American Journal of Alzheimer's Disease & Other Dementias®
Volume 37: 1–10
© The Author(s) 2022
Article reuse guidelines:
sagepub.com/journals-permissions
DOI: 10.1177/15333175221141535
journals.sagepub.com/home/aja
SAGE

Does Long-Term Shift Work Increase the Risk of Dementia? A Systematic Review and Meta-Analysis

Yang Hai, PhD[1], Ying Xue, BD[2], and Yu-hong Wang, MD, PhD[2]

Abstract

Background: Shift work is associated with impaired sleep quality and disrupted circadian rhythms, but the way in which it increases the risk of dementia remains controversial. We conducted a systematic review and meta-analysis to assess the integrated risk of dementia with shift work. **Methods**: Searching in PubMed, Cochrane Library, and the Web of Science databases, the relative risks of dementia with shift work were extracted from 12 included studies with 3975 dementia cases from 84 492 participants. The subgroup analysis was stratified by age, gender, sample size, dementia cases, shift schedule, occupation, and follow-up time. Heterogeneity analysis and publication bias analysis were conducted for quality control. **Results**: The pooled risk ratios (RRs) of dementia with shift work were 1.15 (95%CI = 1.02-1.30). The subgroup analysis found that continuous evening shifts reversibly reduced the risk, but continuous night shifts remarkedly increased the risk of dementia. In addition, a larger cohort and longer follow-up significantly increased the risk of dementia with shift work. **Conclusion**: Shift work shows mild increases in the risk of dementia using meta-analysis.

Keywords

shift work, risk of dementia, circadian rhythm, meta-analysis, population

Introduction

Dementia is an increasing global health concern, particularly with the extending lifespan of human beings. As the most common clinical type of dementia, Alzheimer Disease (AD) accounts for up to 80% of all dementia cases.[1] The prevalence of age-dependent AD increasingly boomed by 146.2% from 2000 to 2018, becoming the fifth cause of death worldwide among people over 65 years of age.[1,2] However, there is still a lack of an effective remedy for dementia. Therefore, it is of strategic significance to screen modifiable risk factors/behaviors in adulthood that could decrease the incidence of dementia in elderhood. With the rapid development of industrialization, shift work is increasingly required for numerous careers that offer 24 h of round service or production.[3] Approximately 16% of employees earning wages and salaries were scheduled for shift work in the U.S. in 2020 (https://www.bls.gov). Irrespective of its undetermined definition, shift work is generally defined as an employment practice that employs workers outside of the hours of 7:00 AM to 6:00 PM[3] Such a schedule negatively impacts sleep quality[4,5] and the normal circadian rhythm, and thereafter, impairs numerous physical functions, including advanced psychoneurological function, metabolic hemostasis, and cardiovascular health.[6-9] Numerous studies have suggested that exposure to shift work may influence the development of neurodegeneration and accelerate neurological aging,[10,11] as well as cognitive function.[12-15] Disturbance of the circadian rhythm has been shown to suppress hippocampal

[1]College of International Education, Harbin Medical University, China
[2]Department of Geriatrics, The First Affiliated Hospital of Harbin Medical University, Harbin, China

Corresponding Author:
Yu-hong Wang, Department of Geriatrics, The First Affiliated Hospital of Harbin Medical University, No. 23 Youzheng Street, Harbin, Heilongjiang 150001, China.
Email: Dr.yuhongwang@gmail.com

Creative Commons Non Commercial No Derivs CC BY-NC-ND: This article is distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs 4.0 License (https://creativecommons.org/licenses/by-nc-nd/4.0/) which permits non-commercial use, reproduction and distribution of the work as published without adaptation or alteration, without further permission provided the original work is attributed as specified on the SAGE and Open Access pages (https://us.sagepub.com/en-us/nam/open-access-at-sage).

neurogenesis in animal studies.[16] Exposure to shift work, even merely 1 night, could significantly disturb sleep and impair short-term memory.[17-19] Studies have revealed that AD affects the functioning areas in the brain responsible for sleep–wake regulations.[20,21] Poor sleep has been shown to contribute to the progression of AD.[21-23] Moreover, chronic memory loss has also been shown as common in shift workers.[24,25] A linear decrease in memory has been shown with prolonged exposure to shift work, indicating a cumulative correlation between shift work and cognitive impairment.[24] Shift work has also been shown to be independently correlated with numerous neurological domains.[19,24,26] Therefore, it seems that long-term shift work greatly reduces cognitive function by impairing sleep and the circadian rhythm.[24] However, not all findings draw such a negative correlation between shift work and cognitive decline, including dementia.[15,27-32] As individual studies have not been able to provide convincing conclusions due to a lack of comprehensive interactions between shift work exposure and dementia, we systematically reviewed and integrated all previous studies using meta-analysis to estimate the potential risk of dementia with exposure to shift work.

Methods

Data Sources and Literature Search

The present study was conducted following the guidelines of the Meta-analysis on Observational Studies in Epidemiology protocol (MOOSE) and the Preferred Items for Systematic reviews and Meta-Analyses (PRISMA) statement (Supplementary Table S1).[33,34] A systematic literature search was conducted using electronic data from 3 databases: PubMed, Cochrane Library, and the Web of Science from their inception to 23 November 2021. Observational studies that provided estimates of the risk of shift work on dementia were extensively searched. The search terms were: "shift work, shiftwork" and "dementia, Alzheimer's disease, Lewy body disease, primary progressive aphasia, progressive supranuclear palsy, Huntington disease, Creutzfeldt Jakob disease, and Wernicke Korsakoff syndrome." The search results from the 3 databases are respectively addressed in Supplementary Table S2. Additionally, a hand search was carried out of all of the reference lists to identify all relevant original publications and reviews. No language restrictions were imposed.

Study Selection

Two researchers independently scanned the titles and abstracts. Animal studies, clinical trials, reviews, letters, and commentaries were excluded. A full-text scan was performed to identify potentially eligible studies. The eligibility of the studies was determined using the following 4 inclusion criteria: (1) Designed as an observational study, including a cohort or case–control study design; (2) included a measurement on shift work defined as either night work, evening work, irregular work, rotational work, or a combination of these; (3) provided an estimated risk of dementia based on a reliable diagnosis; (4) omitted shift work as the core cause of dementia with an independent reference group. Disagreement about the study selection was resolved by discussion and consultation to reach a consensus.

Data Extraction

Two authors independently extracted data, including information on the authors, publication year, country of origin, study design, sample size, number of cases, participant characteristics (age and gender), duration of follow-up, definition of shift work, dementia measurements, risk estimates, a corresponding 95%CI, and adjusted covariates in the statistical analysis. When the original studies had several adjustment models, the risk estimates that represented the maximum extent of adjustment for potentially confounding variables were extracted. Disagreements were discussed to reach a consensus.

Statistical Analysis

Meta-regression analyses were conducted the random effects models using DerSimonian and Laird method. During the present estimate of pooled risk ratios, hazard ratios and incidence rate ratios were deemed equivalent to RRs. The statistic I^2 was estimated to assess the heterogeneity of between-study variations: Values between 0 and 30% represented minimal heterogeneity; between 31 and 50%, moderate heterogeneity; exceeding 50%, To identify the source of potential heterogeneity, a subgroup analysis was conducted with baseline age (>50 and <50 years), gender, follow-up duration (>15 and <15 years), sample size (>5000 and <5000), number of dementia cases (≥100 and <100), schedule of shift work (evening shift, night shift, and rotating shift for cross-sectional schedule; evening–evening shift, night–night shift, rotating–rotating shift, and changeable shift for continuous schedule), and occupation (nurse or non-nurse). A statistical test of interaction was conducted to analyze the disparity between the subgroups.[35] All the analyses were performed with Stata version 16.0 (Stata Corp, College Station, TX). All the tests were two-sided, with a significance level of .05.

Quality Assessment

Sensitivity analyses were conducted to assess the impact of "missing" studies by sequentially removing 1 study at 1 time and re-pooling the remaining studies.[36] Publication bias was assessed with the Begg correlation test,[37] and the Egger linear regression method[38] and a visual inspection of the funnel plot.

The study quality was assessed using the Newcastle–Ottawa Scale (NOS).[39] A study with at least 7 points was defined as a high-quality study.

Results

Study Selection

A search flow diagram is shown in Figure 1. We retrieved 1991 articles and retained 1786 unique references by removing duplicates. Using PRISMA-based reviewing, we retrieved 13 studies for full-text reviewing after excluding 37 reviews. Four cohorts were finally selected.[29-32] During the search, 1 disagreement was that the same cohort was analyzed for 2 different outcomes (dementia incidence/dementia mortality).[29,40] A consensus was reached by retaining 12 studies using dementia incidence as the outcome, characterized by a larger sample size and more details. In summary, 4 articles comprising 5 studies were included, addressing 8 risk estimates of dementia with shift work exposure.

Study Characteristics

The characteristics of the included studies are summarized in Table 1.

All the included studies were prospective cohort studies conducted in northern European countries (Sweden/Demark) and published within the last 5 years (2017-2020). These cohorts presented 3975 dementia cases from 84 492 participants, with an average follow-up duration of 9.8-41.2 years. The average age of the participants at baseline ranged from 37.8 to 60.9 years, indicative of the majority of the shift work exposure experienced in laboring time. Among these cohort studies, 1 study enrolled only occupational nurses[29]; the remaining 4 studies enrolled occupationally mixed populations.[30-32] One study only enrolled male workers[32]; 1 study only female workers[29]; the remaining 3

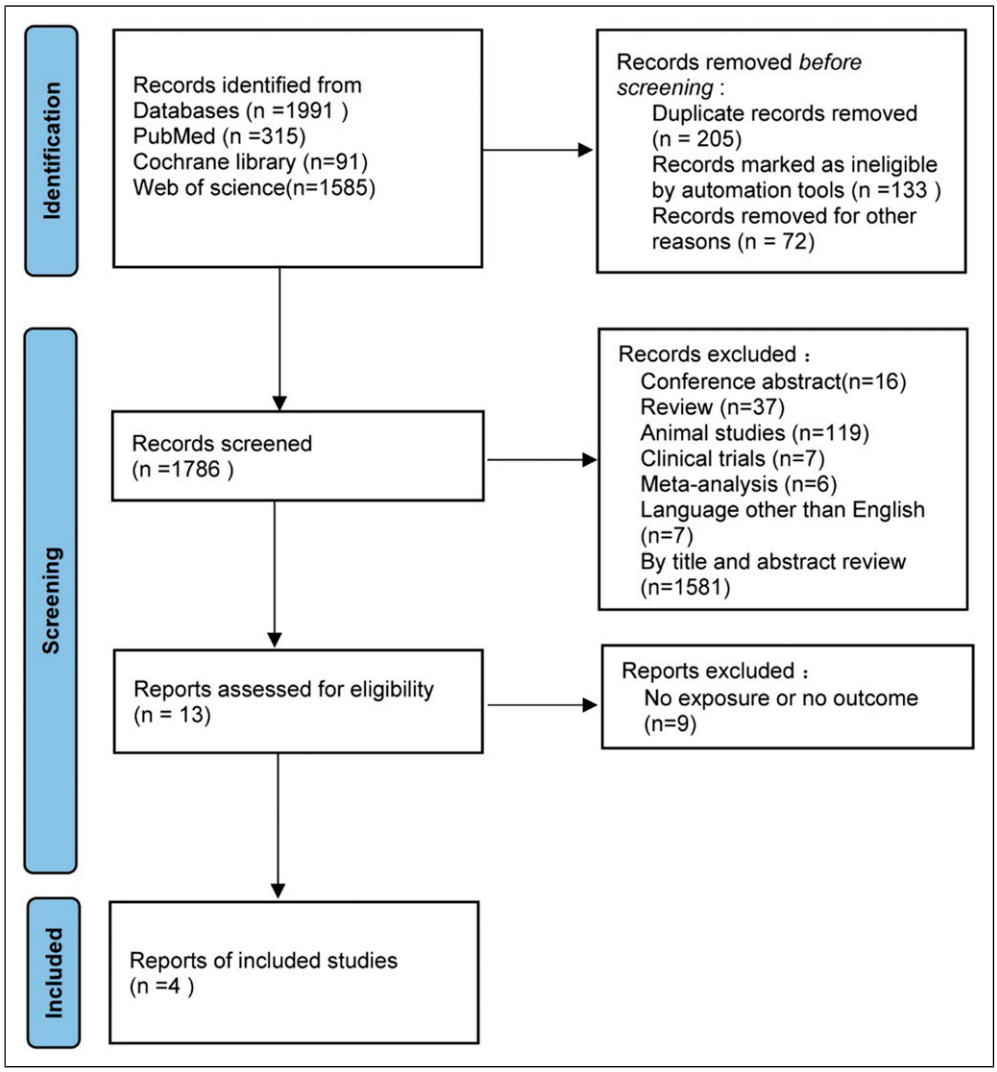

Figure 1. Search flow diagram for the systematic review on risk of dementia with shift work.

Table 1. Characteristics of the Studies Included in the Meta-Analysis.

Author, Year, Country, Study Name	Follow-Up Years	Occupation	Baseline Age, years	*N* (% Female)	Cases	Shift Schedule	Dementia Ascertainment	Dementia Criteria	Covariates	NOS
Nabe-Nielsen et al., 2017, Denmark, CMS	17.8	Not specified	60.9	4731 (0)	629	Shift work	Linkage to national patient and death register	ICD-8, ICD-10	Long working hours, current age, time since exposure assessment, calendar year and socioeconomic status, smoking, physical activity during leisure time, alcohol consumption, BMI, cardiovascular disease, and diastolic and systolic blood pressure	8
Bokenbergeret al., 2018, Sweden, STR	41.2	Not specified	37.8	13 283 (51.50)	983	Shift work	Linkage to national patient register	ICD-8, ICD-9, ICD-10	Age, sex, education, diabetes, cardiovascular disease, and stroke	8
Bokenberger et al., 2018, Sweden, SALT	14.1	Not specified	58.1	41 199 (53.3)	1979	Night work	Linkage to national patient register	ICD-8, ICD-9, ICD-10	Age, sex, education, diabetes, cardiovascular disease, and stroke	8
Nabe-Nielsen et al., 2019, Denmark, DWECS	9.8	Not specified	45.5	3339 (50.3)	83	Shift work night work	Linkage to national patient and death register	ICD-8, ICD-10	Gender, age, time since exposure assessment, calendar year, duration of vocational education, smoking, BMI, and hypertension	8
Jorgensen et al., 2020, Denmark, DNC	16	Nurses	50.3	24 940 (100.0)	301	Evening, night, and rotating shifts	Linkage to the national death register	ICD-8, ICD-10	Age, smoking, physical activity, BMI, alcohol consumption, diet, pre-existing diseases, self-reported health, stressful work environment, marital status, and female reproductive factors	7

CMS, Copenhagen male study; STR, Swedish twin registry; SALT, Screening across the lifespan twin; DNC, Danish nurse cohort; DWECS, Danish work environment cohort study; NOS, Newcastle–Ottawa scale; ICD, International classification of diseases.

studies included both male and female workers.[30,31] For all cohorts, a broad definition of shift work was used and included workers working outside the conventional day time. One study categorized shift work schedules into 3 subtypes: Evening shifts (3:00 PM.–11:59 PM), night shifts (11:00 PM.–7:00 AM), and rotating shifts.[29] One study categorized shift work based on shift schedules with or without night work.[31] All the studies used non-shift day workers as the reference group. All the diagnoses for dementia were identified based on records in the nationwide registered databases of disease or death where the studies were conducted. All the diagnoses referred to the WHO International Classification of Disease (ICD) criteria. All the studies used the incidence of dementia as the outcome.

Meta-RRs of Dementia With Shift Work Exposure

Twelve reports from 4 cohorts presented a positive association between shift work exposure and the incidence of dementia, while only 2 reports presented a negative 1. The pooled RR of dementia with shift work exposure was 1.15 with 95%CI 1.02∼1.30 (Figure 2).

The meta-regressed findings have address high overall heterogeneity (I^2 = 52.8%, P = .016), which was category to considerable heterogeneity (greater than 50%).[41] As all the studies were of good quality (NOS scores are shown in Supplementary Table S3), sensitivity analysis was further conducted by leave-one-out analysis to show the consistency of the pooled RR.

Sensitivity Analysis

We obtained the influence of 1 single study by respective new meta-estimated effect using sensitivity analyses (Figure 3, Supplementary Table 4S). An overall symmetric distribution was shown as 7 increased pooled RRs and 5 decreased pooled RR by omitting-one-study-at-a-time. The largest fluctuation was shown by removing 2007 (remaining pooled RR = 1.198, 95%CI 1.075∼1.335) or by removing 2018(STR) (remaining pooled RR = 1.115, 95%CI .982∼1.265), which were close to the overall effect. Therefore, the pooled RR of dementia with shift work exposure was considered stable.

Publication Bias

No evidence of publication bias was shown by using Egger's test (P = .687) or Begg's test (P = 1.000) (Supplementary Figure S1). We also visualized the publication bias by the funnel plot (Figure 4). The results indicate that the combined estimate and 95%CI were not influenced by any single report.

The symmetry of the funnel plot indicates no publication bias in the present meta-analysis on the risk of dementia with shift work exposure. The solid vertical line represents the

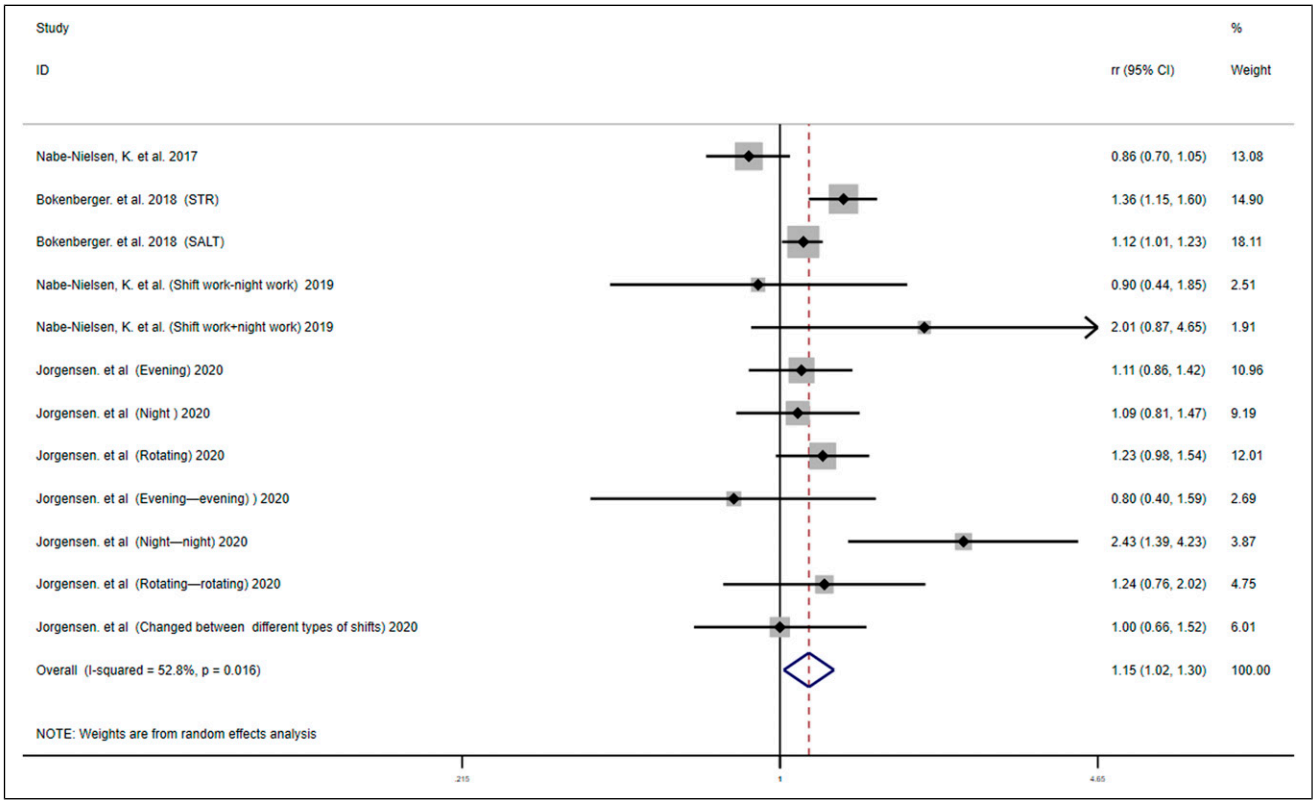

Figure 2. Forest plot of risk estimation of dementia with shift work exposure.

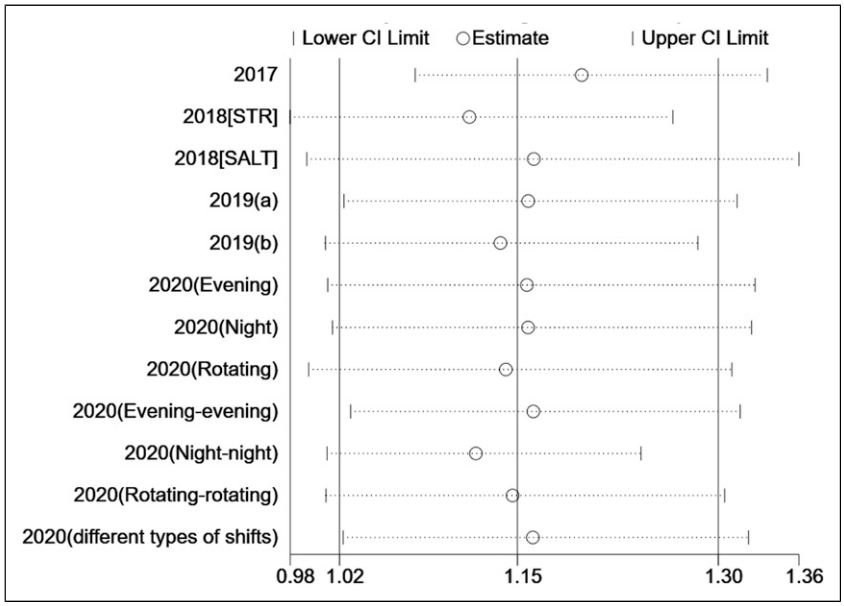

Figure 3. New overall meta-analysis effect by removing a single study at a time.

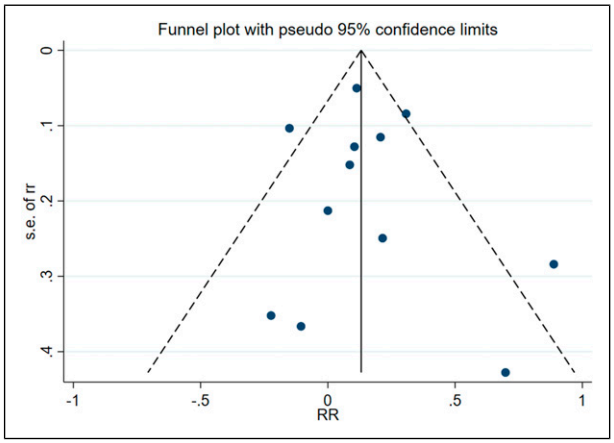

Figure 4. Funnel plot for the relative risks of dementia with shift work exposure.

summary effect estimates. The dotted lines are pseudo 95% CIs.

Subgroup Analysis of Risk of Dementia with Shift Work Exposure

The subgroup analysis yielded considerable consistency with the summarized analyses in reports using only female shift workers, population-based shift workers, shift workers with a long follow-up, cohorts of a large size, cohorts diagnosed with more dementias, evening shift workers, rotating shift workers, and the occupation of nursing (Table 2; Supplementary Figure S2).

No significant variation was shown in the risk of dementia between the 2 age-dependent subgroups. Notably, the reports on population-based shift workers displayed the significantly increased pooled risk, characterized with subgroups harboring larger size, more dementia cases and longer follow-up duration (all P < .0%). Also, the mixed schedule addressed a remarked increase of pooled risk. It was shown that occupational nurses harbored a significant yet slight increase in the risk of dementia compared to non-nurses, largely due to its relatively small size. Of note, all significantly influenced subgroups addressed considerably high heterogeneity, which could well explain the overall 52.8% heterogeneity in the present analysis.

Only Jorgensen et al stratified shift work schedules into 3 subtypes: Evenings, nights, and rotation. They also compared RRs between cross-sectional data and longitudinally continuous data to determine if the risk of dementia increased with a cumulative effect. Interestingly, it was shown that continuous evening shifts exhibited a decreased risk of dementia compared to temporary evening shift work or other schedules.[29] Moreover, a changing shift schedule presented a relatively low risk of dementia. Therefore, these findings indicate that temporary and mild impairment due to shift work might be modified and even reversed by compensatory good rest. However, continuous night shifts exhibited a significantly high risk of dementia compared to temporary night shifts or other schedules.[29,31] Taken together, long-term cumulative exhaustion due to an affected circadian rhythm could not be reserved anymore, instead exaggerating the impairment. Another notable issue is that the subgroup analysis of shift schedules was conducted merely on occupational nurses. As the majority of elderly patients are vulnerable in the early hours, stressful shifts might also contribute to an increased risk of dementia for continuous night shift nurses.

Table 2. Pooled Risk Estimation of Dementia with Shift Work Exposure, by Sub-Group.

Subgroups	Number of Reports	Pooled RR (95%)	*P*-Value	I^2
All studies	12	1.15 (1.02, 1.30)	**.016**	52.8%
Age				
<50 years	4	1.14 (.80, 1.63)	**.003**	78.6%
>50 years	8	1.15 (1.03, 1.29)	.232	24.7%
Gender				
Female	7	1.18 (1.00, 1.40)	.176	33.1%
Male	1	.86 (.70, 1.05)	—	—
Combined	4	1.22 (1.03, 1.46)	.111	50.1%
Follow-up duration				
<15 years	3	1.14 (.94, 1.38)	.329	9.9%
>15 years	9	1.15 (.98, 1.36)	**.007**	61.8%
Sample size				
<10 000	7	1.16 (.85, 1.57)	.341	11.4%
>10 000	5	1.18 (1.08, 1.28)	**.015**	62.0%
Number of cases				
<100	8	1.18 (.97, 1.45)	.144	35.6%
≥100	4	1.13 (.96, 1.34)	**.006**	75.7%
Shift schedule				
Night shifts	3	1.29 (.94, 1.77)	.026	72.7%
Evening shifts	2	1.07 (.84, 1.35)	.328	.0%
Rotating shifts	2	1.23 (1.00, 1.51)	.976	.0%
Mixed	5	1.11 (.83, 1.48)	**.006**	72.7%
Occupation				
Nurse	7	1.18 (1.00, 1.40)	.176	33.1%
Other	5	1.12 (.92, 1.37)	**.007**	71.5%

Note: *P*-value <.05 was shown bold.

Discussion

The present review comprised 80 567 participants with 3707 diagnosed dementia cases. Overall, the pooled analysis of all included studies supports the idea that shift work is associated with an increased risk of dementia (RR = 1.15, 95%CI = 1.02-1.30, P = .016). Such a mild increase in pooled 15% RRs had consistent significance in the majority of the subgroups, including in the population with a long follow-up, large sample size, and many dementia cases. One attributable reason for this is that these cohorts harbored a much larger sample size and more dementia cases. An increased risk was also shown in occupational nurses. The significance in these subgroups partially reflects the cumulative chronicity of dementia. However, some controversial results compelled us to explore the potential mechanism underlying shift work and cognitive impairments that might promote the occurrence of dementia. Thus, we conducted a systematic narrative review between shift work and cognitive impairment. A search flow diagram for risk of cognitive impairment with shift work was shown in Supplementary Figure S3. According to our findings, the 4 analyzed publications indicated that shift work significantly impairs cognitive function with a dose-dependent effect.[24,25,42,43] Moreover, an exponentially sharp trajectory could be seen when the shift work endured over 10 years.[24] However, a reverse or restoration of cognitive decline has also been found with long-term removal from shift work exposure for more than 5 years,[24,42] indicating that impairment from shift work exposure is age-dependently cumulative and could also be modified due to the long-term scenario. In another 3 publications, no significant association was shown between long-term shift work exposure and declined cognition.[15,27,28] Based on these contradictory publications, it is still inconclusive in terms of whether long shift work negatively impacts psychoneurological function from a chronic perspective.

Our meta-analysis has several strengths. This is the first meta-analysis to systematically analyze the association between the risk of dementia and shift work exposure. Moreover, all included studies had high NOS scores. All diagnosed dementia cases were identified based on the ICD system from nationwide databases.

Several caveats must be noted. First, as there is no well-accepted definition of shift work,[44] vague definitions of shift work were used. Varied schedules and/or regimens of shift work, varied intensity, and varied spans between shifts might produce a heterogenous impact on the results. Second, dementia is a clinical syndrome with a wide spectrum and heterogeneous diseases. We conducted the present meta-analysis based on the ICD root criteria without substratification. As the top 2 common dementias,[45] vascular

dementia (VaD) was shown to be closely correlated to numerous cerebrovascular pathologies, including atherosclerosis, large vascular diseases, and microvascular diseases,[46] all of which could be promoted with shift work exposure based on previous meta-analyses.[11,47-50] Therefore, an interaction effect between shift work, vascular risk, and neurological risk should be intensively estimated. Third, shift work definitely disturbs sleep, which indirectly decreases temporary cognition.[4] However, unlike long-term occupational sleep loss,[28] some types of shift work might be working 3 shifts, followed by 3 days off.[51,52] The temporary cognitive impairment related to short-term sleep disturbance could be restored or refreshed by compensatory sleep, vacation, or a long rest.[28] These findings indicate that temporary sleep disturbed by shift work is modifiable. It has also been documented that more than 5 years without shift work could reverse declined chronic cognition due to previous shift work.[24,25,42] Therefore, optimal original data should indicate the continuity of shift work exposure. Fourth, the majority of dementia cases occur in the elderly,[53,54] however, normal aging per se accelerates cognitive decline and degeneration[55,56] and is accompanied by poor sleep,[57,58] the present meta-analysis could not separately adjust the aging-dependent interactive effects within. In another cohort study, using mortality from dementia as the outcome addressed a much higher risk of dementia with shift work exposure.[40] Therefore, more interactive studies between dementia and aging due to shift work are required. Fifth, considerably high heterogeneity was shown. Sixth, numerous potential confounders, including the age at which a shift worker first engaged, individual's genetic diversity, and the adaptability of the circadian clock in response to shift work,[59] *et,al*. could not be analyzed due to data unavailability.

In conclusion, experienced shift workers had a mildly increased risk of dementia in later life based on the present meta-analysis. Given the increase in shift work in the industrialization world and the heavy care and economic burden of dementia, more awareness is required about shift worker health promotion. More cohort studies with a larger size, longer follow-up, better definitions, and optimal schedule data are required for more convincing findings.

Acknowledgments

We thank Dr. Zun-song Hu for the long-term supports on data analysis.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

ORCID iD

Yu-hong Wang https://orcid.org/0000-0002-5679-5717

Supplemental Material

Supplemental material for this article is available online.

References

1. 2020 Alzheimer's disease facts and figures. *Alzheimers dement*; 2020.
2. Global, regional, and national life expectancy, all-cause mortality, and cause-specific mortality for 249 causes of death, 1980-2015: A systematic analysis for the Global Burden of Disease Study 2015. *Lancet (London, England)*. 2016; 388(10053):1459-1544.
3. Wickwire EM, Geiger-Brown J, Scharf SM, Drake CL. Shift work and shift work sleep disorder: Clinical and organizational perspectives. *Chest*. 2017;151(5):1156-1172.
4. Akerstedt T. Shift work and disturbed sleep/wakefulness. *Sleep Med Rev*. 1998;2(2):117-128.
5. Wang XS, Armstrong ME, Cairns BJ, Key TJ, Travis RC. Shift work and chronic disease: The epidemiological evidence. *Occup Med (Oxford, England)*. 2011;61(2):78-89.
6. Dutheil F, Baker JS, Mermillod M, et al. Shift work, and particularly permanent night shifts, promote dyslipidaemia: A systematic review and meta-analysis. *Atherosclerosis*. 2020; 313:156-169.
7. Ghiasvand M, Heshmat R, Golpira R, et al. Shift working and risk of lipid disorders: A cross-sectional study. *Lipids Health Dis*. 2006;5:9.
8. Yang X, Di W, Zeng Y, et al. Association between shift work and risk of metabolic syndrome: A systematic review and meta-analysis. *Nutr Metabol Cardiovasc Dis NMCD*. 2021;31(10): 2792-2799.
9. Wang N, Sun Y, Zhang H, et al. Long-term night shift work is associated with the risk of atrial fibrillation and coronary heart disease. *Eur Heart J*. 2021;42(40):4180-4188.
10. Sallinen M, Kecklund G. Shift work, sleep, and sleepiness - differences between shift schedules and systems. *Scand J Work Environ Health*. 2010;36(2):121-133.
11. Beydoun MA, Beydoun HA, Gamaldo AA, Teel A, Zonderman AB, Wang Y. Epidemiologic studies of modifiable factors associated with cognition and dementia: Systematic review and meta-analysis. *BMC Publ Health*. 2014;14:643.
12. Kwak K, Kim BK, Jang TW, et al. Association between shift work and neurocognitive function among Firefighters in South Korea: A prospective before-after study. *Int J Environ Res Publ Health*. 2020;17(13):4647.
13. Kazemi R, Motamedzade M, Golmohammadi R, Mokarami H, Hemmatjo R, Heidarimoghadam R. Field study of effects of night shifts on cognitive performance, salivary melatonin, and sleep. *Safety and health at work*. 2018;9(2):203-209.
14. Esmaily A, Jambarsang S, Mohammadian F, Mehrparvar AH. Effect of shift work on working memory, attention and response time in nurses. *Int J Occup Saf Ergon JOSE*. 2021;28:1-6.

15. Bokenberger K, Ström P, Dahl Aslan AK, Åkerstedt T, Pedersen NL. Shift work and cognitive aging: A longitudinal study. *Scand J Work Environ Health*. 2017;43(5):485-493.
16. Gibson EM, Wang C, Tjho S, Khattar N, Kriegsfeld LJ. Experimental 'jet lag' inhibits adult neurogenesis and produces long-term cognitive deficits in female hamsters. *PLoS One*. 2010;5(12):e15267.
17. Tadinac M, Sekulić A, Hromatko I, Mazul-Sunko B, Ivancić R. Age and individual sleep characteristics affect cognitive performance in anesthesiology residents after a 24-hour shift. *Acta Clin Croat*. 2014;53(1):22-30.
18. Machi MS, Staum M, Callaway CW, et al. The relationship between shift work, sleep, and cognition in career emergency physicians. *Acad Emerg Med Official J Soc Acad Emerg Med*. 2012;19(1):85-91.
19. Ansiau D, Wild P, Niezborala M, Rouch I, Marquié JC. Effects of working conditions and sleep of the previous day on cognitive performance. *Appl Ergon*. 2008;39(1):99-106.
20. Ju YE, McLeland JS, Toedebusch CD, et al. Sleep quality and preclinical Alzheimer disease. *JAMA Neurol*. 2013;70(5): 587-593.
21. Slats D, Claassen JA, Verbeek MM, Overeem S. Reciprocal interactions between sleep, circadian rhythms and Alzheimer's disease: Focus on the role of hypocretin and melatonin. *Ageing Res Rev*. 2013;12(1):188-200.
22. Tsapanou A, Gu Y, Manly J, et al. Daytime sleepiness and sleep inadequacy as risk factors for Dementia. *Dement Geriatr Cogn Dis Extra*. 2015;5(2):286-295.
23. Ju YE, Lucey BP, Holtzman DM. Sleep and Alzheimer disease pathology–a bidirectional relationship. *Nat Rev Neurol*. 2014; 10(2):115-119.
24. Marquié JC, Tucker P, Folkard S, Gentil C, Ansiau D. Chronic effects of shift work on cognition: Findings from the VISAT longitudinal study. *Occup Environ Med*. 2015;72(4):258-264.
25. Rouch I, Wild P, Ansiau D, Marquié JC. Shiftwork experience, age and cognitive performance. *Ergonomics*. 2005;48(10): 1282-1293.
26. Hart CL, Haney M, Vosburg SK, Comer SD, Gunderson E, Foltin RW. Modafinil attenuates disruptions in cognitive performance during simulated night-shift work. *Neuropsychopharmacol Off Public Am College of Neuropsychopharmacol*. 2006;31(7):1526-1536.
27. Devore EE, Grodstein F, Schernhammer ES. Shift work and cognition in the Nurses' Health Study. *Am J Epidemiol*. 2013; 178(8):1296-1300.
28. Thomas J, Overeem S, Claassen J. Long-Term occupational sleep loss and post-retirement cognitive decline or Dementia. *Dement Geriatr Cognit Disord*. 2019;48(1-2):105-112.
29. Jørgensen JT, Hansen J, Westendorp RGJ, et al. Shift work and incidence of dementia: A Danish nurse cohort study. *Alzheimer's Dementia J of the Alzheimer's Assoc*. 2020;16(9): 1268-1279.
30. Bokenberger K, Sjolander A, Dahl Aslan AK, Karlsson IK, Akerstedt T, Pedersen NL. Shift work and risk of incident dementia: A study of two population-based cohorts. *Eur J Epidemiol*. 2018;33(10):977-987.
31. Nabe-Nielsen K, Hansen Å M, Ishtiak-Ahmed K, et al. Night shift work, long working hours and dementia: A longitudinal study of the Danish work environment cohort study. *BMJ Open*. 2019;9(5):e027027.
32. Nabe-Nielsen K, Garde AH, Ishtiak-Ahmed K, et al. Shift work, long working hours, and later risk of dementia: A long-term follow-up of the copenhagen male study. *Scand J Work Environ Health*. 2017;43(6):569-577.
33. Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLoS Med*. 2009;6(7):e1000097.
34. Stroup DF, Berlin JA, Morton SC, et al. Meta-analysis of observational studies in epidemiology: A proposal for reporting. Meta-analysis of Observational Studies in Epidemiology (MOOSE) group. *JAMA*. 2000;283(15):2008-2012.
35. Altman DG, Bland JM. Interaction revisited: The difference between two estimates. *BMJ (Clinical Research Ed)*. 2003; 326(7382):219.
36. Wallace BC, Schmid CH, Lau J, Trikalinos TA. Meta-Analyst: Software for meta-analysis of binary, continuous and diagnostic data. *BMC Med Res Methodol*. 2009;9:80.
37. Begg CB, Mazumdar M. Operating characteristics of a rank correlation test for publication bias. *Biometrics*. 1994;50(4):1088-1101.
38. Egger M, Davey Smith G, Schneider M, Minder C. Bias in meta-analysis detected by a simple, graphical test. *BMJ (Clinical Research Ed)*. 1997;315(7109):629-634.
39. Wells G. The Newcastle-Ottawa Scale (NOS) for assessing the quality of non-randomised studies in meta-analyses. Paper presented at: Symposium on Systematic Reviews: Beyond the Basics, 2014.
40. Jørgensen JT, Karlsen S, Stayner L, Hansen J, Andersen ZJ. Shift work and overall and cause-specific mortality in the Danish nurse cohort. *Scand J Work Environ Health*. 2017;43(2):117-126.
41. Higgins JP, Thompson SG. Quantifying heterogeneity in a meta-analysis. *Stat Med*. 2002;21(11):1539-1558.
42. Titova OE, Lindberg E, Elmståhl S, Lind L, Schiöth HB, Benedict C. Association between shift work history and performance on the trail making test in middle-aged and elderly humans: The EpiHealth study. *Neurobiol Aging*. 2016;45:23-29.
43. Weinmann T, Vetter C, Karch S, Nowak D, Radon K. Shift work and cognitive impairment in later life - results of a cross-sectional pilot study testing the feasibility of a large-scale epidemiologic investigation. *BMC Publ Health*. 2018; 18(1):1256.
44. Kubo T, Muramatsu K, Fujino Y, Hayashida K, Matsuda S. [International comparison of the definition of night work - promoting health care of shift workers]. *J UOEH*. 2013;35(-Suppl):163-168.
45. Santiago-Mujika E, Luthi-Carter R, Giorgini F, Kalaria RN, Mukaetova-Ladinska EB. Tubulin and tubulin posttranslational modifications in Alzheimer's Disease and vascular dementia. *Front Aging Neurosci*. 2021;13:730107.

46. Iadecola C. The pathobiology of vascular dementia. *Neuron*. 2013;80(4):844-866.
47. Vyas MV, Garg AX, Iansavichus AV, et al. Shift work and vascular events: Systematic review and meta-analysis. *BMJ (Clin Res Ed)*. 2012;345:e4800.
48. Mangialasche F, Kivipelto M, Solomon A, Fratiglioni L. Dementia prevention: Current epidemiological evidence and future perspective. *Alzheimer's Res Ther*. 2012;4(1):6.
49. Puttonen S, Härmä M, Hublin C. Shift work and cardiovascular disease - pathways from circadian stress to morbidity. *Scand J Work Environ Health*. 2010;36(2):96-108.
50. van der Hulst M. Long workhours and health. *Scand J Work Environ Health*. 2003;29(3):171-188.
51. Whitehead DC, Thomas H Jr, Slapper DR. A rational approach to shift work in emergency medicine. *Ann Emerg Med*. 1992; 21(10):1250-1258.
52. Burgess PA. Optimal shift duration and sequence: recommended approach for short-term emergency response activations for public health and emergency management. *Am J Publ Health*. 2007;97(Suppl 1):S88-S92.
53. Prince M, Bryce R, Albanese E, Wimo A, Ribeiro W, Ferri CP. The global prevalence of dementia: A systematic review and metaanalysis. *Alzheimer's Dementia J Alzheimer's Assoc*. 2013; 9(1):63-75.e62.
54. Winblad B, Amouyel P, Andrieu S, et al. Defeating Alzheimer's disease and other dementias: A priority for European science and society. *Lancet Neurol*. 2016;15(5):455-532.
55. Deary IJ, Corley J, Gow AJ, et al. Age-associated cognitive decline. *Br Med Bull*. 2009;92:135-152.
56. Petersen RC, Smith GE, Waring SC, Ivnik RJ, Kokmen E, Tangelos EG. Aging, memory, and mild cognitive impairment. *Int Psychogeriatr*. 1997;9(Suppl 1):65-69.
57. Espiritu JR. Aging-related sleep changes. *Clin Geriatr Med*. 2008;24(1):1-14, v.
58. Morin CM, Gramling SE. Sleep patterns and aging: Comparison of older adults with and without insomnia complaints. *Psychol Aging*. 1989;4(3):290-294.
59. Knutson KL, von Schantz M. Associations between chronotype, morbidity and mortality in the UK Biobank cohort. *Chronobiol Int*. 2018;35(8):1045-1053.