (0.95, 1.83)	0.0967	1.21 (0.84, 1.75)	0.2959
	Always	0.85 (0.55, 1.32)	0.4744	0.90 (0.54, 1.49)	0.6831
	*Linear trend**	*1.04 (0.96, 1.12)*	*0.3217*	*1.03 (0.95, 1.12)*	*0.4613*
Action	Never	Reference		Reference	
	Seldom	1.18 (0.94, 1.49)	0.1598	1.12 (0.87, 1.44)	0.3790
	Sometimes	1.03 (0.83, 1.29)	0.7703	0.98 (0.76, 1.25)	0.8433
	Often	1.29 (0.92, 1.79)	0.1348	1.01 (0.70, 1.47)	0.9446
	Always	0.84 (0.54, 1.31)	0.4478	0.76 (0.45, 1.28)	0.3055
	*Linear trend**	*1.02 (0.95, 1.10)*	*0.5916*	*0.98 (0.90, 1.06)*	*0.5760*
Maintenance	Never	Reference		Reference	
	Seldom	1.01 (0.80, 1.28)	0.9251	0.96 (0.74, 1.25)	0.7741
	Sometimes	0.74 (0.59, 0.94)	0.0125	0.74 (0.57, 0.96)	0.0218

(continued on next page)

Table 3 (*continued*)

Variable	Sleep quality	Unadjusted		Adjusted	
		RRR (95% CI)	*p*	RRR (95% CI)	*p*
	Often	0.71 (0.50, 1.01)	0.0554	0.67 (0.46, 0.99)	0.0465
	Always	**0.39** (**0.24**, **0.65**)	**0.0002**	**0.41** (**0.23**, **0.73**)	**0.0024**
	*Linear trend**	*0.85* (*0.79*, *0.92*)	*0.0001*	*0.85* (*0.77*, *0.93*)	*0.0003*
Stage of change: alcohol use					
Contemplation	Never	Reference		Reference	
	Seldom	0.94 (0.641, 1.371)	0.7404	0.97 (0.639, 1.463)	0.8749
	Sometimes	1.29 (0.913, 1.834)	0.1474	1.34 (0.913, 1.954)	0.1365
	Often	0.92 (0.516, 1.623)	0.7614	1.05 (0.573, 1.937)	0.8671
	Always	1.78 (0.844, 3.770)	0.1293	1.97 (0.911, 4.261)	0.0850
	*Linear trend**	*1.08* (*0.96*, *1.23*)	*0.1983*	*1.12* (*0.98*, *1.28*)	*0.0979*
Preparation	Never	Reference		Reference	
	Seldom	1.27 (0.949, 1.700)	0.1076	1.22 (0.893, 1.656)	0.2153
	Sometimes	**1.57** (**1.184**, **2.069**)	**0.0016**	**1.60** (**1.189**, **2.145**)	**0.0019**
	Often	**1.86** (**1.274**, **2.708**)	**0.0013**	1.68 (1.100, 2.571)	0.0164
	Always	1.58 (0.812, 3.055)	0.1792	1.53 (0.761, 3.083)	0.2325
	*Linear trend**	*1.20* (*1.09*, *1.32*)	*0.0001*	*1.19* (*1.07*, *1.31*)	*0.0010*
Action	Never	Reference		Reference	
	Seldom	1.03 (0.811, 1.315)	0.7930	1.09 (0.847, 1.410)	0.4937
	Sometimes	**1.37** (**1.092**, **1.722**)	**0.0066**	**1.38** (**1.082**, **1.767**)	**0.0095**
	Often	1.15 (0.811, 1.622)	0.4386	1.11 (0.758, 1.621)	0.5938
	Always	1.79 (1.076, 2.985)	0.0251	1.63 (0.949, 2.798)	0.0768
	*Linear trend**	*1.12* (*1.04*, *1.21*)	*0.0048*	*1.11* (*1.02*, *1.21*)	*0.0178*
Maintenance	Never	Reference		Reference	
	Seldom	0.98 (0.842, 1.142)	0.7999	0.96 (0.816, 1.127)	0.6118
	Sometimes	0.880 (0.752, 1.027)	0.1047	0.85 (0.715, 0.999)	0.0480
	Often	0.83 (0.660, 1.051)	0.1233	0.85 (0.656, 1.093)	0.2026
	Always	0.98 (0.663, 1.438)	0.9039	0.88 (0.582, 1.327)	0.5389
	*Linear trend**	*0.95* (*0.90*, *1.01*)	*0.0805*	*0.94* (*0.89*, *1.00*)	*0.0452*
Stage of change: smoking					
Contemplation	Never	Reference		Reference	
	Seldom	1.09 (0.79, 1.51)	0.5905	1.11 (0.79, 1.58)	0.5425
	Sometimes	1.29 (0.94, 1.77)	0.1093	1.22 (0.87, 1.72)	0.2425
	Often	**2.06** (**1.39**, **3.06**)	**0.0003**	**1.91** (**1.24**, **2.94**)	**0.0034**
	Always	**2.49** (**1.40**, **4.43**)	**0.0019**	**2.70** (**1.41**, **5.17**)	**0.0026**
	*Linear trend**	*1.25* (*1.13*, *1.38*)	*<.0001*	*1.24* (*1.11*, *1.38*)	*0.0001*
Preparation	Never	Reference		Reference	
	Seldom	1.25 (0.87, 1.79)	0.2335	1.25 (0.85, 1.83)	0.2649
	Sometimes	**1.66** (**1.18**, **2.34**)	**0.0035**	1.55 (1.08, 2.24)	0.0184
	Often	**2.00** (**1.29**, **3.12**)	**0.0020**	1.46 (0.90, 2.39)	0.1277
	Always	1.15 (0.53, 2.47)	0.7286	1.11 (0.48, 2.58)	0.8083
	*Linear trend**	*1.19* (*1.07*, *1.33*)	*0.0018*	*1.12* (*0.99*, *1.27*)	*0.0622*
Action	Never	Reference		Reference	
	Seldom	1.18 (0.84, 1.66)	0.3485	1.08 (0.75, 1.55)	0.6921
	Sometimes	1.24 (0.89, 1.74)	0.2102	1.04 (0.72, 1.50)	0.8311
	Often	1.56 (1.01, 2.42)	0.0455	1.29 (0.80, 2.08)	0.3027
	Always	1.61 (0.83, 3.11)	0.1589	1.16 (0.53, 2.54)	0.7081
	*Linear trend**	*1.14 (1.02, 1.27)*	*0.0201*	*1.05 (0.93, 1.19)*	*0.4046*
Maintenance	Never	Reference		Reference	
	Seldom	0.89 (0.68, 1.15)	0.3778	0.89 (0.67, 1.19)	0.4344
	Sometimes	**0.70** (**0.54**, **0.92**)	**0.0092**	0.76 (0.56, 1.01)	0.0610
	Often	**0.56** (**0.38**, **0.82**)	**0.0030**	0.68 (0.44, 1.04)	0.0768
	Always	0.49 (0.26, 0.90)	0.0217	0.68 (0.34, 1.39)	0.2964
	*Linear trend**	*0.83* (*0.76*, *0.91*)	*0.0001*	*0.88* (*0.80*, *0.98*)	*0.0169*

Statistical analyses

Univariate analyses examined sleep quality associated with stages of change using an omnibus chi-square test. The primary analyses included multinomial logistic regression analyses, with stage of change variable as outcome ("precontemplation" as reference) and sleep quality as predictor variable. First, these analyses assessed whether a linear trend for worsening sleep quality was associated with each stage of change variable (see the linear trend rows in Table 3). This approach allows for the assessment of whether the likelihood of any particular stage changes as sleep quality is better or worse (in a somewhat linear fashion). The strength of this approach is that sleep quality is a directional construct and this analysis allows for exploration of this aspect of sleep quality. The utility of this approach lies in the usefulness of understanding results in the context of "better" vs "worse" sleep.

Second, sleep quality was treated as a categorical variable ("never" as reference). This exploratory analysis allows for the investigation of which sleep categories were specifically associated with which stages of change, for which health behaviors (see results in Table 3). This approach complements the linear approach in that it recognizes that although sleep quality is a directional construct, the variable used is ordinal and, further, relationships may not be linear. For example, there may be threshold effects (e.g., results only evident when sleep quality is very poor). This analytic approach allows for the examination of each category of sleep quality separately to discern these effects. All analyses were repeated after adjustment for covariates.

p values < 0.01 were considered statistically significant, based on a family-wise cutoff of 0.01, based on 0.05/5 health behavior domains. All analyses were performed using STATA 12.0 software (College Station, TX).

Results

Characteristics of the sample

Sample characteristics are reported in Table 2. The base sample consisted of n = 13,322 individuals who provided data. When survey respondents were compared to those who did not respond, small differences were seen; respondents were nominally older (mean age 45 vs 42) and more likely to be female (63% vs 51%).

Sleep quality and stages of change

See Table 2 for distributions of outcomes and univariate analyses and Table 3 for regression results examining linear trends between sleep quality and stages of change, as well as the multinomial regression results by each health behavior category. Sample sizes for analyses were as follows: For stress management, n = 2257 individuals were excluded based on a "Not Needed" response and 1 had missing data, resulting in an analysis sample of n = 11,064. For weight management, n = 1673 individuals responded "Not Needed" and n = 1 was missing (final n = 11,648). For Physical Activity, n = 516 responded "Not Needed" and n = 1 was missing (final n = 12,805). For alcohol use, n = 7473 responded "Not Needed" and n = 1 was missing (final n = 5848). For Smoking, n = 10,326 responded "Not Needed" and n = 1 was missing (final n = 2995).

Regarding overall patterns of results, for stress management, worse sleep was associated with increased likelihood of contemplation, preparation, and action, and decreased likelihood of maintenance. For weight management, worse sleep quality was generally associated with increased likelihood of contemplation and preparation. For Physical Activity, overall, worse sleep quality was associated with decreased likelihood of maintaining healthy changes that were already made. For alcohol use, worse sleep quality was associated with engaging in preparation and action. Finally, for Smoking, worse sleep quality was associated with increased likelihood of contemplation. These results were based on analysis that excluded respondents who indicated "not needed" on any of the stage of change questions.

Discussion

The present study evaluated whether sleep quality was associated with stages of change of health behaviors, including domains of stress, weight, physical activity, alcohol, and smoking. Overall, poor sleep quality was associated with increased likelihood of contemplation, preparation and in some cases action, but lower likelihood of maintenance of some healthy behavioral changes. This suggests that poor sleep quality may motivate thinking about or even initiating healthy behavior change, but poor sleep quality may also hinder an individual's ability to maintain healthy behaviors. Because of the correlational nature of the present study, no causal interpretations of the present data can be made. It is possible, though, that the present data support directional hypotheses that could be explored in future studies. Extrapolations should thus be interpreted with appropriate caution.

Several previous studies have documented cross-sectional associations between poor sleep and the health behaviors investigated in the present study: weight control problem (Patel, 2009), high stress (Grandner et al., 2010), physical activity (Baron et al., 2013), alcohol use (Chakravorty et al., 2013; Perney et al., 2012), and smoking (Cohrs et al., 2014). Further, there have been investigations of potential causal mechanisms linking sleep and these behaviors, including diet (Grandner et al., 2013a, 2014), exercise (Reid et al., 2010), decision-making (Drummond et al., 2012; Killgore, 2010; Pace-Schott et al., 2012), and others. These studies suggest that these behaviors are somehow linked to sleep. But no previous studies have linked sleep to these health behaviors through investigating the behavioral motivation and maintenance stages of change.

Our findings suggest that poor sleep quality increases readiness and/or motivation for engaging in healthy behaviors (for example, being in a contemplation or preparation stage, relative to precontemplation) and engaging in behaviors (i.e. action stage). Poor sleep quality, even a non-specific complaint such as the one assessed in the present study, can serve as a warning indicating that something is wrong. For example, overall poor sleep quality is correlated highly with subclinical depressive symptoms (Grandner et al., 2006) and a recent study showed that 94% of US adults reported that "not getting enough sleep" impacts their daily functioning, including a wide range of domains such as mood, school work, family/home responsibilities, work responsibilities, social functioning, and even intimate/sexual functioning (Gradisar et al., 2013). If poor sleep quality so broadly impacts daytime functioning, perhaps it serves to highlight or amplify the negative impact of unhealthy behaviors. If this is true, it makes sense that poor sleep quality is associated with motivation to initiate (and initial actions regarding) behavior change. Interestingly, we found that poor sleep is related to the action stage of change in alcohol use and stress, but in earlier stages of change in other health behaviors. This perhaps is because alcohol use and stress are oftentimes direct causes of sleep disturbance (Chakravorty et al., 2013; Ebrahim et al., 2013; Foster and Peters, 1999; Mauss et al., 2013; Slopen and Williams, 2014; Spiegelhalder et al., 2013), and individuals who experience poor sleep quality are more ready to take actions to change these behaviors.

The reasons why poor sleep quality may motivate behavior change may also partially explain why poor sleep quality may hinder maintenance of healthy behaviors. Since poor sleep leads to functional deficits, it may make maintenance of healthy behavior more difficult. For example, poor sleep quality is associated with daytime fatigue/tiredness (Grandner and Kripke, 2004), which may increase the effort necessary to maintain behaviors. Also, if poor sleep quality is associated with sleep loss and fatigue, impaired ability to make healthful choices may be due to self-regulation resource depletion (Daviaux et al., 2014; Hagger, 2010; Hagger, 2014; Roth et al., 2001). For example, sleep deprivation is associated with decreased ability to make healthy food choices (Greer et al., 2013).

Taken together, the evidence suggests that not only is poor sleep quality associated with stress and weight management, sedentary lifestyle, and alcohol use, but poor sleep quality may make maintenance of healthy behavior change in these domains more difficult. Sleep may serve as a gateway behavior (Fleig et al., 2014; Nigg et al., 2009) in that it restores energy needed for developing and maintaining a balanced, healthy lifestyle. Future studies will be needed to evaluate whether improvements in sleep quality (perhaps as part of EWP) can improve maintenance of other healthy behaviors, and to better understand specifically how and why poor sleep hinders long-term healthy behavior change. Another area of focus for future studies may be exploring how health risk factors often co-occur, and the role of this overlap in promoting or inhibiting healthful behavior change. Finally, the finding that poor sleep may motivate behavior change may be useful in the development and implementation of health behavior interventions.

Limitations

The single-item measure of sleep quality is problematic for several reasons. Most importantly, this question has not been specifically validated against any standard sleep measure; thus it is unclear to what degree the construct captured by this item represents better-validated measures of sleep. Second, self-reported, single-item, retrospective sleep items are not ideal for assessing sleep. Objective measures such as actigraphy and prospective measures such as sleep diary would be ideal. Results should be interpreted with appropriate caution. That said, single-item sleep quality measures have proven useful in many previous studies (Grandner, 2014). The HRA responses data we used were self-reported, so we cannot know the actual respondents' engagement in health behavior change. Including the "not needed" response choice represents a limitation in that it is not clear whether endorsement of this choice indicates "not applicable" (warranting exclusion) or one of the other stages of change, such as precontemplation (not considering acting), contemplation (i.e., decided not to act) or maintenance (i.e., action already underway). Exclusion of this response may have excluded individuals from analysis who would have otherwise been included and may have produced different results. The data were cross-sectional, and causal inference cannot be made. The lack of depressive symptoms data also prevented us from controlling the possible confounding effect of depressive symptoms on poor sleep quality. Finally, the low HRA participation rate (although typical) may have resulted in a sample biased on one of the measures of interest.

Conclusions

The present study demonstrated that poor sleep quality was associated with an elevated likelihood of contemplating or initiating behavior change, but a decreased likelihood of maintaining healthy behavior change. This indicates that it is important to include sleep improvement as one of the lifestyle management interventions offered in EWP to comprehensively reduce health risks and promote health of the large employee population.

Conflict of interest

The authors report no conflicts of interest.

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