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Personality and Sleep Quality: Evidence From Four Prospective Studies

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Objective: The present study examined the longitudinal association between personality traits and sleep quality in 4 samples of middle-aged and older adults. ***Method:*** Participants ($N > 22,000$) were adults aged 30 to 107 years old from the Wisconsin Longitudinal Study (WLS), the Midlife in the United States Study (MIDUS), the Health and Retirement Study (HRS), and the Midlife in Japan Study (MIDJA). Personality and sleep quality were assessed at baseline and again 4 to 10 years later. ***Results:*** Scoring lower on neuroticism and higher on extraversion was associated with better sleep quality at baseline and over time, with effect sizes larger than those of demographic factors. Low conscientiousness was associated with a worsening of sleep quality over time. Openness and agreeableness were unrelated to sleep quality. Poor sleep quality at baseline was associated with steeper declines in extraversion, agreeableness, and conscientiousness and a smaller decrease in neuroticism over time. ***Conclusion:*** Replicable findings across samples support longitudinal associations between personality and sleep quality. This study identified specific personality traits that are associated with poor and worsening sleep quality, and substantiated previous findings that poor sleep quality is associated with detrimental personality trajectories.

Keywords: personality, sleep quality, adulthood, personality development

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Poor sleep quality—the extent to which individuals have trouble falling and staying asleep, awaking too early, and feeling unrested because of poor sleep (Chen et al., 2015) is a significant health issue. Sleep difficulties are related to declines in physical and mental health (Fernandez-Mendoza & Vgontzas, 2013; Li, Wu, Gan, Qu, & Lu, 2016; Potvin, Lorrain, Belleville, Grenier, & Préville, 2014; Sofi et al., 2014), limitations in activities of daily living (Spira et al., 2014), and cognitive impairment and Alzheimer's disease (Bubu et al., 2017; Fortier-Brochu & Morin, 2014; Lo, Groeger, Cheng, Dijk, & Chee, 2016). Moreover, poor sleep quality is related to an increased risk of future hospitalization (Kaufmann et al., 2013) and ultimately culminates with a higher mortality risk (Parthasarathy et al., 2015). Given these deleterious implications, there is a need for a better understanding of the factors associated with sleep quality. With this in mind, the present study examines whether personality is associated with concurrent sleep quality and changes in quality over time, and whether sleep quality is related to changes in personality across adulthood and old age.

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According to the Five Factor Model (FFM; Digman, 1990; McCrae & John, 1992), personality is described by five traits: neuroticism, the tendency to experience distress and negative emotions; extraversion, the tendency to experience positive emotions and to be sociable; openness, the tendency to be curious and creative; agreeableness, the tendency to be cooperative and altruistic; and conscientiousness, the tendency to be self-disciplined and organized. Past research has implicated personality traits to sleep quality. Neuroticism, for example, has been associated consistently with poor sleep quality (Allen, Magee, & Vella, 2016; Cellini, Duggan, & Sarlo, 2017; Duggan, Friedman, McDevitt, & Mednick, 2014; Gray & Watson, 2002; Hintsanen et al., 2014; Huang, Peck, Mallya, Lupien, & Fiocco, 2016; Kim et al., 2015; Williams & Moroz, 2009). Most studies have also found a relation between conscientiousness and better sleep quality (Duggan et al., 2014; Gray & Watson, 2002; Hintsanen et al., 2014; Kim et al., 2015; Williams & Moroz, 2009), although two studies did not find support for this association (Allen et al., 2016; Cellini et al., 2017). Higher extraversion has been related to better sleep quality in some studies (Allen et al., 2016; Gray & Watson, 2002; Hintsanen et al., 2014; Williams & Moroz, 2009), but not in others (Cellini et al., in press; Duggan et al., 2014; Huang et al., 2016; Kim et al., 2015). Openness and agreeableness have generally been found to be unrelated to sleep (Allen et al., 2016; Duggan et al., 2014; Hintsanen et al., 2014; Huang et al., 2016; Kim et al., 2015; Williams & Moroz, 2009), but one study found that higher openness is related to sleep difficulties (Allen et al., 2016), and two others reported an association between agreeableness and better sleep quality (Cellini et al., 2017; Hintsanen et al., 2014). Most of these studies used global measures of sleep quality, such as the Pittsburgh Sleep Quality Index (PSQI), which provide a composite score based on participants' assessment of subjective sleep quality, sleep latency, sleep duration, habitual sleepiness, sleep disturbances, use of sleeping medication, and daytime dysfunction (Cellini et al., 2017; Duggan et al., 2014; Gray & Watson, 2002; Huang et al., 2016; Kim et al., 2015; Williams & Moroz, 2009). In some studies, sleep quality was assessed using scales that focus on trouble falling sleep, waking during sleep, difficulties staying asleep, and feelings of tiredness after a night's sleep (e.g., Allen et al., 2016; Hintsanen et al., 2014). These studies generally suggest that neuroticism, extraversion, and conscientiousness are the most important personality correlates of sleep quality.

Furthermore, other studies have shown that there are likely other personality-related factors that link neuroticism, extraversion, and conscientiousness to sleep quality. Allen et al. (2016) found that the link between neuroticism and sleep difficulties is mediated by its association with the tendency to experience more negative affect, whereas extraversion is associated with better sleep quality through its link with more positive affect. Moreover, neuroticism is related to higher stress sensitivity (Friedman & Kern, 2014; Leger, Charles, Turiano, & Almeida, in press), and worse mental and physical health (Strickhouser, Zell, & Krizan, in press; Sutin et al., 2013), which can disrupt sleep quality. Extraverted and conscientious individuals have better mental and physical health (Strickhouser et al., in press), and lower reactivity to stressors (Leger et al., in press), which may lead to better sleep quality. In addition, higher neuroticism and lower conscientiousness are related to health-related behaviors that can undermine sleep quality, such as physical inactivity, smoking, and alcohol consumption (Hakulinen et al., 2015a, 2015b; Sutin et al., 2016).

Despite this body of research on the association between personality and sleep, evidence remains relatively limited in at least two aspects. First, previous studies have been mostly cross-sectional; longitudinal evidence for associations between personality and change in sleep quality over time is scarce. Second, most previous studies have not addressed whether sleep quality is associated with a change in personality. One study reported that sleep onset problems in adolescence are related to higher neuroticism at midlife (Danielsson, Jansson-Fröjmark, Linton, Jutengren, & Stattin, 2010), but it did not examine the extent to which these problems are associated with changes in neuroticism and other personality traits over time. Therefore, there are reasons to expect that poor sleep may be associated with detrimental personality changes. Sleeping difficulties are associated with impaired biological, physical, emotional, and cognitive functioning (e.g., Bubu et al., 2017; Sofi et al., 2014; Li et al., 2016), and impaired functioning in these domains has been related to declines in emotional stability, extraversion, agreeableness, openness, and conscientiousness (Jokela, Hakulinen, Singh-Manoux, & Kivimaki, 2014; Karsten et al., 2012; Stephan, Sutin, Luchetti, & Terracciano, 2016; Stephan, Sutin, & Terracciano, 2014). Such personality changes are considered detrimental because they are associated with a range of poor health outcomes, including premature mortality (Chow & Roberts, 2014; Human et al., 2013; Mroczek & Spiro, 2007).

The present study examined the association between personality and sleep quality in four longitudinal samples of middle-aged and older adults. Three American samples and one Japanese sample were used to test for cross-cultural consistency in the link between personality and sleep quality. Based upon existing research, it was hypothesized that higher neuroticism and lower extraversion and conscientiousness would be associated with poor sleep quality when measured concurrently and would also account for a worsening in sleep quality over time. In addition, it was hypothesized that poor sleep quality would be associated with relative increases in neuroticism and decreases in extraversion, agreeableness, openness, and conscientiousness over time.

Method

Participants

Participants were drawn from three United States samples, the Wisconsin Longitudinal Study (WLS), the Midlife in the United States Study (MIDUS), the Health and Retirement Study (HRS), and one Japanese sample, the Midlife in Japan Study (MIDJA). Descriptive statistics for the four samples are presented in Table 1. This study was exempt from Institutional Review Board review because it was based on publicly available data sets. Attrition analyses for the four samples are presented in supplemental materials. Overall, participants with follow-up data were younger, more educated, reported better sleep quality, and had lower neuroticism and higher extraversion, openness, agreeableness and conscientiousness than those without data at follow-up.

The WLS is a study of 10,317 participants who were born between 1937 and 1940 and who graduated from Wisconsin high schools in 1957 (Herd, Carr, & Roan, 2014). The WLS sample is

Table 1
Baseline Characteristics of the Samples

Variables	WLS		MIDUS		HRS		MIDJA	
	M/%	*SD*	*M*/%	*SD*	*M*/%	*SD*	*M*/%	*SD*
Age (years)	53.20	.62	56.17	12.31	69.70	9.65	54.13	14.00
Sex (% women)	54%	—	56%	—	59%	—	51%	—
Race (% White)	100%	—	94%	—	86%	—	0%	—
Education	13.71	2.31	7.30	2.53	12.89	2.93	4.48	2.08
Diabetes (% yes)	4%	—	10%	—	22%	—	7%	—
High blood pressure (% yes)	21%	—	30%	—	62%	—	19%	—
Lung/respiratory disease (% yes)	6%	—	3%	—	12%	—	7%	—
Stroke (% yes)	—		1%		7%		1%	
Cancer (% yes)	2%		14%		17%		—	
Heart disease/trouble (% yes)	5%		18%		27%		—	
Emotional/psychiatric disorders/problems (% yes)	—		18%		17%		9%	
Arthritis (% yes)	23%		26%		65%		10%	
Baseline sleep quality[a]	1.23	1.75	1.79	1.44	1.92	1.35	2.24	1.60
Baseline neuroticism[a]	3.20	.98	2.06	.62	2.01	.61	2.10	.56
Baseline extraversion[a]	3.84	.89	3.10	.57	3.18	.56	2.43	.68
Baseline openness[a]	3.64	.80	2.90	.53	2.92	.56	2.19	.61
Baseline agreeableness[a]	4.75	.74	3.45	.50	3.53	.48	2.63	.63
Baseline conscientiousness[a]	4.87	.68	3.39	.46	3.37	.49	2.60	.55
Follow-up sleep quality[b]	1.63	1.84	1.83	1.45	2.03	1.37	2.28	1.60
Follow-up neuroticism[c]	3.01	.91	2.05	.62	1.96	.60	2.05	.52
Follow-up extraversion[c]	3.79	.87	3.08	.57	3.16	.57	2.39	.66
Follow-up openness[c]	3.58	.77	2.88	.54	2.90	.57	2.14	.59
Follow-up agreeableness[c]	4.80	.71	3.43	.49	3.51	.50	2.60	.61
Follow-up conscientiousness[c]	4.81	.69	3.40	.46	3.37	.49	2.59	.51

Note. WLS = Wisconsin Longitudinal Study; MIDUS = Midlife in the United States Study; HRS = Health and Retirement Study; MIDJA = Midlife in Japan Study. See method section for differences in the assessment and coding of sleep quality, personality, and education in each sample.
[a] WLS: $N = 6{,}513$; MIDUS: $N = 3{,}790$; HRS: $N = 11{,}422$; MIDJA: $N = 1{,}003$. [b] WLS: $N = 5{,}287$; MIDUS: $N = 2{,}433$; HRS: $N = 8{,}965$; MIDJA: $N = 637$. [c] WLS: $N = 5{,}387$; MIDUS: $N = 2{,}444$; HRS: $N = 7{,}403$; MIDJA: $N = 640$.

broadly representative of older, White, non-Hispanic Americans who have completed at least a high school education. Personality and sleep data were collected in 1992–1993 and again in 2003–2005. At baseline, 6,513 participants had complete data on personality, sleep, and demographics, and almost 10 years later 5,287 of those individuals had complete sleep data and 5,387 had complete personality data.

The MIDUS is a longitudinal study of U.S. adults (Radler, 2014). The second (2004–2005, MIDUS II) and third waves (2013–2014, MIDUS III) were used in the present study. The second and third waves of the MIDUS were used because they had similar measures of sleep quality. In total, 3,790 individuals provided complete data on personality, sleep quality, and demographic information at baseline. Of the baseline participants who were assessed again 10 years later, 2,433 had complete sleep data and 2,444 had complete personality data.

The MIDJA is a parallel survey of the MIDUS conducted on randomly selected adults from the Tokyo metropolitan area (Radler, 2014). Baseline demographic, personality, and sleep quality data were obtained in 2008 from a total of 1,003 participants. The measures used in the MIDJA were developed in English, translated into Japanese, and back-translated into English. Several studies have provided support for the cross-cultural validity of this approach (Curhan et al., 2014; Dunkel, 2013; Park et al., 2013; Ryff et al., 2015). Follow-up data were obtained in 2012, resulting in a 4-year time interval. Of the baseline sample, 637 participants had complete sleep data and 640 participants had complete personality data at follow-up.

The HRS is a national longitudinal study of Americans older than 50 years and their spouses, conducted by the University of Michigan (Sonnega, Faul, Ofstedal, Langa, Phillips, & Weir, 2014). Starting in 2006, HRS implemented an enhanced face-to-face interview that included a psychosocial questionnaire with personality items. Half of the sample answered this questionnaire in 2008, and the other half answered it in 2010. The decision to include both the 2008 and 2010 waves of the HRS as the baseline measure of personality and sleep quality was guided by the personality change analysis: this strategy allowed us to keep a 4-year period between baseline and follow-up measures, from 2008 to 2012 and from 2010 to 2014. Data from both waves were pooled, for a total of 11,422 participants with complete personality, sleep quality, and demographic data at baseline. The 2014 wave was used as the follow-up measure of sleep quality, with 8,965 individuals who had complete data. Follow-up personality data were obtained from the 2012 wave for participants in the 2008 sample and from the 2014 wave for participants in the 2010 wave. Therefore, there was a 4-year interval between the baseline and follow-up personality assessment for all participants. Of the total baseline sample, 7,403 participants had complete personality data 4 years later.

Measures

Personality. In the MIDUS, the MIDJA, and the HRS, personality traits were assessed with the Midlife Development Inventory (MIDI; Lachman & Weaver, 1997). Participants were

asked how much 26 adjectives that assessed neuroticism, conscientiousness, extraversion, openness, and agreeableness described them on a scale ranging from 1 (*not at all*) to 4 (*a lot*). Cronbach αs ranged from .50 to .86 across the three samples. In the WLS, a 29-item version of the Big Five Inventory (BFI; John, Donahue, & Kentle, 1991) was used. Participants were asked whether they agreed or disagreed with descriptive statements using a 6-point rating scale, ranging from 1 (*disagree strongly*) to 6 (*agree strongly*; Cronbach's α = .61 to .77). The MIDI and the BFI are both well-validated measures of FFM personality traits (Soto, John, Gosling, & Potter, 2011; Zimprich, Allemand, & Lachman, 2012).

Sleep quality. Sleep quality was assessed at baseline and follow-up in the four samples. In the WLS, participants were first asked whether or not they had trouble sleeping in the past 6 months. If participants reported that they had trouble, they answered two additional items: "How often have you had trouble sleeping?" with scores ranging from 1 (*monthly or less*) to 3 (*daily or more often*) and "How much discomfort has trouble sleeping caused you in the last six months?" with scores ranging from 0 (*none*) to 3 (*a lot*). Consistent with past research (Rosenström et al., 2012), participants were coded zero if they answered no to the first question, and the two additional items were summed if participants responded yes to the first question. The scores ranged from 0 to 6 with higher scores representing worse sleep quality.

HRS participants answered four questions: "How often do you have trouble falling asleep?", "How often do you have trouble with waking up during the night?", "How often do you have trouble with waking up too early and not being able to fall asleep again?", and "How often do you feel really rested when you wake up in the morning?". Consistent with past research (Kaufmann et al., 2013), the responses of "most of the time" or "sometimes" to the first three questions and "sometimes" or "rarely or never" to the fourth question were coded as indicators of sleep difficulties. These four items were then summed as an index of sleep quality, with scores ranging from 0 to 4 (higher scores indicating worse sleep quality).

In the MIDUS, participants were asked to indicate how often they experienced each of the following: "Have trouble falling asleep," "Wake up during the night and have difficulty going back to sleep," "Wake up too early in the morning and are unable to get back to sleep," and "Feel unrested during the day, no matter how many hours of sleep you had." Consistent with past research (Kaufmann et al., 2013), the responses of "almost always," "often," or "sometimes" to the four questions were coded as indicators of poor sleep quality. These four items were summed as an index that ranged from 0 to 4, with higher scores representing worse sleep quality.

In the MIDJA, a single item asked participants "During the past 30 days, how often have you experienced . . . trouble getting to sleep or staying asleep?" They were asked to answer on a scale from 1 (*not at all*) to 6 (*almost everyday*).

Covariates. Age, sex, and educational level were included as covariates in each analysis given their association with both sleep quality (Jaussent et al., 2011; Kaufmann et al., 2013; Stamatakis, Kaplan, & Roberts, 2007) and personality (Löckenhoff et al., 2008; McCrae et al., 2005; Specht, Egloff, & Schmukle, 2011). Education was reported in years in the WLS and the HRS, whereas it was measured on a scale ranging from 1 (*no grade school*) to 12 (*doctoral level degree*) in the MIDUS, and from 1 (*8th grade high school*) to 8 (*graduate school*) in the MIDJA. Race (coded as 1 for White and 0 for other) was controlled for in the MIDUS and the HRS.

Supplemental analyses included depressive symptoms and sleep medication as additional covariates. The 20-item Center for Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977) was used in the WLS, and a shorter 8-item version of the CES-D was used in the HRS (Wallace et al., 2000). The Composite International Diagnostic Interview Short Form scales (CIDI-SF; Kessler, Andrews, Mroczek, Ustun, & Wittchen, 1998) were used in the MIDUS. In the MIDJA, participants answered an item that asked them to rate how often they experienced nerves, anxiety, or depression in the last 30 days, ranging from 1 (*once a month*) to 5 (*daily*). Sleep medication data was available in the MIDUS and the HRS, but not in the other two samples. In the MIDUS, participants were asked to report whether they ever used sedatives, including either barbiturates or sleeping pills on their own during the past 12 months. In the HRS, participants were asked whether they took any medications or used other treatments to help them sleep in the past 2 weeks.

Data Analysis

Regression analysis was used to examine the association between baseline personality traits and sleep quality. For comparison purposes, personality traits and sleep quality were converted to z-scores in each sample. In each sample, baseline sleep quality was regressed on baseline personality, controlling for the demographic factors. All traits were entered simultaneously. Supplemental analyses were conducted, including sleep medication and depressive symptoms as covariates.

In line with the common approach of including baseline values as covariates to examine longitudinal change (Shankar & Hinds, in press; Sirois & Wood, 2017), we also examined the association between personality and changes in sleep quality in regression models with personality at baseline as a predictor of sleep at follow-up, including sleep at baseline and demographic variables as covariates. Baseline sleep medication and depressive symptoms were further controlled in supplemental analyses. To test whether baseline sleep quality was associated with a change in personality traits, we used linear regression to predict each personality trait at follow-up from baseline sleep, controlling for demographic factors and baseline personality.

The effect estimates from each sample were combined in a random-effects meta-analysis. We combined the results from each sample on the baseline association between personality and sleep quality, the relation between personality and change in sleep quality, and the association between baseline sleep quality and change in personality. Heterogeneity was assessed with the Q statistic. The meta-analysis was performed using the Comprehensive Meta-Analysis software.

Results

Cross-Sectional Associations Between Personality and Sleep Quality

As hypothesized, regression analysis revealed that neuroticism was associated with sleep quality at baseline in the four samples;

extraversion and conscientiousness were associated with sleep quality in half of the samples (see Table 2). More specifically, higher neuroticism was related to worse sleep quality, whereas higher extraversion and conscientiousness were associated with better sleep quality. The meta-analysis partially confirmed this pattern and indicated that neuroticism was the strongest personality correlate of sleep quality across the four samples. Extraversion was also found to be significantly associated with sleep quality in the meta-analysis, but conscientiousness was not. There was little support for sex and age as a moderator of the relation between personality and sleep quality at baseline (see supplemental material).

The overall pattern of associations was similar when depressive symptoms and sleep medication were included as covariates (supplemental material Table 1). Specifically, most associations remained significant, except for the associations of agreeableness in the WLS and HRS and of conscientiousness in the HRS. In addition, significant relationships between conscientiousness and openness, and sleep quality emerged in the WLS and the HRS, respectively.

Personality and Changes in Sleep Quality

Across the four samples, sleep quality declined (scores increased) over the follow-up period. As hypothesized, the longitudinal analyses indicated that individuals in all four samples who scored higher on neuroticism at baseline reported larger declines in sleep quality (see Table 3). For extraversion, our hypothesis was supported in the two samples that had 4-year follow-ups: Individuals who scored higher on extraversion at baseline maintained better sleep quality over time. Again there was little evidence for moderation by age or sex, with no interaction replicating across studies (see supplemental material). The meta-analysis confirmed the pattern of associations for neuroticism and extraversion, and further revealed that conscientiousness was associated with improvements in sleep quality over time. The overall pattern of associations was unchanged when depressive symptoms and sleep medication were included in the analysis (see supplemental material Table 2).

Sleep Quality and Personality Changes

The final set of analyses tested the association between sleep quality and personality changes. Consistent with our hypothesis, sleep quality was associated with changes in neuroticism, agreeableness, and conscientiousness in the HRS, MIDJA, and WLS samples; these associations did not replicate in the MIDUS sample (see Table 4). These results indicate that higher sleeping difficulties at baseline are associated with less of a decrease in neuroticism and with greater decreases in agreeableness and conscientiousness. These associations should be interpreted in the context of overall personality change in the samples. In the HRS, MIDJA, and WLS samples, the average mean level of both neuroticism ($0.05 \leq d \leq 0.19$) and conscientiousness ($0.08 \leq d \leq 0.12$) decreased. Agreeableness decreased in the HRS ($d = 0.06$) and MIDJA ($d = 0.11$) and increased in the WLS ($d = 0.06$). This pattern of associations was confirmed by the meta-analytic results (see Table 4). In addition, we found that poor sleep quality at baseline was associated with steeper declines in extraversion in two samples and in the

Table 2
Summary of Analysis Predicting Baseline Sleep Quality From the Five Personality Traits

Variables	WLS	MIDUS	HRS	MIDJA	Random effect	Heterogeneity Q
Age	−.01 [−.038; .009]	.04* [.007; .069]	.02 [−.001; .035]	.12*** [.052; .188]		
Sex	−.11*** [−.132; −.082]	−.09*** [−.119; −.055]	−.10*** [−.122; −.086]	−.03 [−.095; .030]		
Education	.01 [−.017; .035]	−.03* [−.066; −.003]	−.07*** [−.087; −.050]	−.02 [−.083; .051]		
Race	—	−.01 [−.042; .018]	.00 [−.015; .020]	—		
Neuroticism	.22*** [.195; .248]	.28*** [.252; .316]	.22*** [.206; .244]	.26*** [.199; .327]	.23*** [.197; .263]	16.59***
Extraversion	−.02 [−.050; .000]	−.10*** [−.142; −.065]	−.08*** [−.106; −.059]	−.09 [−.180; .001]	−.06*** [−.085; −.029]	10.83*
Openness	.03* [.002; .056]	−.01 [−.052; .022]	−.01 [−.035; .011]	.04 [−.044; .132]	00 [−.018; .027]	6.94
Agreeableness	−.03* [−.053; −.001]	.06** [.023; .097]	.04*** [.021; .067]	−.02 [−.115; .074]	01 [−.024; .053]	20.74***
Conscientiousness	−.01 [−.034; .017]	−.05*** [−.088; −.022]	−.03** [−.055; −.012]	.03 [−.041; .109]	−.02 [−.046; .002]	8.03*
Adjusted R^{2a}	.07	.13	.10	.07		

Note. WLS = Wisconsin Longitudinal Study; MIDUS = Midlife in the United States Study; HRS = Health and Retirement Study; MIDJA = Midlife in Japan Study. WLS: $N = 6{,}513$; MIDUS: $N = 3{,}790$; HRS: $N = 11{,}422$; MIDJA: $N = 1{,}003$. Coefficients are standardized coefficients (confidence intervals in parentheses).
[a] $\Delta R^2_{\text{Personality}}$: WLS: .05, MIDUS: .10, HRS: .07, MIDJA: .07.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 3
Summary of Analysis Predicting Follow-Up Sleep Quality From the Five Personality Traits

Variables	WLS	MIDUS	HRS[a]	MIDJA	Random effect	Heterogeneity Q
Age	.01 [−.011; .039]	.01 [−.025; .044]	.01 [−.011; .024]	.03 [−.036; .102]		
Sex	10*** [−.130; −.078]	−.04* [−.078; −.006]	−.02** [−.043; −.007]	−.06* [−.129; −.001]		
Education	−.01 [−.034; .019]	−.01 [−.048; .022]	−.06*** [−.080; −.044]	.03 [−.041; .093]		
Race		.01 [−.023; .044]	−.01 [−.032; .003]	—		
Baseline sleep	.35*** [.327; .377]	.49*** [.455; .526]	.51*** [.488; .524]	.58*** [.519; .646]		
Neuroticism	.13*** [.098; .154]	.09*** [.053; .127]	.09*** [.070; .107]	.09** [.024; .158]	10*** [.089; .119]	2.20
Extraversion	−.02 [−.044; .008]	−.03 [−.069; .017]	−.04*** [−.067; −.022]	−.11* [−.204; −.024]	−.03** [−.054; −.013]	4.57
Openness	.01 [−.018; .038]	−.01 [−.050; .032]	.01 [−.016; .028]	.01 [−.073; .102]	.00 [−.01; .020]	.60
Agreeableness	.00 [−.026; .028]	.02 [−.020; .062]	.02 [−.000; .044]	−.01 [−.105; .081]	.01 [−.001; .028]	1.69
Conscientiousness	−.02 [−.046; .007]	−.03 [−.063; .010]	−.03** [−.055; −.014]	.04 [−.035; .116]	−.02** [−.043; −.007]	3.78
Adjusted R^{2b}	.19	.30	.32	.39		

Note. WLS = Wisconsin Longitudinal Study; MIDUS = Midlife in the United States Study; HRS = Health and Retirement Study; MIDJA = Midlife in Japan Study. WLS: N = 5,287; MIDUS: N = 2,433; HRS: N = 8,965; MIDJA: N = 637. Coefficients are standardized coefficients (confidence intervals in parentheses).
[a] Adjusted for time elapsed between assessment. [b] $\Delta R^2_{\text{Personality}}$: WLS: .02, MIDUS: .01, HRS: .01, MIDJA: .02.
* $p < .05$. ** $p < .01$. *** $p < .001$.

overall meta-analysis. We did not find an association with a change in openness (see Table 4). There was little support for a moderation by age and sex (see supplemental material).

Discussion

Based on four large samples of middle-aged and older adults, the present study examined the association between personality and sleep quality. The strongest and most consistent association was found for neuroticism, which was associated with more sleep difficulties concurrently and over 4 to 10 years at follow-up. Higher extraversion was related to better sleep quality at baseline and fewer sleeping difficulties over time, whereas less consistent associations were found between conscientiousness and sleep quality at baseline and follow-up. Furthermore, more sleeping difficulties were associated with greater declines in agreeableness and conscientiousness and a smaller decline in neuroticism over time. Most findings replicated across four samples that differed in age, cultural context, and measures of personality and sleep. Thus, the present study provides a robust account of the link between personality and sleep quality. The study is particularly innovative in examining the longitudinal associations between sleep quality and personality changes.

Similar to previous cross-sectional studies conducted among middle-aged adults (Allen et al., 2016; Hintsanen et al., 2014), neuroticism had the strongest associations with indicators of poor sleep. The present study provides a critical addition to existing knowledge by showing that neuroticism is a risk factor for declines in sleep quality over time with follow ups ranging from 4 to 10 years and for both middle-age and older adults. Neuroticism reflects a tendency to experience distress and anxiety and is generally associated with excessive negatively toned cognitive activity (worry and rumination). Cognitive processes, particularly the phenomena of not being able to shut off or control thoughts, are thought to be an important factor in insomnia (Espie, Inglis, Tessier, & Harvey, 2001; Harvey, 2002). In addition, hostility, a facet of neuroticism, has been linked to poor sleep quality (Tsuchiyama, Terao, Wang, Hoaki, & Goto, 2013). Individuals with higher neuroticism have an increased sensitivity to stressors (Friedman & Kern, 2014; Leger et al., in press; Mroczek & Almeida, 2004), which is likely to amplify and perpetuate sleeping difficulties both concurrently and over time. In addition, neuroticism is associated with common mental disorders (Ormel et al., 2013) that are comorbid with poor sleep (Fernandez-Mendoza & Vgontzas, 2013; Potvin et al., 2014). High neuroticism is also related to poor respiratory function and increased risk of lung disease (Terracciano, Stephan, Luchetti, Gonzalez-Rothi, & Sutin, in press; Weston, Hill, & Jackson, 2015), which are associated with sleep disturbances (Budhiraja et al., 2012; Hynninen et al., 2013). Behavioral pathways may also operate. Higher neuroticism is related to alcohol use (Hakulinen et al., 2015a), smoking (Hakulinen et al., 2015b), and physical inactivity (Allen, Walter, & McDermott, 2017; Sutin et al., 2016; Wilson & Dishman, 2015), all of which increase the risk of poor sleep (Brook, Rubenstone, Zhang, & Brook, 2012; Haario, Rahkonen, Laaksonen, Lahelma, & Lallukka, 2013; Smagula, Koh, Wang, & Yuan, 2016). Individuals high in neuroticism also tend to evaluate everything negatively, and that tendency likely extends to evaluations of their sleep. Hyperarousal may also be a potential mechanism that ex-

Table 4
Summary of Analysis Predicting Follow-Up Personality Traits From Baseline Sleep Quality

Samples	Neuroticism	Extraversion	Openness	Agreeableness	Conscientiousness
WLS[a]	.04*** [.019; .059]	−.01 [−.026; .010]	.01 [−.011; .025]	−.02* [−.044; −.001]	−.04*** [−.062; −.021]
MIDUS[b]	.01 [−.020; .044]	−.02 [−.048; .008]	−.02 [−.047; .009]	−.01 [−.044; .016]	−.02 [−.047; .013]
HRS[b]	.08*** [.062; .098]	−.04*** [−.052; −.019]	−.03*** [−.045; −.013]	−.03*** [−.052; −.017]	−.05*** [−.068; −.033]
MIDJA[a]	.07* [.011; .131]	−.07* [−.119; −.014]	−.02 [−.078; .033]	−.07* [−.130; −.010]	−.08** [−.140; −.024]
Random effect	.06** [.022; .104]	−.04** [−.064; −.010]	−.02 [−.051; .009]	−.04*** [−.054; −.019]	−.06*** [−.079; −.033]
Heterogeneity Q	16.19**	7.11	8.81*	3.48	5.43

Note. WLS = Wisconsin Longitudinal Study; MIDUS = Midlife in the United States Study; HRS = Health and Retirement Study; MIDJA = Midlife in Japan Study. WLS: N = 5,387; MIDUS: N = 2,444; HRS: N = 7,403; MIDJA: N = 640. Coefficients are standardized coefficients (confidence intervals in parentheses).
[a] Adjusted for age, sex, education, and baseline personality. [b] Adjusted for age, sex, education, race, and baseline personality.
* $p < .05$. ** $p < .01$. *** $p < .001$.

plains the link between higher neuroticism and worsening sleep (Cellini et al., 2017). Future research would benefit from objective indices of sleep to test whether the association between neuroticism and subjective sleep quality extends to objective measures of sleep.

As expected, high extraversion was related to relatively better sleep quality at baseline and fewer difficulties longitudinally. This association is consistent with past research, which has reported that higher extraversion is related to fewer sleep difficulties in adulthood (Allen et al., 2016; Hintsanen et al., 2014). The present study extended this relation to fewer sleeping difficulties over time, mainly in the samples with 4 years of follow-up. Because extraversion is related to lower stress reactivity (Leger et al., in press), lower risk of lung disease and better respiratory function (Terracciano et al., in press), and a more physically active lifestyle (Sutin et al., 2016), this profile may contribute to the lower likelihood of sleep difficulties.

Our hypothesis was partially confirmed for conscientiousness: Higher conscientiousness was related to better sleep quality in two of the four samples at baseline. This mixed pattern of association among our samples is consistent with past research on the relation between personality and sleep among middle-aged adults. Previous research has generally reported that higher conscientiousness is associated with better sleep quality (Duggan et al., 2014; Gray & Watson, 2002; Kim et al., 2015; Williams & Moroz, 2009), although two studies on middle-aged adults have found no relation when all traits were considered simultaneously (Allen et al., 2016; Hintsanen et al., 2014). The relation between conscientiousness and sleep quality could be partially attributable to the stress buffering effect of conscientiousness (Javaras et al., 2012; Leger et al., in press). In addition, conscientiousness is related to physical activity (Sutin et al., 2016), lower body mass index (Jokela, Hintsanen, et al., 2013), lower likelihood of smoking (Hakulinen et al., 2015), and fewer chronic diseases (Weston et al., 2015), which may mediate the association between high conscientiousness and fewer sleeping difficulties. Finally, higher conscientiousness is associated with more nocturnal blood pressure dipping and lower systolic blood pressure at night (Terracciano et al., 2014), which are physiological correlates of better sleep quality (Sherwood et al., 2011). The association between higher conscientiousness and better sleep quality was found only in U.S. samples, whereas there was no association in the Japanese sample. Because recent research has found that conscientiousness is unrelated to some health outcomes in Asian samples (e.g., BMI; Shim et al., 2014; Sutin et al., 2015), this finding could suggest that conscientiousness may play a protective role in the United States and may not be related to sleep quality in Japan. The difference may also be because of methodological differences. For example, the measurement of sleep quality may be less reliable in the MIDJA, because it is based upon a single-item measure.

Finally, openness and agreeableness were not related to sleep quality at baseline nor over time. This pattern was found in the meta-analysis and across most of the samples, and is consistent with the majority of previous studies that generally found no association between these traits and sleep quality (Duggan et al., 2014; Huang et al., 2016; Kim et al., 2015; Williams & Moroz, 2009), including those conducted among adults (Allen et al., 2016; Hintsanen et al., 2014).

Sleep quality may be one pathway through which personality contributes to health and cognitive outcomes. Personality is related to sleeping difficulties, and these difficulties are related to lower physical and cognitive functioning, inflammatory processes, and mortality risk (Fortier-Brochu & Morin, 2014; Parthasarathy et al., 2015; Spira et al., 2014). Therefore, poor sleep quality over time may explain in part why high neuroticism and low conscientiousness are related to impaired physical functioning and cognition (Canada, Stephan, Jaconelli, & Duberstein, 2016; Luchetti, Terracciano, Stephan, & Sutin, 2016; Terracciano et al., in press), higher inflammation (Luchetti, Barkley, Stephan, Terracciano, & Sutin, 2014), and mortality risk (Jokela, Batty, et al., 2013). Future research is needed to examine the potential mediating role of poor sleep quality in the personality-health relation.

We also found novel evidence that sleep quality was associated with personality change. In three of the four samples and over periods ranging from 4 to almost 10 years, we found that more sleep difficulties were related to steeper declines in extraversion, agreeableness, and conscientiousness, and a slight decline in neuroticism. Overall, the associations between sleep quality and personality change were stronger in the samples with a shorter follow-up (HRS and MIDJA had an approximately 4-year interval) compared with the samples with longer follow-ups (WLS and MIDUS had an approximately 10-year follow-up). The longer follow-up period combined with the younger age of the MIDUS sample could potentially be why poor sleep was not related to personality change in this sample. Overall, the findings are consistent with the notion that sleeping difficulties are related to the

depletion of physical, cognitive, and emotional resources, which over time may culminate in personality change. Poor sleep is accompanied by chronic fatigue (Goldman et al., 2008), biological dysfunctioning (Chen, Redline, Shields, Williams, & Williams, 2014), functional limitations (Dam et al., 2008; Spira et al., 2014), depressive symptoms (Potvin et al., 2014), and cognitive impairment (Fortier-Brochu & Morin, 2014). Depletion of these resources is challenging for individuals' enthusiasm and energy, altruism and cooperativeness, self-discipline and organization, and emotional stability over time (Jokela et al., 2014; Karsten et al., 2012; Mueller et al., 2016; Stephan et al., 2016; Sutin, Zonderman, Ferrucci, & Terracciano, 2013). However, there was no association between sleep quality and personality change in the MIDUS. This study contributes to existing knowledge on personality development by identifying a new factor associated with detrimental patterns of personality changes.

The strengths of this study include the examination of concurrent and longitudinal associations between personality and sleep quality using four large samples of adults. Several limitations should also be considered. Attrition analysis revealed a selection effect. Indeed, the four longitudinal samples were characterized by more favorable baseline personality and sleep quality profiles than individuals without data at follow-up, which raises the issue of representativeness of the samples and limits generalizability of our findings. However, the associations reported in this study may underestimate the size of the relation between personality and sleep quality given that participants without complete data had lower sleep quality and less favorable personality profiles at baseline. The results were obtained using self-reported measures of sleep. Although these self-reported assessments are correlated with objective measures (Lauderdale, Knutson, Yan, Liu, & Rathouz, 2008), additional studies are needed using an objective assessment of sleep quality. Whether similar findings can be obtained with polysomnography or actigraphy remains to be seen, as personality traits have often but not always had consistent associations across subjectively and objectively assessed health parameters (Sutin & Terracciano, 2016; Terracciano et al., 2013). Furthermore, this study examined some components of sleep quality but not the relation between personality and other aspects of sleep, such as duration. Future research should also examine the pathways through which personality contributes to sleep quality. Moreover, longitudinal studies with more than two repeated measures of personality and sleep quality are necessary to separate *relative* changes in rank-ordering of individuals on sleep over time from *absolute* changes in sleep quality within individuals (Hamaker, Kuiper, & Grasman, 2015). The prospective associations in the present work only speak to relative changes between individuals and not to individual trajectories of change. Both sleep and personality were measured with brief measures that preclude examination of more fine-tuned personality-sleep associations. The size of the association between personality and sleep quality was relatively small. However, it was consistently larger than the effect size of recognized demographic factors, such as age, education, sex, and race. Moreover, personality is unlikely to have a large association with sleep quality, given that sleep is a complex, and multidetermined phenomenon that is dependent upon a variety of factors ranging from genetic to environmental (Genderson et al., 2013). Finally, we included United States and Japanese samples, but the same analysis in a broader array of cultures is needed to test for cross-cultural similarities and differences.

In summary, this study identified relatively small but replicable associations between personality and sleep quality across adulthood. The results also suggest that personality assessment may be useful in identifying individuals at higher risk of worsening sleep that are likely to benefit from preventive actions. In clinical populations of individuals suffering from insomnia, personality could be helpful for tailoring interventions to improve adherence and, ultimately, sleep quality. Finally, tracking personality changes over time may provide information about individuals suffering from sleep difficulties. This study paves the way for future research on sleep quality and personality across adulthood.

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