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The relationship between NEO-five personality traits and sleep-related characteristics: A systematic review and meta-analysis

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ABSTRACT

An increasing body of research has suggested personality traits as a possible predisposing factor for individual differences in sleep pattern and problems. However, the findings were mixed and there remained a lack of a quantitative synthesis. As searched in the four databases (Web of Science, Embase, PsycINFO, PubMed), 60 studies (n = 73,540; female = 60 %) that used standardized measures to evaluate the relationship between NEO-five personality traits and sleep-related outcomes (sleep quality and sleep duration) were identified. Meta-analyses were performed using random-effects model and the results suggested that poor sleep quality was associated with a higher level of neuroticism (r = 0.287) but a lower degree of openness (r = −0.042), conscientiousness (r = −0.132), extraversion (r = −0.086), and agreeableness (r = -0.064). Shorter sleep duration was found to be associated with a higher level of neuroticism (r = 0.066) but not with other personality dimensions. The findings were mainly limited to the general population. Future research should investigate whether comparable patterns of associations are present in the clinical populations. There is also a need for more research with a prospective design utilizing objective sleep measurements and to explore the mechanisms underlying the association of personality factors with sleep-related characteristics, especially sleep quality and duration.

Abbreviations

AASM	American Association of Sleep Medicine
EEG	electroencephalogram
FFM	five-factor model
IPIP	international personality item pool
iRBD	idiopathic rapid eye movement sleep behavior disorder
NEO	Neuroticism extraversion openness
OCEAN	Openness conscientiousness extraversion agreeableness neuroticism
PRISMA	preferred reporting items for systematic reviews and meta-analyses
PROMIS	patient-reported outcome measurement information system
PSG	polysomnography
PSQI	Pittsburgh sleep quality index
SMD	standard mean difference

1. Introduction

Sleep, which accounts for one-third of a person's lifespan, has been increasingly recognized as an important factor linking to one's physical and mental health. Adequate duration and good quality are the core elements of healthy sleep. Despite the recommended 8–10 h of sleep for adolescents and at least 7 h for adults, as suggested by the American Association of Sleep Medicine's (AASM) guideline, epidemiological studies showed that 23–56 % of the global population experience sleep problems [1]. Recent studies also documented a secular trend of decrease in sleep duration, especially in the United States, Canada, Europe, and Asia [2,3]. Inadequate sleep, including poor sleep quality and short sleep duration, is associated with an increased risk of cardiovascular diseases, neurodegenerative disorders, depression and anxiety disorders as well as impaired cognitive functioning [4–7].

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Considering the high prevalence and the deleterious impacts of sleep problems, it is important to understand the factors associated with sleep quality and quantity for planning tailored treatment and prevention.

Individual's susceptibility to sleep problems may be linked to a variety of biological factors, such as age, gender, and a familial predisposition to sleep problems [8–10]. Meanwhile, a growing body of research has suggested that psychosocial differences, especially personality traits, which account for individual variability in a consistent pattern of thinking, feeling, and acting, might also play an important role explaining one's vulnerability to sleep problems [11]. There are several prominent personality models, such as Cattell's 16 personality model, Eysenck's personality model, and the five-factor model (FFM). Cattell's model was developed through factor analysis of a large set of personality data [12]. Eysenck's model was developed based on biological factors, proposing that personality is shaped by innate predispositions [12]. Despite the widespread use of these three models, all of which capture a comprehensive analysis of a wide range of personalities, the FFM stands out as the only one demonstrating moderate-to-high longitudinal stability, reliability, and cross-cultural applicability (r = |0.68–0.84|) [9,13–15]. FFM, also known as "big five", "NEO-five", or "OCEAN", is a commonly adopted conceptual model of personality traits. It includes five broad dimensions, namely openness (being creative, open-minded, and aesthetic), conscientiousness (being competent, ordered, and self-disciplined), extraversion (being warm, assertive, and affective), agreeableness (being modest, compliant, and cooperative) and neuroticism (being vulnerable to stress, self-conscious, and impulsive) [11,16].

Previous research suggested that (NEO-five) personality traits might affect various aspects of one's life, including sleep characteristics [17]. More specifically, individuals with high neuroticism and low conscientiousness tend to be more sensitive to stressful events and are prone to exhibiting excessive worry, as driven by heightened negative affect (high neuroticism) and poor inhibitory control (low conscientiousness) [18,19]. These characteristics are associated with heightened emotional reactivity and cognitive arousal, which can lead to sleep problems, especially short sleep duration and poor sleep quality [20–22]. However, the findings about the association of sleep quality or duration with personality traits were inconsistent. Some studies conducted in the general population showed that individuals with sleep problems, namely short sleep duration and poor sleep quality, tend to exhibit a higher level of neuroticism but a lower level of extraversion, openness, conscientiousness and agreeableness [17,23–25]. Nonetheless, some other studies found no association between sleep problems and personality traits, for example, in individuals with chronic medical conditions [26,27]. Despite that there has been some evidence suggesting that certain demographic and clinical characteristics may potentially be implicated in the association between personality traits and sleep, there is a lack of systematic synthesis on these potential moderating factors.

The current study aimed to systematically synthesize the existing evidence to address the following questions: 1) whether one's sleep related characteristics (i.e., sleep quality, sleep quantity) might be associated with NEO-five personality traits; 2) if sociodemographic factors, such as age and sex, and clinical characteristics (e.g., the severity of depressive and anxiety symptoms) would moderate the associations of sleep quality and sleep quantity with personality characteristics.

2. Methods

2.1. Protocol and registration

The current study followed the guidelines of the Preferred reporting items for systematic reviews and meta-analyses (PRISMA). The protocol of this review was registered in PROSPERO (https://www.crd.york.ac.uk/prospero/display_record.php?RecordID=302676).

2.2. Searching strategy

The following electronic databases, PubMed, PsycINFO, Embase, and Web of Science, were searched. The searching terms were selected to identify relevant articles that explored the association of sleep-related characteristics, especially sleep quality and sleep duration and personality traits. The selection of these terms was guided by the strategies as employed in previous meta-analyses which also similarly investigated these two key concepts [28–31]. We combined search terms and MESH terms using the following keywords: ("personality" OR "neurotic*" OR "openness" OR "extraver*" OR "extrover*" OR "agreeable*" OR "conscientious*") AND ("sleep(MESH)" OR "sleep quality" OR "sleep duration" OR "sleep quantity" OR "sleep stage*" OR "actigraph" OR "polysomnograph"). Relevant publications were searched from the inception of each database until Jan 2022. Furthermore, we conducted a manual search based on the reference list of the published articles to identify potentially relevant studies. Two authors (RW and ZM) independently assessed the eligibility of the studies by initially reviewing the abstracts, followed by examining the full texts. Disagreement was resolved by discussing with a third author (SXL).

2.3. Eligibility criteria

Studies were included if they met the following inclusion criteria: 1) Studies published in English; 2) Studies conducted in human participants with the sample mean age 12 or above [32]; 3) Studies that adopted validated measurements of NEO-Five personality traits; 4) Studies that used either validated self-reported questionnaires or objective assessments, such as polysomnography or actigraphy, to measure sleep-related outcomes (e.g., sleep duration, sleep quality); 5) Studies that reported the relevant effect sizes of the association between sleep-related characteristics and personality traits. The grey literature, such as single case reports, animal studies, conference abstracts was not included. Reviews or meta-analyses were excluded but, if their topics were relevant to the current research question, their included studies were manually reviewed.

2.4. Data extraction

The information extracted from eligible studies included the surname of the first author, title, year of publication, study design, sample composition, sample size, percentage of females, participants' mean age, and the correlations between NEO-five personality traits and outcome measures (i.e., sleep quality or duration). For studies with missing data, their corresponding authors were contacted. For studies with overlapped samples, data were only extracted once from the study with a larger sample size. For longitudinal studies, only baseline correlations between personality traits and sleep characteristics were extracted for meta-analysis.

2.5. Quality assessment

Two authors (RW and ZM) independently conducted the quality assessment for all the included studies. The standardized assessment criteria developed by Kmet and colleagues was used for the assessment for risk of bias. It is a 14-item checklist for assessing study design, analysis, and results of each study [33]. Each item can be scored as: yes (2-point), partial (1-point), and no (0-point). The final score of the study was calculated as the summed scores divided by the total possible scores, where quantitative studies with a total score larger than 75 % was considered as high quality, 50–75 % as moderate quality, less than 50 % as low quality. Any discrepancies were resolved through discussion between the two reviewers to reach a consensus.

2.6. Data synthesis and statistical analysis

In this review, sleep quality was based on participants' self-reported ratings of sleep quality or device-measured (e.g., polysomnography, actigraphy) sleep efficiency, which was defined by the ratio of total sleep time to time in bed. Sleep duration was defined as self-reported (e.g., questionnaires, sleep diary) or device-measured amount of time an individual slept during bedtime episode [34,35]. Personality traits were assessed using self-reported questionnaires based on the FFM dimensions. A comprehensive list of the measurements of personality traits and sleep characteristics are presented in Appendix A and B. Pearson's correlation was extracted as the key measure of effect size to reflect the strength of the association between NEO-five personality traits and outcome measures (i.e., sleep quality and duration). For the studies that divided participants into groups (i.e., poor versus good sleep quality group, or short versus long sleep duration group), the following formula was used to convert the standard mean differences (SMD) to point-biserial correlation (r_{pb}):

$$r_{pb} = \frac{SMD}{\sqrt{SMD^2 + \frac{N^2-2N}{n_1 n_2}}}$$

Odds ratios were converted to Pearson's r first and then transformed the same way as of the converted r_{pb} to Fisher's z for normal distribution and reconverted to Pearson's r. For the studies in which data were not available for conversion, qualitative synthesis was performed. In most self-report instruments of sleep quality (e.g., Pittsburgh sleep quality index [PSQI]), higher scores demoted poorer sleep quality, except that for the patient-reported outcome measurement information system (PROMIS) and sleep efficiency as measured by actigraphy, where higher values indicated better sleep quality. For the sleep duration subscale of PSQI, higher scores suggested shorter sleep duration. As such, the direction of the correlations that were based on PROMIS and actigraphy for sleep quality and the sleep duration subscale of PSQI was reversed to ensure a consistent interpretation of the direction of the associations for all the measures. Positive correlations between personality traits and sleep quality parameters suggested that higher ratings for a specific personality trait was associated with poorer sleep quality. Positive correlations between personality characteristic and sleep duration parameters suggested that higher ratings for a particular personality trait was related with longer sleep duration. The degree of correlations can be interpreted as small ($r \geq |0.10|$), moderate ($r \geq |0.30|$), or high correlation ($r \geq |0.50|$) [36].

Meta-analyses on the correlations between NEO-five personality traits and sleep quality or sleep duration were performed if at least three studies were available for analysis. We conducted separate meta-analysis for the association of sleep quality or sleep quantity with each personality domain (i.e., openness, conscientiousness, extraversion, agreeableness, and neuroticism) using random-effect model in R [37–39]. The statistical significance was set as $p < 0.05$. The degree of heterogeneity was assessed with the I^2 Index, with I^2 values of 25, 50, and 75 % referred to as low, moderate, and high levels of heterogeneity, respectively. Leave-one-out sensitivity analyses were conducted to remove influential cases and outliers from the analysis. Subgroup analyses were performed for categorical variables, such as study composition (clinical or general population), sleep measures (PSQI or others), personality measures (big five inventory-related [BFI], NEO-related, or others), geographic regions (Asia or non-Asia), study quality (low, moderate, or high quality), study sample sizes (small: $n < 100$; medium: $n = 100$ to 1000; large: $n > 1000$), whilst meta-regressions were performed for continuous factors, such as age, female percentage, the severity of depressive and anxiety symptoms. Egger's regression was performed, if at least 10 studies were available for analysis, to detect potential publication bias among the studies included in the meta-analysis.

3. Results

The PRISMA diagram of the selection process is shown in Fig. 1. The initial search identified 6917 studies for eligibility screening. Among these, the full text of 273 studies was retrieved and assessed for eligibility, and 60 studies met the study criteria. Of these, 56 studies reported relevant data for meta-analysis. Fifty-five studies examined the relationship between sleep quality and personality traits whilst twelve studies reported the relationship between sleep quantity and personality traits. The PRISMA checklist is shown in Appendix C.

3.1. Characteristics of the included studies

The key characteristics of the studies included for quantitative and qualitative analysis are summarized in Table 1. A total of 73,540 participants (female:60 %) with a mean age of 34.23 (age range: 13.3–88.23 years old) were included while six studies did not report mean age of the samples (four studies conducted in the college student sample, one study conducted in adults aged between 18 and 30, one study conducted in adults aged over 60) and one study did not report gender ratio in the sample) [40–46]. There were 55 cross-sectional studies and five longitudinal studies. Most studies ($n = 53$, 91.67 %) were conducted in the general population, whilst five studies were solely based on the clinical populations, including those with depression, delay-phased sleep wake disorder, type 2 diabetes, and tinnitus [26,27,47–49]. Two other studies included both the general and clinical populations (insomnia or bipolar disorders) [50,51]. Self-reported sleep quality was assessed by PSQI ($n = 48$) and other measures ($n = 9$) including Groningen sleep quality questionnaire, PROMIS, restorative sleep questionnaire, sleep quality scale, self-rating scores of sleep, and World Health Organization quality-of-life scale. Self-reported sleep duration was assessed by one subscale of PSQI. Only three studies used actigraphy, where sleep efficiency was extracted to reflect sleep quality and total sleep time was used to reflect sleep duration [30,52,53]. All the included studies adopted questionnaires to assess personality traits, including NEO-five inventories ($n = 17$), big five inventories ($n = 17$), and others ($n = 26$), which included adjective based personality test, Eysenck personality inventory, international personality item pool (IPIP), midlife development inventory, mini-IPIP), mini-big five markers, multidimensional personality questionnaire, ten item personality inventory, and Zuckerman–Kuhlman personality questionnaire. Quality assessment results showed that all the included studies had moderate to high quality. The detailed ratings of each study are shown in the supplementary files, see Fig. S1.

3.2. Sleep quality and NEO-five personality traits

3.2.1. Sleep quality and openness ($n = 30$)

Thirty studies examined the association between sleep quality and openness whilst 29 of them were included in the meta-analysis [19,20,26,27,40,42,47,50,52–72]. The pooled result (Fig. 2A) suggested a significant relationship between openness and sleep quality ($r = -0.042$, 95 %CI = −0.078, −0.006, $p = 0.021$, $I^2 = 76$ %, standard Z = −3.13), indicating that a higher degree of openness was associated with better sleep quality. Due to the high heterogeneity (I^2>75 %), sensitivity and subgroup analyses were performed (Fig. S2A and Table S1). After omitting one study [59] based on the outlier detection of sensitivity analysis, the association remained significant ($r = -0.041$, $p = 0.032$). Subgroup analyses (Table S1) further revealed a significant association of sleep quality with openness only among the general population (r = -0.038, $p = 0.026$), but not in the clinical populations ($r = -0.101$, p = 0.296) [10,11,29,31]. Furthermore, studies that used PSQI to measure sleep quality ($r = -0.050$, $p = 0.048$) and those that adopted BFI-related inventories to measure openness ($r = -0.078$, $p = 0.022$) showed a significant association between sleep quality and openness. In addition, studies with small ($r = -0.185$; $p = 0.016$) and medium sample sizes (r

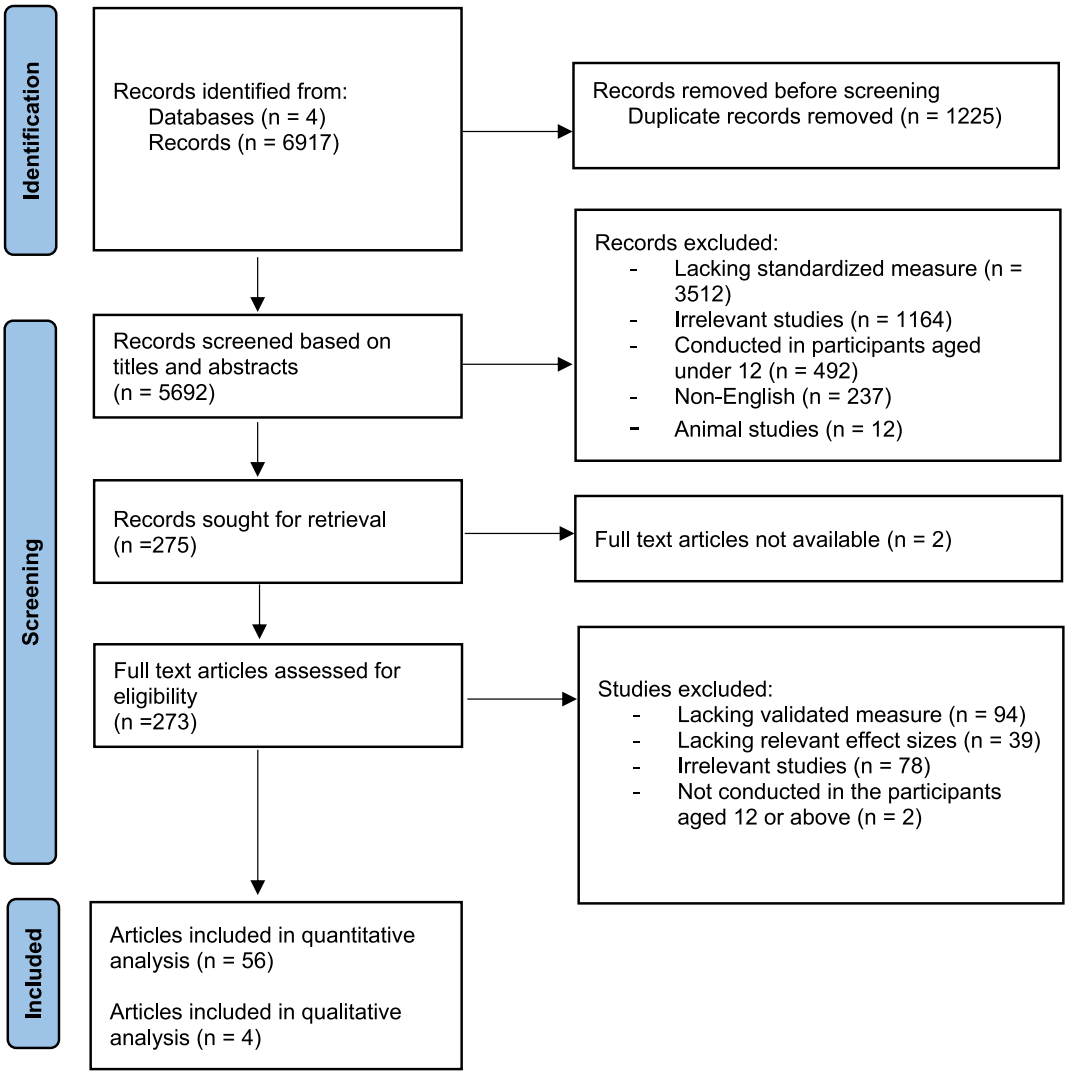

Fig. 1. Flowchart of the review.

= −0.037; p = 0.029) demonstrated a significant association of sleep quality with openness. Such an association was not observed when using other sleep measurements or personality inventories. There was one study with a lack of sufficient data to generate a correlation coefficient and was therefore included for only qualitative synthesis. This study reported no association between sleep quality and openness among young adults [46].

3.2.2. *Sleep quality and conscientiousness (n = 35)*

There were 35 studies that examined the association between sleep quality and conscientiousness [18–20,24,26,27,40,42,47,50,52–74] while two of them were not included in the meta-analysis due to a lack of effect size [46,75]. The pooled effect size of 33 studies (Fig. 2B) indicated a significant association (r = −0.132, 95 %CI = −0.164, −0.099, p < *0.001*, I^2 = 83.3 %, standard Z = −27.05), suggesting that a higher level of conscientiousness was associated with better sleep quality. After omitting one influential study [59] in the sensitivity analysis, the overall pooled result remained significant (r = −0.132, p < 0.001) (Fig. S2B). Subgroup analyses further suggested that the associations between sleep quality and conscientiousness retained across different populations, geographic regions, or study sample sizes and different measurement tools of sleep and personality traits (Table S1). Two qualitatively assessed studies were both conducted in young adults and suggested that a higher degree of conscientiousness was significantly associated with better sleep quality, as reflected by more restorative sleep, when controlling for sociodemographic variables, such as sex, race, age, work status, marital status, and alcohol consumption [46,75].

3.2.3. *Sleep quality and extraversion (n = 34)*

Thirty-four studies investigated the link between sleep quality and extraversion, with 33 of them providing sufficient data for meta-analysis [19,20,26,27,40–42,44,47,50,52–77]. The pooled results suggested that individuals with a higher level of extraversion tended to report better sleep quality (r = −0.086, 95 %CI = −0.124, −0.048, p < 0.001, I^2 = 84.2 %, standard Z = −21.97) (Fig. 2C). The association remained significant (r = −0.086, p < 0.001) after omitting one influential study [59] in the sensitivity analysis (Fig. S2C). Subgroup analyses suggested a significant association of sleep quality with extraversion observed in the general population (r = −0.083, p < 0.001) and the clinical population (r = −0.127, p < 0.001) (Table S1). Except for the studies that used BFI (r = -0.086, p = 0.079), those studies that used other measurements of personality features (NEO: r = −0.113, p = 0.021; others: r = −0.081, p < 0.001) and sleep quality (PSQI: r = −0.089, p < 0.001; others: r = −0.077, p < 0.001) all found significant associations between extraversion and sleep quality. The association between sleep quality and extraversion remained significant across different study sample sizes. One study was not included in the meta-analysis due to a lack of computable effect size and found a significant negative association

Table 1
Characteristics of included studies.

	Author	Regions	Design	Population	N	Age	Female %	Personality Measure	Sleep Measure	Statistical Method	Quality Assessment	Main Findings
1	Allen et al., 2016	Oceania	Cross-sectional	General	14065	44.4	53.10	Others	PSQI	Spearman correlation	70 %	+SQ (C; E; A; ES) +Sdur (ES)
2	Atroszko et al., 2015	Europe	Cross-sectional	General	993	21.6	73.82	Others	WHQOL-BREF	Pearson correlation	75 %	+SQ (C; E; A; ES)
3	Atroszko et al., 2018	Europe	Cross-sectional	General	1137	20.3	60.86	Others	WHQOL-BREF	Pearson correlation	75 %	+SQ (ES) -SQ (C; E; A)
4	Calkins et al., 2013	North America	Cross-sectional	General	118	18.9	55.93	NEO	PSQI	Spearman correlation	95 %	+SQ (ES)
5	Carciofo, 2020	Asia	Cross-sectional	General	625	19.8	69.76	BFI	PSQI	Pearson correlation, controlling for age and gender	80 %	+SQ (C; ES)
6	Carciofo, 2021	Asia	Cross-sectional	General	265	20.8	63.77	BFI	PSQI	Spearman correlation	80 %	+SQ (C; E; A; ES)
7	Cellini et al., 2017	North America	Cross-sectional	General	498	26.6	70.88	BFI	PSQI	Spearman correlation	80 %	+SQ (C; E; A; ES)
8	Chang et al., 2015	Asia	Cross-sectional	General	4266	22.2	33.80	Others	PSQI	Odds ratio	77 %	+SQ (ES)
9	Charzyńska et al., 2021	Europe	Cross-sectional	General	1157	20.3	51.94	Others	WHQOL-BREF	Pearson correlation	95 %	+SQ (C; E; A; ES)
10	*Chauvin et al., 2015	Europe	Cross-sectional	Clinical + General	274	49.22	100.00	NEO	PSQI	Pearson correlation	85 %	+SQ (ES)
11	Cheng et al., 2011	Asia	Cross-sectional	General	4318	College students	34.00	Others	PSQI	Odds ratio	77 %	
12	Christian et al., 2011	North America	Cross-sectional	General	250	63.8	74.00	NEO	PSQI	Spearman correlation	90 %	+SQ (ES)
13	Corey et al., 2020	North America	Cross-sectional	General	171	60	91.23	BFI	PSQI	Pearson correlation	90 %	+SQ (C; E; A; ES)
14	Ding et al., 2020	Asia	Cross-sectional	General	1423	19.6	72.03	Others	PSQI	Pearson correlation	85 %	+SQ (ES)
15	Duggan et al., 2014	North America	Cross-sectional	General	430	19.9	50.70	BFI	PSQI	Pearson correlation	85 %	+SQ (C; ES)
16	*Emert et al., 2017	North America	Cross-sectional	General	553	18.8	76.67	BFI	RSQ	Pearson correlation, controlling for sociodemographic variables	85 %	+SQ (C)
17	Fairholme & Manber., 2014	North America	Cross-sectional	General	63	34.4	61.90	NEO	PSQI	Pearson correlation	75 %	ns
18	Fang et al., 2018	Asia	Cross-sectional	General	172	32.2	100.00	BFI	PSQI	Pearson correlation	75 %	+SQ (C; E; ES)
19	Friedman et al., 2007	North America	Cross-sectional	General	94	73.5	100.00	NEO	PSQI	Pearson correlation	95 %	+SQ (ES) +Sdur (ES)
20	Gamaldo et al., 2020	North America	Cross-sectional	General	93	66.6	77.42	BFI	PSQI	Pearson correlation	86 %	+SQ (O; C; ES) -SQ (E)
21	Herlache et al., 2018	North America	Cross-sectional	General	143	19.9	38.46	BFI	PSQI	Pearson correlation	85 %	+SQ (ES)
22	Huang et al., 2016	Asia	Cross-sectional	General	114	57.9	76.32	NEO	PSQI	Pearson correlation	86 %	+SQ (ES)
23	Inagaki et al., 2021	Asia	Cross-sectional	Clinical	56	59.1	39.29	NEO	PSQI	Pearson correlation	95 %	ns
24	Khazaie et al., 2019	Asia	Cross-sectional	General	999	30.7	42.84	Others	PSQI	Standardized Mean Difference	90 %	+SQ (ES)
25	Kim et al., 2015	Asia	Cross-sectional	General	1406	33.3	100.00	NEO	PSQI	Pearson correlation	95 %	+SQ (C; E; A; ES)
26	Kircaburun et al., 2017	Europe	Cross-sectional	General	353	College students	45.89	BFI	SQS	Pearson correlation	75 %	+SQ (C; ES)
27	Lai, 2018	Oceania	Cross-sectional	General	13424	44.3	52.92	Others	PSQI	Pearson correlation	95 %	+SQ (C; E; ES)
28	McHugh et al., 2011	Europe	Cross-sectional	General	505	Range >60	/	Others	PSQI	Spearman correlation	80 %	+SQ (ES)
29	Mead et al., 2021	North America	Cross-sectional	General	358	19.9	68.99	Others	Actigraphy	Pearson correlation	85 %	+Sdur (C) -Sdur (E)

(*continued on next page*)

Table 1 (*continued*)

	Author	Regions	Design	Population	N	Age	Female %	Personality Measure	Sleep Measure	Statistical Method	Quality Assessment	Main Findings
30	Micic et al., 2017	Oceania	Cross-sectional	Clinical	34	22.4	44.12	NEO	PSQI	Pearson correlation	85 %	+SQ (E)
31	Mokros et al., 2017	Europe	Cross-sectional	General	140	22.3	0.00	Others	PSQI	Pearson correlation	90 %	+SQ (ES)
32	Monteiro et al., 2020	Europe	Cross-sectional	General	746	23.8	70.24	Others	GSQQ	Pearson correlation	75 %	+SQ (C; ES)
33	*Muzni et al., 2020	Europe	Cross-sectional	General	671	Range 18-30	38.90	BFI	PSQI	Pearson correlation, controlling for sociodemographic coviriates	90 %	+SQ (C)
34	Ogutlu et al., 2021	Europe	Cross-sectional	General	445	13.3	42.92	BFI	PSQI	Pearson correlation	90 %	+SQ (O; C; ES) +Sdur (O; ES)
35	Onder et al., 2014	Europe	Cross-sectional	General	1251	21	64.99	Others	PSQI	Pearson correlation	85 %	+SQ (C; A; ES)
36	Otaka et al., 2019	Asia	Cross-sectional	Clinical	504	63.9	41.87	Others	PSQI	Pearson correlation	90 %	+SQ (E; ES) -Sdur (ES)
37	Ramsawh et al., 2011	North America	Cross-sectional	General	327	18.9	72.17	NEO	PSQI	Pearson correlation	75 %	+SQ (ES)
38	Rathi et al., 2018	Asia	Cross-sectional	General	166	20.9	46.39	Others	PSQI	Pearson correlation	85 %	+SQ (E; ES)
39	Saksvik-Lehouillier et al., 2022	Europe	Cross-sectional	General	52	22.6	78.85	NEO	PSQI	Pearson correlation	75 %	+SQ (ES)
40	Saunders et al., 2013	North America	Cross-sectional	Clinical + General	255	32.4	60.39	NEO	PSQI	Pearson correlation	85 %	+SQ (ES)
41	Sella et al., 2020	Europe	Cross-sectional	General	122	41	62.30	BFI	PSQI	Pearson correlation	85 %	ns
42	Slavish et al., 2018	North America	Cross-sectional	General	242	46.8	66.53	Others	PROMIS	Pearson correlation	85 %	+SQ (ES)
43	Soehner et al., 2007	North America	Cross-sectional	General	101	31.8	44.55	Others	PSQI	Spearman correlation	85 %	+SQ (ES)
44	Sutin et al., 2020	North America	Cross-sectional	General	620	72.6	54.03	Others	Actigraphy	Pearson correlation controlling for sociodemographic covariates	75 %	ns
45	Tahara et al., 2021	Asia	Cross-sectional	General	4490	47.4	26.70	NEO	PSQI	Spearman correlation	80 %	+SQ (C; E; ES) -SQ (A)
46	Tan et al., 2017	North America	Cross-sectional	General	523	23.5	76.86	BFI	PSQI	Pearson correlation	90 %	+SQ (ES)
47	Tiffin et al., 1995	Europe	Cross-sectional	General	20	35.9	50.00	Others	PSQI	Pearson correlation	68 %	+SQ (ES)
48	Uzarska et al., 2021	Europe	Cross-sectional	General	1156	20.3	51.99	Others	WHQOL-BREF	Pearson correlation	90 %	+SQ (C; A; E; ES)
49	Watson, 2003	North America	Cross-sectional	General	236	College students	52.54	NEO	PSQI	Pearson correlation	77 %	+SQ (C; ES)
50	Williams & Moroz., 2009	North America	Cross-sectional	General	77	19.5	51.95	NEO	PSQI	Pearson correlation	75 %	+SQ (C; ES)
51	Wong et al., 2016	Asia	Cross-sectional	General	166	20.1	66.27	Others	PSQI	Pearson correlation	80 %	+SQ (ES)
52	Yeh et al., 2020	Asia	Cross-sectional	General	864	34.3	70.95	BFI	PSQI	Pearson correlation	80 %	+SQ (O; ES)
53	Zamani et al., 2021	Asia	Cross-sectional	General	343	22	56.27	NEO	PSQI	Pearson correlation	91 %	+SQ (ES)
54	Zhang et al., 2021	Asia	Cross-sectional	General	142	College students	52.11	NEO	SRSS	Spearman correlation	95 %	+SQ (O; C; E; ES)
55	Zhao et al., 2019	Asia	Cross-sectional	Clinical	193	50.3	49.74	BFI	PSQI	Pearson correlation	95 %	+SQ (ES)
56	Catherman et al., 2021	North America	Longitudinal	General	302	18.58	69.87	BFI	PSQI	Spearman correlation	85 %	+SQ (ES)
57	*Dørheim et al., 2016	Europe	Longitudinal	General	3177	31.1	100.00	Others	PSQI	Pearson correlation	90 %	+Sdur (E) -Sdur (A)
58	Krizan & Hisler, 2019	North America	Longitudinal	General	382	53.1	63.00	Others	Actigraphy	Pearson correlation	90 %	+SQ (O; C; E; A; ES) +Sdur (O)

(*continued on next page*)

Table 1 (*continued*)

	Author	Regions	Design	Population	N	Age	Female %	Personality Measure	Sleep Measure	Statistical Method	Quality Assessment	Main Findings
59	Lau et al., 2021	Asia	Longitudinal	General	7181	24.9	64.10	Others	PSQI	Pearson correlation	85 %	+SQ (C; E; A; ES)
60	Parker et al., 2018	Oceania	Longitudinal	Clinical	332	88.2	28.61	Others	PSQI	Pearson correlation	91 %	+SQ (ES)

Notes: This table is sequenced by the design of the studies by alphabetical order. In the column of personality measure, label "Others" includes ABPT, EPI, EPQ, EPQ-R, IPIP, MIDI, mini-marker, MPI, TIPI, MPQ, and ZKPQ while "NEO" label includes NEO-FFI, NEO-PI, NEO-PI-R, and NEO-PI-3; "BFI" label includes BFI, BFI-10, BFI-44, BFAS, and BFQ. In the column of quality assessment, >75 % indicates high quality, 50–75 % indicates moderate quality, <50 % indicates low quality.
Abbreviations: SQ = sleep quality; Sdur = sleep duration; O = openness; C = conscientiousness; E = extraversion; A = denotes agreeableness; ES = emotional stability. "/" and "*" refer to missing information and studies included for qualitative analysis, respectively. "+", "-", "ns" refer to positive, negative, and insignificant associations, respectively. "General" and "clinical" indicates the general and clinical population, respectively.

between conscientiousness and sleep quality after controlling for demographic variables and alcohol consumption in young adults [46].

3.2.4. Sleep quality and agreeableness (n = 29)

Twenty-nine studies examined the association between sleep quality and agreeableness, and all provided relevant data for pooling effect sizes [19,20,26,27,40,42,47,50,52–72]. The result suggested that a higher degree of agreeableness was associated with better sleep quality (r = −0.064, 95 %CI = −0.098, −0.031, $p < 0.001$, I^2 = 80.3 %, standard Z = −9.83) (Fig. 2D). After omitting one influential study [66], the association remained significant (r = −0.063, $p < 0.001$) (Fig. S2D). Subgroup analyses (Table S1) found a significant association between sleep quality and agreeableness in the general population (r = −0.063, $p < 0.001$) but not in the clinical populations (r = −0.086, p = 0.290). Furthermore, significant associations between sleep quality and agreeableness were found across different assessment tools of sleep quality (PSQI: r = −0.074, $p < 0.005$; others: r = −0.052, p = 0.022), and in studies using BFI-related inventories (r = −0.104, p = 0.009) and other personality inventories (r = −0.052, $p < 0.001$). In studies with a medium sample size (r = −0.068; p = 0.026), a significant association between sleep quality and agreeableness was found. This association remained significant across different geographic regions.

3.2.5. Sleep quality and neuroticism (n = 58)

There were 58 studies that assessed the association between sleep quality and neuroticism whilst 55 of them were included for meta-analysis 18–20,24,26,27,40–42,44,47–92. The pooled result suggested that individuals with higher levels of neuroticism tended to report poorer sleep quality (r = 0.287, 95 %CI = 0.253, 0.327, $p < 0.001$, I^2 = 87.9 %, standard Z = 68.42) (Fig. 2E). The association of sleep quality and neuroticism remained significant (r = 0.284, $p < 0.001$) after omitting one influential study in the sensitivity analysis (Fig. S2E). Significant associations between sleep quality and neuroticism retained across different populations, geographic regions, or study sample sizes and regardless of the use of different measurements of sleep quality and personality (Table S1). Qualitative review was conducted in three studies due to a lack of sufficient data for computing the effect sizes [46,51,75]. Two studies found that a higher degree of neuroticism was associated with poorer sleep quality among healthy young adults [46,75]. Another study reported similar results, namely a higher level of neuroticism was associated with poorer self-reported sleep quality in both individuals with insomnia and good sleepers [51].

3.2.6. Sleep duration and NEO-five personality traits

Twelve studies that examined the relationship between NEO-five personality traits and sleep duration were included in the meta-analysis (Fig. 3). Shorter sleep duration was significantly associated with a higher degree of neuroticism (n = 12, r = 0.066, 95 %CI = 0.021, 0.111, $p < 0.001$, I^2 = 46.2 %, standard Z = −10.23). No significant association was found for other personality dimensions, namely openness (n = 8, r = −0.012, 95 %CI = −0.072, 0.047, p = 0.684, I^2 = 60.4 %, standard Z = 1.19), conscientiousness (n = 9, r = −0.048, 95 %CI = −0.104, 0.008, p = 0.095, I^2 = 61.7 %, standard Z = −4.38), and extraversion (n = 9, r = 0.037, 95 %CI = 0.004, 0.078, p = 0.075, I^2 = 23.2 %, standard Z = −3.08), and agreeableness (n = 8, r = −0.013, 95 %CI = −0.030, 0.004, p = 0.1366, I^2 = 0 %, standard Z = −1.58). In one of the qualitatively assessed studies, which included 3177 pregnant women, sleep quantity, as derived by the sleep duration subscale of PSQI, was found to be associated with extraversion (B = 0.059, p = 0.01) and agreeableness (B = 0.002, p = 0.02) after adjusting for anxiety, depression, age and parity at 32-week of pregnancy [93]. Another study showed that longer sleep duration (as measured by PSQI) was associated with a higher level of neuroticism, agreeableness, extraversion and conscientiousness but a lower level of openness among young adults aged between 18 and 30 years old [46].

3.2.7. Publication of bias and meta-regressions

The results indicated no significant publication bias for all the associations between sleep quality and NEO-five personality traits, namely openness (t = −2.06, p = 0.05), conscientiousness (t = −0.67, p = 0.51), extraversion (t = 0.83, p = 0.42), agreeableness (t = −1.28, p = 0.21), and neuroticism (t = 1.35, p = 0.18). Similar finding was found for the relationship between sleep duration and neuroticism (t = 1.29, p = 0.20). Their funnel plots were provided in Fig. S3.

Meta-regression findings suggested age did not moderate the associations between sleep characteristics and personality traits. Female gender significantly moderated the link between sleep quality and agreeableness with a modest effect (β = -0.199, 95 % CI = −0.396, 0.002, p = 0.047). The severity of depressive and anxiety symptoms was found to moderate the relationship between sleep quality and neuroticism (depression: β = 0.012, 95 % CI = 0.003, 0.022, p = 0.013; anxiety: β = -0.198, 95 % CI = −0.398, 0.002, p = 0.052). The severity of depressive symptoms significantly moderated the relationship between neuroticism and sleep duration (β = 0.051, 95 % CI = 0.012, 0.090, p = 0.011). More details can be found in Table S2.

4. Discussion

The objective of this study was to systematically examine the association between NEO-five personality traits and sleep-related characteristics, especially sleep quality and duration. To the best of our knowledge, this was the first systematic review to summarize this relationship. In general, an intricated relationship between NEO-five personality traits and sleep quality and duration was observed. Notably, poor sleep quality was associated with a higher degree of neuroticism but with a lower degree of openness, conscientiousness, extraversion and agreeableness. Shorter sleep duration was correlated with a higher level of neuroticism, but not with openness, conscientiousness, extraversion, and agreeableness.

4.1. Sleep and neuroticism

Of the five personality dimensions, neuroticism was most commonly investigated in the existing literature, and was found to have a stronger

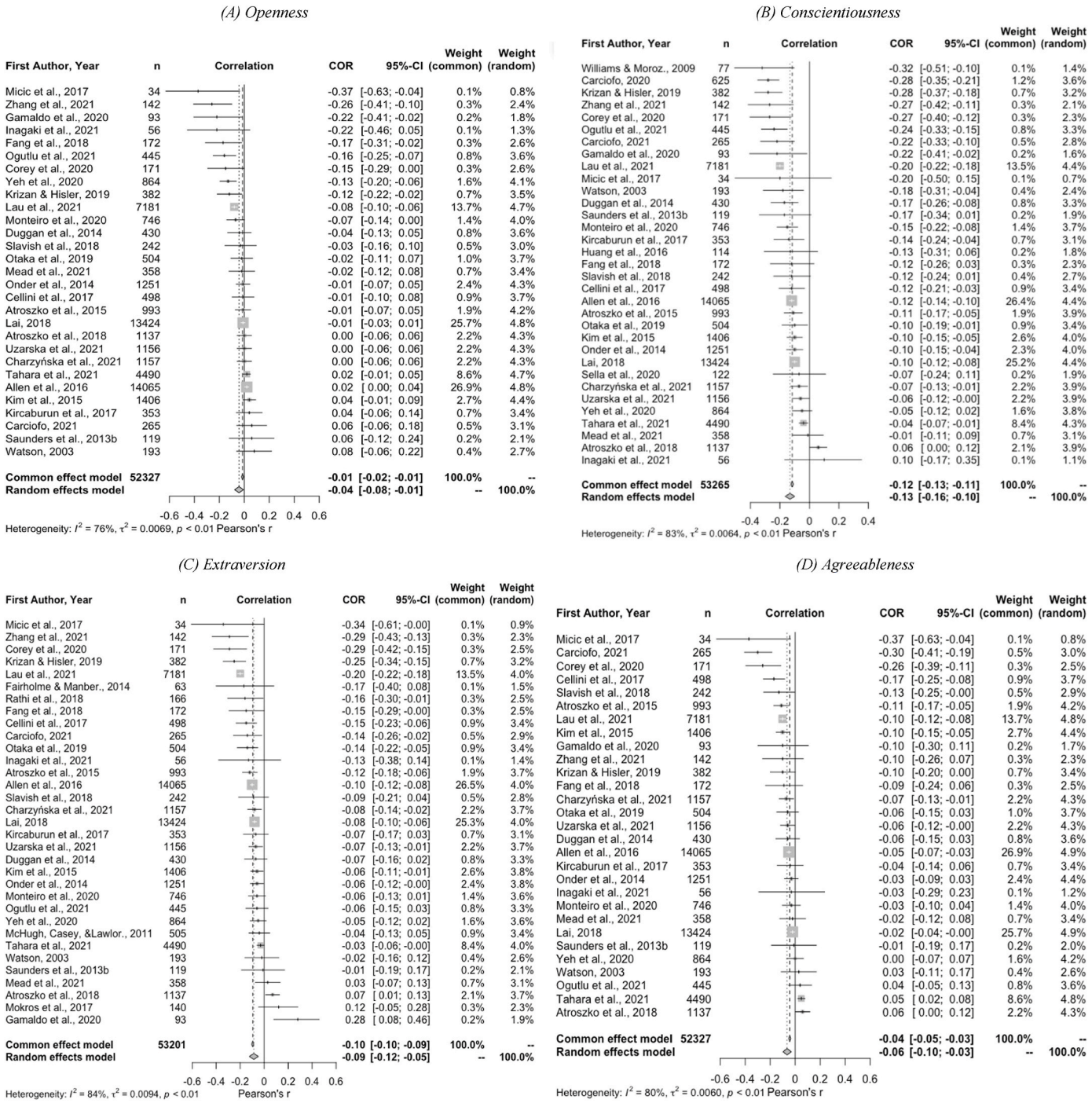

Fig. 2. Forest plot of the pooled effect sizes of the association of sleep quality with personality traits.

association with sleep-related characteristics, especially sleep quality and duration. The results were in accordant with the findings from two previous meta-analyses on the relationship between sleep quality and two sub-facets of neuroticism (i.e., self-control and aggression) [28,94,95]. Guarana and colleagues identified 61 studies and found poor sleep quality was significantly associated with a lower degree of self-control (inhibiting impulses and overcoming temptations) with a small-to-moderate effect size (|r| = 0.26–0.35) [28]. Likewise, Veen and colleagues identified 96 studies and suggested that poor sleep quality was significantly associated with a higher degree of aggression (|r| = 0.28) [95]. However, the underlying mechanisms of such associations remain elusive. It is possible that heightened arousal level may underlie the link between neuroticism and sleep quality. As supported by electroencephalographic evidence, neuroticism is associated with a heightened physiological response to stress, which may lead to a longer time for ones to return to a restful state after experiencing events with acute stress [22,96–100]. Earlier empirical studies also demonstrated the relationship of negative affect, rumination and perceived stress with sleep quality with a small to moderate effect size (r = |0.30–0.38|), suggesting that those with higher levels of negative affect and rumination tend to report poorer sleep quality [61,65,87]. Moreover, neuroticism has been found to be associated with more sleep-related

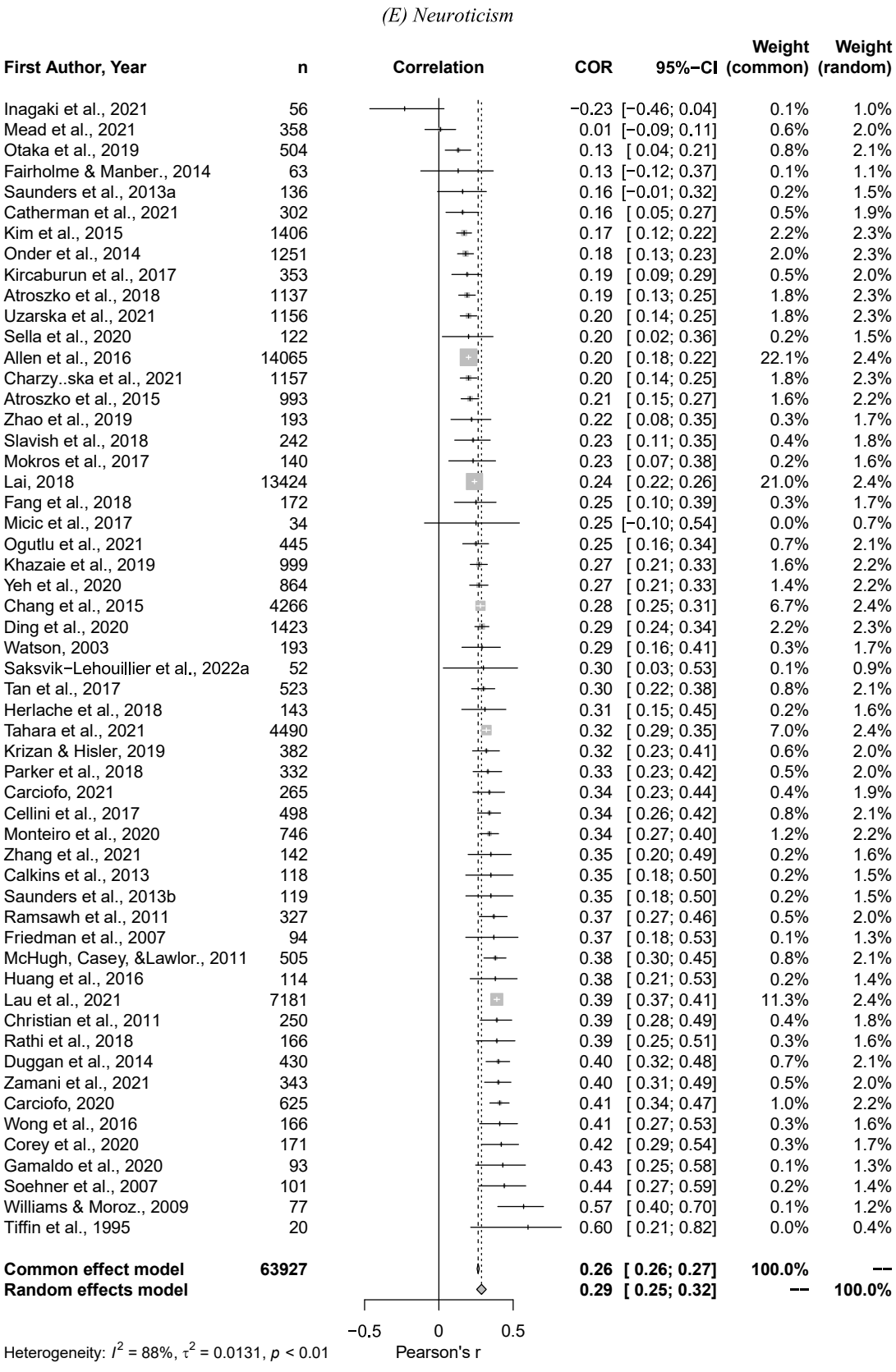

Fig. 2. (*continued*).

dysfunctional beliefs, which reflected a heightened level of cognitive arousal before sleep [24,51,59,87]. Such increased cognitive processing, especially before bedtime, might be the underlying mechanism explaining the relationship between neuroticism and sleep quality. Nonetheless, since previous studies were primarily carried out during daytime or pre-sleep period instead of sleep period, the interplay among

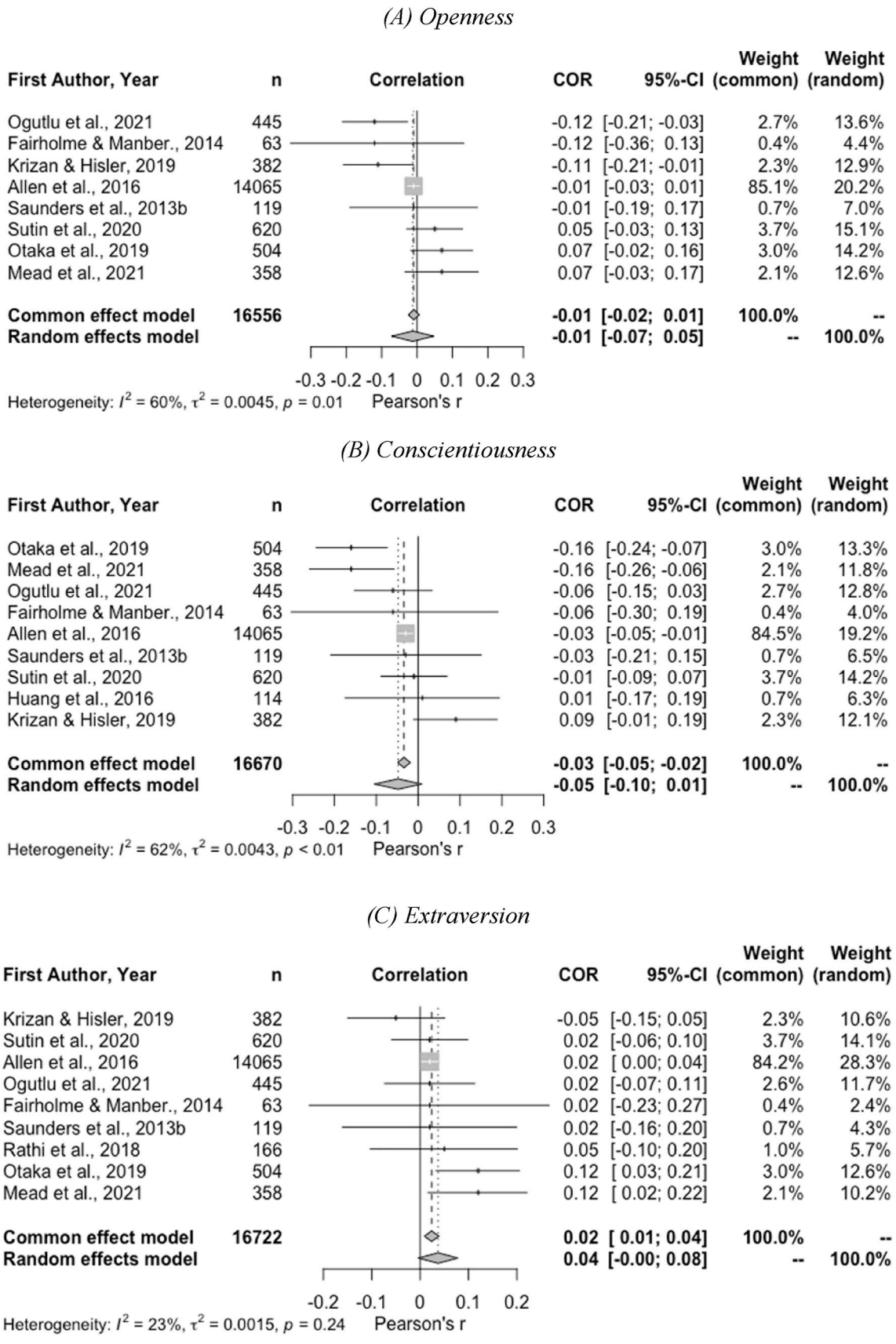

Fig. 3. Forest plot of the pooled effect sizes of the association of sleep duration with personality traits.

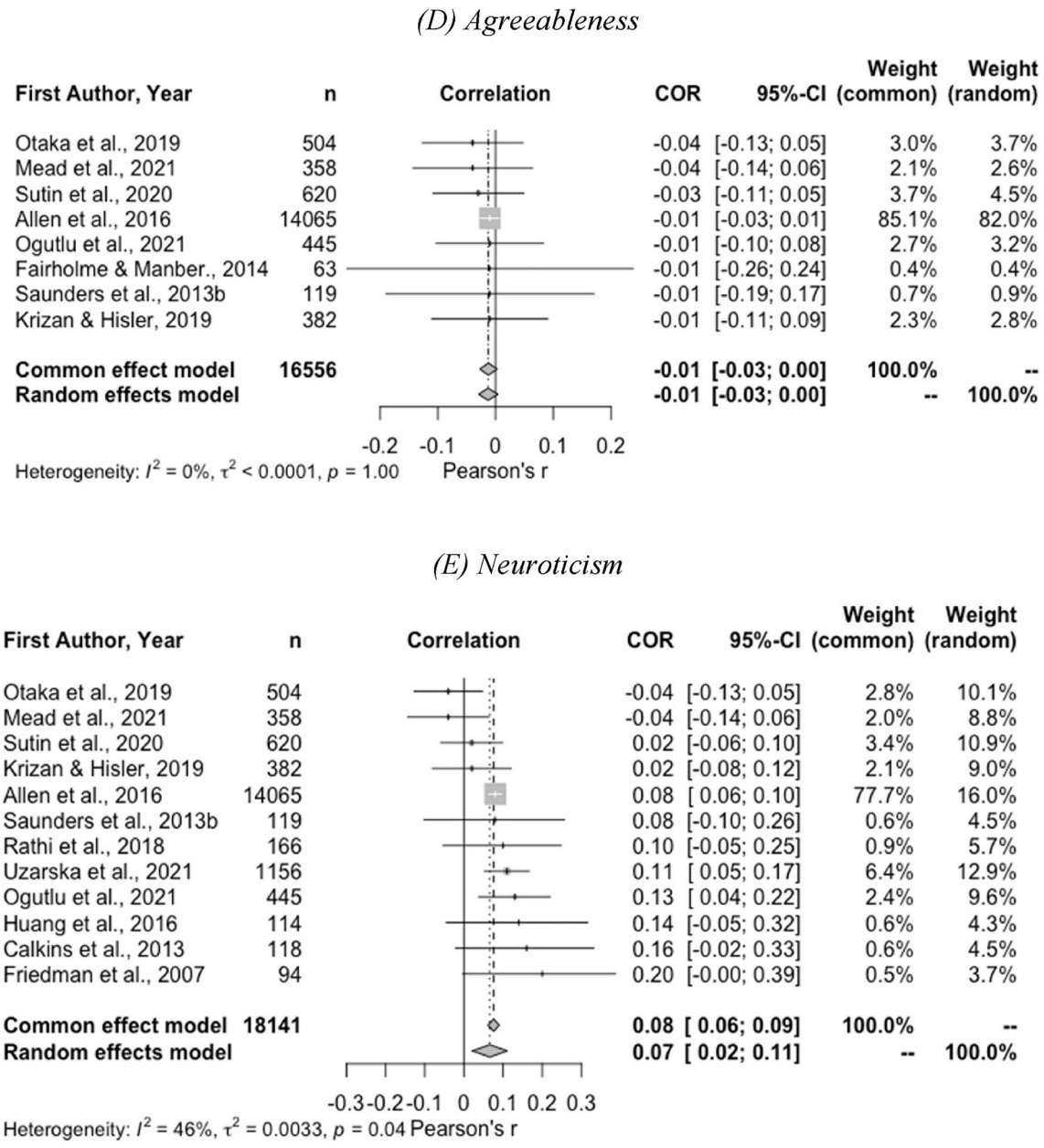

Fig. 3. (*continued*).

personality traits, cortical arousal, and diurnal sleep is yet clear. More research using objective measures including polysomnography and neuroimaging techniques is needed to explore whether night time cortical activity might be implicated in the relationship between neuroticism and sleep disturbances.

Shorter sleep duration has been found to only be associated with a higher level of neuroticism but not with the other personality dimensions. Previous research suggested that overlapping genetic factors may explain the phenotypic associations between neuroticism and sleep duration, albeit that the specific genetic component is yet to be identified [101]. Furthermore, both short sleep duration and neuroticism have been found to be associated with hyperarousal. Specifically, a high level of neuroticism was associated with heightened alpha and beta activities, which are the typical band power suggestive of cortical hyperarousal [102,103]. In this regard, individuals with PSG-derived short sleep duration (<6 h) were also found to have a heightened level of cortical arousal as compared to those with normal sleep duration (>6 h) [104–108]. More research is needed to further explore the possible factors underlying the mechanism linking short sleep duration and neuroticism.

4.2. Sleep and other personality dimensions

Significant associations between sleep quality and other personality dimensions, namely openness, conscientiousness, extraversion, and agreeableness were also found. Although there has been limited research to explore the physiological mechanism underlying this link, lifestyle habits and practices, such as substance use, regularity of sleep pattern, and physical activity, may explain the association of sleep quality and these personality features [30,109–112]. Furthermore, those with high levels of conscientiousness, extraversion, and openness are more likely to use adaptive coping strategies, which may buffer the negative effects of stress on sleep quality [113–116]. Subgroup analyses showed a more consistent pattern of associations between those personality traits and sleep quality in the general population but not in the clinical populations. On the other hand, the meta-regression results suggested the

severity of depressive and anxiety symptoms significantly moderated the associations between sleep quality and neuroticism. In the same vein, a previous meta-analysis reported a stronger association between personality trait (i.e., aggression) and sleep quality in individuals with psychological or medical conditions as relative to healthy individuals [95]. One potential explanation might be related to the limited number of studies conducted in adults from the clinical populations (clinical population: n = 6, sample size = 1316; general population: n = 54, sample size = 72,224). Therefore, future studies are warranted to further delineate the relationship between sleep and personality traits among individuals with clinical disorders. In terms of the potential moderating factors in the association between sleep-related characteristics and personality traits, the results showed that gender (i.e., the percentage of female participants in the whole sample) significantly moderated the correlation between sleep quality and agreeableness with a modest effect (ß = −0.21). Previous studies suggested that female gender is associated with poorer sleep quality, whilst females also tend to be more agreeable as relative to their male counterparts [117]. It has been suggested that individuals with a higher degree of agreeableness are more attentive to physical and mental health issues, which, in turn, more likely to report poorer sleep quality [118,119].

4.3. Strengths and limitations

This study was the first systematic review synthesizing the results on the relationship between NEO-five personality traits and sleep-related characteristics (i.e., sleep quality and duration). Some limitations of the current study should be noted. Firstly, although the number of studies and the overall sample size included in our meta-analysis were large, most of the samples were based on adults from the general population, which may limit the generality of the findings to other age groups and clinical populations. For instance, there was only one of the included studies conducted in adolescents (participants aged under 18) while all the other studies were conducted in the adult samples. Furthermore, the findings of the present meta-analysis primarily focused on cross-sectional associations (55 cross-sectional studies, 5 longitudinal studies). Although there were some longitudinal studies that measured sleep and personality characteristics at few different time waves, we could only identify one study with a four-year follow-up to prospectively examine the predictive effects of big five personality traits on sleep quality, which showed that a greater degree of neuroticism and a lower level of extraversion and conscientiousness predicted lower sleep quality. However, this study did not include an objective measure of sleep or individuals with sleep-wake disorders. Therefore, more longitudinal research, especially including mendelian randomization genetic studies, is warranted to further explore the potential genetically causal relationship between personality traits and sleep-related characteristics. In addition, although the meta-regression results suggested that mood symptoms, including depressive and anxiety symptoms, moderate the association between neuroticism and sleep quality, mediation analyses or structural equation modelling was not performed due to insufficient effect sizes. Future studies are warranted to examine the interplay among personality traits, sleep disturbances, and mental disorders, which may shed light on the early identification of individuals with a higher risk of developing or experiencing mental illness and implement targeted prevention or intervention. More studies based on the clinical samples are also warranted to explore whether other clinical characteristics (e.g., the onset, duration, and symptom severity of other physical and mental disorders) may play a role in moderating the relationship between personality traits and sleep.

4.4. Implications and conclusion

Neuroticism is the only personality dimension found to be associated with sleep duration. Neuroticism is also referred to as '*negative emotionality*' characterized by more frequent and persistent negative emotions and stress responses, or being inversely labelled as '*emotional stability*' [59,120,121]. In a 6-month prospective study, NEO-five personality traits, especially neuroticism, was found to positively predict insomnia severity [122]. Another recent study suggested that a higher degree of neuroticism and a lower level of extraversion are associated with future neurodegenerative phenoconversion in idiopathic rapid eye movement sleep behavior disorder (iRBD) patients, suggesting that NEO-five personality traits are associated with sleep problem other than insomnia [123]. The current findings may have the implications in informing early identification of individuals at a higher risk of developing sleep disturbances and considering personality traits when designing early prevention or tailored intervention for sleep problems.

Empirical evidence suggested that personality traits, especially a higher level of neuroticism and lower degree of extraversion and conscientiousness, are associated with psychopathological symptoms, especially the severity of depressive, anxiety, and psychotic symptoms [124–126]. Furthermore, our findings indicated depressive symptom as a moderator of the relationship between neuroticism and sleep, especially poor sleep quality and shorter sleep duration. Similarly, a 4-year longitudinal study suggested that neuroticism underlies the association between sleep disturbances and the onset of depression [127]. The findings underscore the important role of neuroticism in the relationship between sleep disturbances and mental health outcomes, emphasizing the need to attend to these interconnected factors in clinical practice and intervention strategies.

In sum, the current meta-analytic results showed that individuals with a lower degree of openness, conscientiousness, extraversion and agreeableness and a higher level of neuroticism tend to have poorer sleep quality, whilst individuals with a higher degree of neuroticism tend to have shorter sleep duration. Future research should consider adopting longitudinal study design, diverse study populations and device-derived sleep measurements to confirm the robustness and generalizability of the association between sleep and personality traits.

5. Practice points

- Poor sleep quality is associated with a lower degree of openness, conscientiousness, extraversion, and agreeableness and a higher level of neuroticism.
- Shorter sleep duration is associated with a higher level of neuroticism.
- Female gender moderates the association between sleep quality and agreeableness.
- Depressive and anxiety symptoms moderate the association between sleep quality and neuroticism.

Research agenda

Given the limitations in the existing literature, future studies should consider to:

- Further examine the relationship between sleep related characteristics and personality features in clinical populations, especially those individuals with insomnia or other sleep-wake disorders.
- Explore the causal relationship between sleep-related features and the NEO-five personality traits using a longitudinal study design and objective measurements.
- Explore the mechanisms underlying the association between sleep-related characteristics and NEO-five personality traits.

Conflict of interest

Y.K.Wing. Received consultation fee from Eisai Co., Ltd., honorarium from Eisai Hong Kong for lecture, travel support from Lundbeck HK limited for overseas conference and honorarium from Aculys Pharma, Inc for lecture. JWY Chan received a personal fee for joining an expert

panel meeting of Eisai Co., Ltd. Other authors declare that they have no conflicts of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.smrv.2025.102081.

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